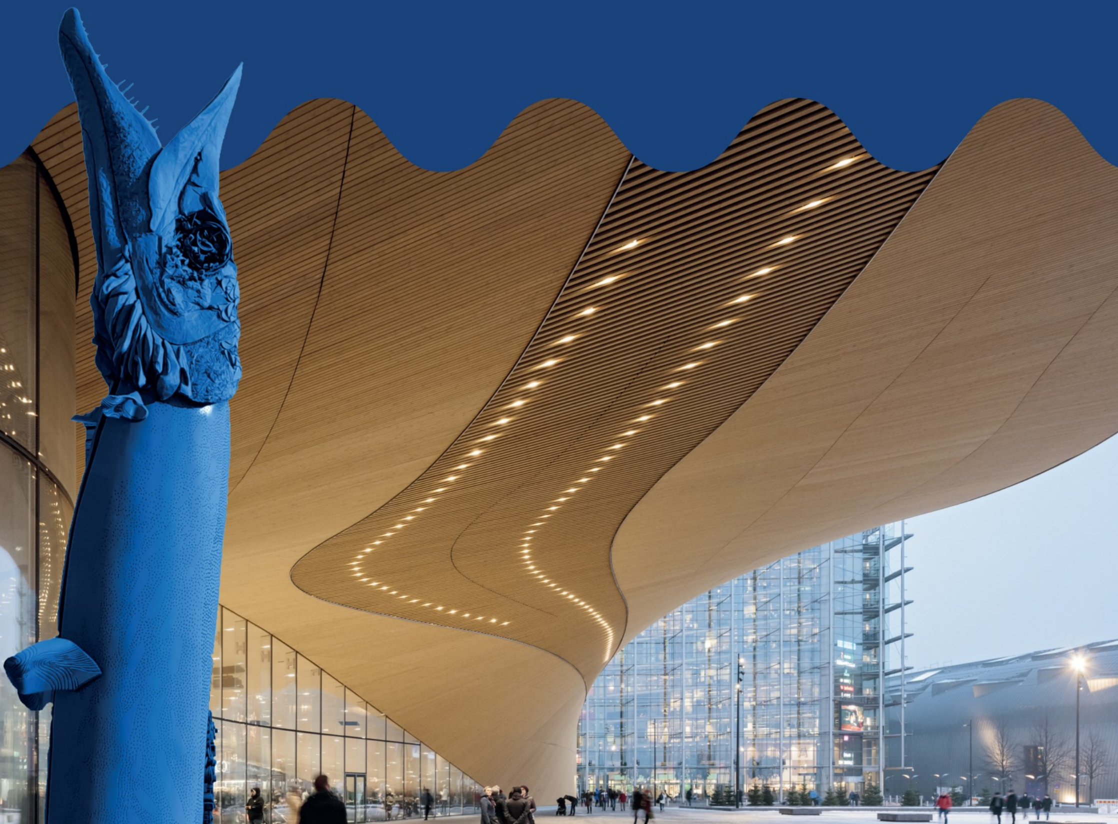
THE NEUROSCIENCES AND MUSIC | VIII

Wiring, re-wiring, and well-being

13-16 June 2024

HELSINKI | FINLAND
& online



ISO 9001
BUREAU VERITAS
Certification

Child neurology. Just ahead

THE NEUROSCIENCES AND MUSIC | VIII

Wiring, re-wiring, and well-being

Helsinki | Finland & online

13-16 June 2024

In partnership with

In collaboration with

PROMOTION PARTNERS

Australian Music & Psychology Society

Brams

International Laboratory for Brain, Music, and Sound Research

European Society for the Cognitive Sciences Of Music

IAMM

INTERNATIONAL ASSOCIATION FOR MUSIC & MEDICINE

www.iammonline.com

music perception

Organization for Human Brain Mapping

Advancing Understanding of the Human Brain

sempre:

Society for Education, Music and Psychology Research

SMPC

Society for Music Perception and Cognition

World Federation of Music Therapy

SPONSORS AND GRANTS

BRAIN PRODUCTS
Solutions for neurophysiological research

MED-EL

NEUROPLAY

SENTINA

VIE

Thanks for the generous support

SUOMEN KULTTUURIRAHASTO

Finnish Cultural Foundation

SIGNE & ANE GYLLENBERG FOUNDATION

JENNY AND ANTTI WIHURI FOUNDATION

SCIENTIFIC COMMITTEE

Mari Tervaniemi, Helsinki
Eckart Altenmüller, Hanover
Giuliano Avanzini, Milan
Elvira Brattico, Bari / Aarhus
Shinichi Furuya, Tokyo
Stefan Koelsch, Bergen
Nina Kraus, Chicago
Katie Overy, Edinburgh
Aniruddh Patel, Boston
Virginia Penhune, Montreal
Gottfried Schlaug, Worcester
Barbara Tillmann, Lyon
Peter Vuust, Aarhus

SCIENTIFIC ADVISORS

Isabelle Peretz
Robert Zatorre

SCIENTIFIC COORDINATOR

Luisa Lopez, Viterbo / Rome

HOSTING COMMITTEE

University of Helsinki
Mari Tervaniemi
(conference director)
Teppo Särkämö
(conference co-director)
Sara Miyabe (local coordinator)
Minna Huotilainen
Tanja Linnavalli
Aleksi Sihvonen
Paula Virtala

University of the Arts Helsinki / Sibelius Academy
Juha Ojala

University of Jyväskylä
Petri Toiviainen
Esa Ala-Ruona

University of Turku
Vesa Putkinen

ORGANIZATION AND ADMINISTRATION

Fondazione Pierfranco e Luisa Mariani
Viale Bianca Maria, 28
20129 Milan, Italy
Tel: +39 02 795458
neuromusic@fondazione-mariani.org
www.fondazione-mariani.org

Vice-president and Neuromusic director
Maria Majno

Meeting coordinator
Samuele Spinelli

Speakers' information
Renata Brizzi

Enrolments and administration
Cristina Giovanola
Marina Antonioli

Posters
Anna Illari

Social program
Lucia Confalonieri

CONTACTS

The *staff of the Mariani Foundation* is available for Speakers and Participants from 12 June 2024 on the Italian mobile telephone +39 340 6454 612

Local coordinator
University of Helsinki
Finnish mobile telephone
+358 (0) 29415 7764

Volunteers will be available for assistance, wearing navy blue special T-shirts during the conference hours.

The Mariani Foundation for Paediatric Neurology and the Centre of Excellence in Music, Mind, Body and Brain (MMBB), University of Helsinki, welcome you to **The Neurosciences and Music | VIII** congress.

The eight edition of this established series again gathers the main experts of music neuroscience from all over the world for the premier event in the field.

The focus theme of the congress is **Wiring, Re-wiring, and Well-being**. This theme reflects the unique capacity of music to build connections, both between persons and within the brain, to facilitate the learning and re-learning of skills in the healthy and injured brain, and to foster development and well-being in daily life and in educational and rehabilitative settings.

This booklet provides an essential version of the program for ease of reference.

For the full program with all abstracts and the full list of posters please scan the QR code below

For more information please refer to www.neuromusic.org

PROGRAM

DAY 1
Thursday, 13 June 2024

Great Hall
University of Helsinki
Main building
Unioninkatu 34, Helsinki

13.00-14.30
Registration

14.30-14.35
Opening of conference

14.35-15.50
WORKSHOP 1
(onsite & online)
OPPORTUNITIES AND APPLICATIONS FOR MUSIC RESEARCH IN THE ERA OF PERSONALIZED MEDICINE
Organizers:
Matt McCrary
Hanover Medical School, Germany
Clara E. James
University of Applied Sciences and Arts, Switzerland
Damien Marie
University of Geneva, Switzerland
Eckart Altenmüller
Hanover University of Music, Drama and Media, Germany
André Lee
Hanover University of Music, Drama and Media, Germany

15.50-16.20
Coffee break

16.20-16.30
Musical interlude 1
Russ Palmer: Deafblind Blues

16.30-17.45
WORKSHOP 2
(onsite & online)
A SONG FOR THE ELECTRIC EAR – DEVELOPING MUSIC APPRECIATION AND PERCEPTION AFTER COCHLEAR IMPLANTATION
Organizers:
Bjørn Petersen
Aarhus University & Royal Academy of Music, Aarhus, Denmark
Li Xu
Ohio University, Athens, USA
Ritva Torppa
University of Helsinki, Finland
Jeremy Marozeau
Technical University of Denmark

16.30-17.45
WORKSHOP 3
(onsite only for max. 30 persons)
WIRING BY SYNCHRONY: WHEN DALCROZE MEETS NEUROSCIENCE
Organizers:
Daniele Schön
CNRS, Inserm & Aix-Marseille University, France
Marja-Leena Juntunen
Sibelius Academy, University of the Arts Helsinki, Finland

17.45-19.30
WELCOME RECEPTION

17.45-18.00
Welcome by University of Helsinki, Mariani Foundation & Hosting Committee

18.00-18.15
Musical performance

18.15-19.30
Snacks & drinks

DAY 2
Friday, 14 June 2024
Scandic Marina Congress Center
Katajanokanlaituri 6, Helsinki

08.00-09.00
Registration

09.00-09.15
Official welcome

09.15-10.30
SYMPOSIUM 1
EXTRAORDINARY VARIATIONS OF SINGING: FROM WIRING TO RE-WIRING, AND WELL-BEING
Chair: Isabelle Peretz

Characterising singing phenotypes to identify genetic variants and the role of environmental factors in shaping the development of singing ability
Sarah Wilson
University of Melbourne, Australia

Neural architectures and adaptive processes underlying singing: A multi-level inquiry
Boris Kleber
Aarhus University, Denmark

Group and solo singing effects on well-being
Dawn Merrett
University of Montreal, Canada

Neural basis of the preservation of singing and song learning in aphasia
Teppo Särkämö
University of Helsinki, Finland

10.30-10.40
Short transition break

10.40-11.55
SYMPOSIUM 2
EFFICACY AND NEURAL MECHANISMS OF SINGING IN AGEING AND NEUROLOGICAL REHABILITATION
Chair: Aleksi Sihvonen

Can amateur singing modify cognitive ageing trajectories?
Pascale Tremblay
Université Laval, Canada

Vocal music listening and group singing as neural rehabilitation tools for stroke and aphasia
Aleksi Sihvonen
University of Helsinki, Finland

ParkinSong: Therapeutic singing interventions to address communication impairments in Parkinson's disease
Jeanette Tamplin
University of Melbourne, Australia

Lasting effects of recreational group singing on depressive symptoms in elderly care home residents: The multinational MIDDEL trial
Christian Gold
NORCE Norwegian Research Centre AS & University of Bergen, Norway;
University of Vienna, Austria

11.50-13.10
Lunch

13.10-13.25
Musical interlude 2
Helsinki Aphasia Choir

13.25-14.10

KEYNOTE LECTURE

The health benefits of arts & cultural engagement: Zooming from psychobiological mechanisms to population-level effects

Daisy Fancourt

University College London, UK

14.10-14.15

Short transition break

14.15-15.00

BEST POSTER TALKS 1

For details please refer to the full program

Unravelling the brain mechanisms of earworm experiences

Laura Muntaner Marcé et al.

Barcelona, Spain

Examining the effects of a closed-loop nostalgia brain-music interface for well-being and memory retrieval in both young and elderly people

Yuna Sakakibara et al.

Tokyo, Japan

Enriched music-supported therapy for individuals with chronic stroke: A randomized controlled trial

Emma Segura et al.

Barcelona, Spain

Genome-wide variation associated with active music engagement in mid- to late-life is positively correlated with resilience to mental illness

Tara Lynn Henechowicz et al.

Toronto, Canada

15.00-15.30

Coffee break

15.30-17.00

Poster session 1 (online)

Web-conferencing space Gather.town

17.00-18:15

SYMPOSIUM 3

MUSIC FOR PAIN: TOWARDS A MECHANISTIC UNDERSTANDING

Chair: Joke Bradt

Increasing the therapeutic effects of music: Novel insights into pain reduction and emotional valence

Stefan Koelsch

University of Bergen, Norway

Examining the impact of the emotional impact of music on pain perception

Mathieu Roy

McGill University, Canada

What are the macroscopic circuits involved in music-induced analgesia?

Eduardo Garza-Villarreal

Universidad Nacional Autónoma de México

Music therapy for chronic pain management in people with advanced cancer: A mechanistic clinical trial

Joke Bradt

Drexel University, USA

19.30-22.00

EVENING AT HELSINKI MUSIC CENTRE (MUSIIKKITALO)

Mannerheimintie 13 A, Helsinki

19.30-21.30

Musical performance

Black Box

Resonaarigroup

20.30-22.00

Light buffet & drinks

DAY 3

Saturday, 15 June 2024

Scandic Marina Congress Center

09.00-10.15

SYMPOSIUM 4

RHYTHM, MUSIC AND SPEECH PROCESSING IN THE INFANT BRAIN: FROM THE INVESTIGATION OF INITIAL WIRING TO PERSPECTIVES FOR REWIRING

Chairs: Barbara Tillmann & Paula Virtala

Rhythm processing: Development of neural coding during the third trimester of gestation

Sahar Moghimi

INSERM & Université de Picardie Jules Verne, France

Rhythm processing and language acquisition: A temporal sampling perspective

Usha Goswami

University of Cambridge, UK

Enhanced neural representation of speech fundamental frequency in neonates exposed to music before birth

Jordi Costa-Faidella

University of Barcelona, Spain

Effects of a music listening intervention on neural speech sound processing in dyslexia-risk infants

Paula Virtala

University of Helsinki, Finland

10.15-11.45

Poster session 2 (onsite)

11.45-13.00
Lunch

13.00-13.15
Musical interlude 3
Anna-Karin Korhonen

13.15-14.30
SYMPOSIUM 5
WIRING AND RE-WIRING THE BRAIN USING RHYTHM TRAINING
Chairs: Simone Dalla Bella & Jessica Grahn

The promise of rhythmic auditory-motor training for children with developmental coordination disorder (DCD): Let's dance!
Laurel Trainor & Chantal Carrillo
McMaster Institute for Music and the Mind & McMaster University, Canada

Rhythmic capacities and stuttering: Potential of rhythm training for children who stutter
Simone Falk
University of Montreal, Canada

Rhythm processing in schizophrenia patients and in-ear EEG neurofeedback technologies to (re)wire the brain
Shinya Fujii
Keio University & Vie Style Inc., Japan

Wired for sound: Illuminating mechanisms of music on movement
Jessica Grahn
Western University, Canada

14.30-14.40
Short transition break

14.40-15.55
SYMPOSIUM 6
MUSIC IMPROVISATION AS A TOOL TOWARDS UNDERSTANDING THE BEHAVIOR AND BRAIN PROCESSING OF HUMAN CREATIVITY
Chair: Psyche Loui

Structural regularities of extant improvisations reveal cognitive constraints and motor associations
Martin Norgaard
Georgia State University, USA

The dynamical wiring and rewiring of the improvising brain
Peter Vuust
Aarhus University, Denmark

From improvisation to the perception of creativity: Time-sensitive models and equitable predictions
Psyche Loui
Northeastern University, USA

Reward and motor neurophysiological correlates of live music improvisation
Anna Palumbo
New York University, USA

15.55-16.25
Coffee break

16.25-17.10

BEST POSTER TALKS 2

For details please refer to the full program

Development of neural encoding and spontaneous movements to music over the first year of life
Trinh Nguyen et al.
Rome, Italy
Vienna, Austria

Predictive coding in natural music: Time-resolved modeling of expectations in polyphonic music
Paul Robert et al.
Marseille, France

Understanding embodied cognitive mechanisms of music based on brain predictive processing
Tatsuya Daikoku
Tokyo, Japan
Cambridge, UK

The 12-year AMseL-Study: influence of neuroanatomical disposition, natural development and musical training-induced plasticity on the human auditory system from childhood to adulthood
Peter Schneider et al.
Graz, Austria

17.10-17.25

Musical interlude 4

Elisa Seppänen

17.30-18.45

SYMPOSIUM 7
THE PLEASURABLE URGE TO MOVE TO MUSIC: SEARCHING FOR NEURAL MECHANISMS AND DEVELOPMENTAL ORIGINS

Chair: Maria Witek

Quenching the Groove: The Effects of SMA cTBS on the Pleasurable Urge to Move to Music
Connor Spiech
Concordia University, Canada

Assessing the development of the syncopation-groove relationship in infants and children
Daniel Cameron
McMaster University, Canada

The pleasurable urge to move to music: searching for neural mechanisms and developmental origins
Erin Hannon
University of Nevada, USA

Predictive processes shape the effects of age and Parkinson's on the relation between syncopation and the urge to move to music
Tomas Matthew
Aarhus University, Denmark

20.00-23.00

Dinner at Restaurant Sipuli

Kanavaranta 7, Helsinki
by previous enrolment

DAY 4

Sunday, 16 June 2024

Scandic Marina Congress Center

09.00-10.15

SYMPOSIUM 8

MUSIC, MEMORY, AND IMAGINATION IN THE BRAIN: INSIGHTS FROM MULTI-MODAL NEUROPHYSIOLOGY

Chair: Elvira Brattico

Electrophysiological correlates of auditory regularity expectations and violations at short and long temporal scales: Studies in intracranial EEG and prefrontal cortex lesion patients
Alejandro Blenkmann
University of Oslo, Norway

Cross-frequency coupling and replay as markers of working memory functions in humans
Philippe Albouy
Université Laval, Canada

The neural representation of imagined melodies
David Quiroga Martinez
University of California, USA

Multi-scale neurophysiology of musical recognition: Network hierarchies and perspectives on aging
Leonardo Bonetti
Aarhus University, Denmark

10.15-11.45
Poster session 3

11.45-13.00
Lunch

13.00-13.15
Musical interlude 5
Verna Kylmänen

13.15-14.30

SYMPOSIUM 9

PERSPECTIVES ON THE MATURATION OF AUDITORY, COGNITIVE AND EXECUTIVE SKILLS ASSOCIATED WITH MUSIC TRAINING DURING CHILDHOOD: CONSENSUS AND UNRESOLVED QUESTIONS

Chair: Assal Habibi

Longitudinal changes in attention during infant-directed singing in autistic and non-autistic infants: Considerations for intervention mechanisms
Miriam Lense
Vanderbilt University Medical Center, USA

Inhibition mediates the influence of music training on IQ in 5- to 7-year-old children
Franziska Degé
Max Planck Institute for Empirical Aesthetics, Germany

Do behavioral advantages diminish while neural differences persist? Longitudinal studies on executive functions in musically trained and untrained children and adolescents
Vesa Putkinen & Katri Saarikivi
University of Helsinki, Finland

The Brain's Crescendo: How music training enriches child neurocognitive development. Evidence from Longitudinal and Cross-Sectional Studies
Assal Habibi
University of Southern California, USA

14.30-14.40
Short transition break

14.40-15:25
BEST POSTER TALKS 3
For details please refer to the full program

Enhancement of temporal processing via transcutaneous vagus nerve stimulation
Mehrdad Bahadori et al.
(online video)
Montreal, Canada

Musical biofeedback paradigms to promote high-intensity gait training
Prithvi Kantan et al.
Copenhagen, Denmark

Capturing rhythm categorisation in the human brain across cortical and subcortical auditory signals
Francesca Barbero et al.
Leuven, Belgium

Listening while playing the organ: How auditory-motor integration may influence the frequency following response
Isabelle Arseneau-Bruneau et al.
Montreal, Canada

15.25-15.55
Coffee break

15.55-17.10
SYMPOSIUM 10
MUSIC-RELATED NEUROPLASTICITY OVER THE LIFESPAN: LONGITUDINAL STUDIES
Chair: Rebecca Schaefer

How music alters brain plasticity: A longitudinal twin study on sensorimotor synchronization and brain developmental patterns
Lara Wierenga
Leiden University,
The Netherlands

Healthy aging with music: Practicing piano to promote brain plasticity and quality of life in older adults
Florian Worschech
Hanover University of Music, Drama and Media, Germany

Musically embedded motor learning and brain plasticity over the life span
Rebecca Schaefer
Leiden University,
The Netherlands

Plasticity of beta and gamma-band neuromagnetic oscillations of the sensorimotor systems in chronic stroke: Comparison between music-supported therapy and manual training
Takako Fujioka
Stanford University, USA

17.10-17.15
Short transition break

17.15-17.45
CLOSING SESSION
Awards
Announcements

19.30-00.00
Closing party at Bar Loose
Annankatu 21, Helsinki

ABSTRACTS

Workshop 1

OPPORTUNITIES AND APPLICATIONS FOR MUSIC RESEARCH IN THE ERA OF PERSONALIZED MEDICINE

Organizers:
Matt McCrary
Institute of Human Genetics, Hannover Medical School, Hannover, Germany
Clara E. James
University of Applied Sciences and Arts, Western Switzerland School of Health Sciences Geneva & University of Geneva, Switzerland
Hugo Willerval
University of Applied Sciences and Arts Western Switzerland – Geneva, Switzerland
Damien Marie
CIBM Center for Biomedical Imaging, University of Geneva, Switzerland
André Lee & Eckart Altenmüller
Institute of Music Physiology and Musicians' Medicine
University of Music, Drama and Media
Hannover, Germany

The development and implementation of personalized medicine is increasingly the subject of international attention and investment, integrating behavioral, phenotypic and genotypic data to broadly deliver targeted preventive programs, precision diagnostics, and 'the right treatment for the right patient at the right time'. This shift towards an individualized, N of 1 approach leverages the synthesis and use of 'big data' and presents opportunities to significantly advance both music research and its clinical and public health applications. Specifically, 'real world' datasets promise to provide a means of comprehensively considering and controlling for presently limiting individual variability in responses to music engagement. The prospective benefits are more reliable clinical and public health and clinical outcomes and novel, reproducible research insights. Anticipated research gains relate to both the impact and mechanisms of music's effects on health/wellbeing and the mediating role of genetic and environmental factors on musical contributions to development and neuroplasticity (i.e. 'wiring' and 're-wiring'). This workshop symposium aims to demonstrate the possibilities through three 'use cases' from ongoing work: 1) applying commercial wearables to capture individual psycho-physiologic responses to music engagement in natural settings; 2) music practice interventions with well-adapted instruments (tongue drums), compared to psychomotor training, to promote neuroprotection, and enhance functioning of patients with Mild Cognitive Impairment (MCI); and 3) personalized approaches to dystonia and pain management in expert musicians, demonstrating videos and a decision tree for individualized therapeutic decisions in the above mentioned conditions.

WORKSHOP 2

(onsite & online)

A SONG FOR THE ELECTRIC EAR – DEVELOPING MUSIC APPRECIATION AND PERCEPTION AFTER COCHLEAR IMPLANTATION

Organizers:

Bjørn Petersen
Aarhus University & Royal Academy of Music, Aarhus, Denmark
Li Xu
Ohio University, Athens, USA
Ritva Torppa
University of Helsinki, Finland
Jeremy Marozeau
Technical University of Denmark

Music depends on the ear to translate acoustic waves into neural signals for the brain. Sadly, for some people, this bridge is damaged, and they need to rely on hearing devices like cochlear implants to regain a sense of hearing. Yet, unlike glasses that can restore clear vision, cochlear implants convey a significantly altered signal to the brain. Adapting to this requires significant rewiring, especially when deciphering complex musical notes.
This symposium will present behavioral and neurological evidence on how the plastic auditory system of children adapts to musical and speech sounds delivered via cochlear implants. We will explore how informal singing and rigorous singing training may contribute to this adaptation process. We will then discuss the transfer effects of singing and music interventions on the speech and language skills of children with CIs, potentially enhancing their overall well-being.
The next presentation will examine the perceptual dimensions through which adult cochlear implant users appreciate music and explores how technological advancements may enable the creation of music tailored to their unique auditory perceptions. Lastly, we will share new evidence of early and long-term neural adaptation to CIs, highlighting enhanced music discrimination abilities and beat synchronization.
This symposium features a panel of internationally renowned experts in the field of music perception in cochlear implant users, encompassing diverse approaches from neuroscience and engineering to music training."

WORKSHOP 3

(onsite only for max. 30 persons)

WIRING BY SYNCHRONY: WHEN DALCROZE MEETS NEUROSCIENCE

Organizers:

Daniele Schön
CNRS, Inserm & Aix-Marseille University, France

Marja-Leena Juntunen
Sibelius Academy, University of the Arts Helsinki, Finland

The aim of this workshop is to raise the neuroscience community awareness of the pedagogical approach of music education developed by Émile Jacques-Dalcroze.

At the heart of this approach is the idea of musical learning as based on embodied experience. Exercises involving listening, whole-body movement, use of voice, and improvisation aim to deepen musical experience and understanding and improve musical expression skills.

More than a century ago, Jaques-Dalcroze had many intuitions that have been confirmed much later by cognitive science and neuroscientific research. For instance, the belief that it is impossible to conceive a rhythm without thinking of the body in motion was later confirmed by neuroscientific studies showing that listening to musical rhythms activates the motor cortex.

In practice we will propose a 30 minute Dalcroze session, focusing on responding to music through movement and tuning into each other through kinaesthetic listening.

The session will be conducted by Marja-Leena Juntunen who is an internationally reknown Dalcroze pedagogue. Then, we will have an open discussion moderated by Daniele Schön on the Dalcroze exercises in terms of cognitive processes (20 minutes). Finally, if time allows, we will briefly describe how this approach can be adapted to non-musician primary-school teachers.

The more specific aims of this workshop are :

1. To suggest that neuroscientific ideas and research can be possibly inspired by music education practices
2. To suggest that neuroscience can in turn explain why some pedagogical choices are more efficient than others
3. To illustrate the importance of body and rhythm in music education
4. To demonstrate how music-movement integration may increase social bonding and interpersonal understanding.

The activities will consist in

- A 30 minutes Dalcroze session conducted by Marja-Leena Juntunen who is an internationally reknown Dalcroze pedagogue. During this session participants will move to music (live played on a piano by ML Juntunen) as well as to each other through expressive kinaesthetic « listening ».
- An open discussion chaired by Daniele Schön on the Dalcroze exercises in terms of cognitive processes (20 minutes).
- A short description on how this approach can be adapted to non-musician primary-school teachers (this has been done in Marseille on a large scale project involving 10 primary schools and 100 school teachers).

SYMPOSIUM 1

EXTRAORDINARY VARIATIONS OF SINGING: FROM WIRING TO RE-WIRING AND WELL-BEING

Chair: Isabelle Peretz
Speakers: Sarah Wilson, Boris Kleber, Dawn Merrett, Teppo Särkämö

This symposium aims to explore human singing behaviour across the spectrum of ability, from exceptional singers to everyday singers and poor pitch singers, along with amusia and the preservation of singing in neurological disorders. Aligned with the conference theme, the talks will first present state-of-the-art knowledge of the genetics and neurobiology of singing, identifying ways to identify phenotypes of singing ability and factors crucial to its early development, considered through the lens of gene-environment interactions. How the wiring of the singing network varies across the spectrum of ability will also be examined, interrogating the role of training in re-wiring key pathways pertinent to enhanced interoceptive awareness and singing skill. The presentations will then turn to the broader benefits of singing for our emotional and social wellbeing, taking account of the impact of solo and group singing on our physiology, hormonal functioning, and sense of social connectedness. Ways in which the benefits of singing can be harnessed in clinical practice will be considered, along with the wiring that accounts for its preservation and training-induced learning in the context of left hemisphere stroke and aphasia.
By taking a systems neuroscience approach to singing and mapping molecular, neurobiological, behavioural, social and clinical findings, this symposium will provide a comprehensive overview of our current understanding of extraordinary variations in the universal human ability to sing.

Characterising singing phenotypes to identify genetic variants and the role of environmental factors in shaping the development of singing ability.

Sarah Wilson
Melbourne School of Psychological Sciences,
The University of Melbourne,
Australia

Background: Little is known about genetic variants underlying the spectrum of human singing ability and their interactions with environmental factors in shaping expression of this skill. Identification of variants has been hampered by a paucity of studies and inadequate phenotyping, with over-reliance on self-reported singing activities and few objective singing measures. This talk presents the findings of a series of studies designed to address these issues and advance discovery of genetic variants of singing ability.
Method: A range of methods were used, including (i) systematic review of

behavioural and molecular genetic music studies, (ii) bivariate and structural equation modelling (SEM) in a sample of Australian twins, and (iii) deep phenotyping of large families with many exceptional and poor pitch singers.
Results: The review developed six basic criteria for identifying robust phenotypes, and supported the use of an objective singing phenotypic index (SPI). Using this index, twin modelling showed significant heritability of singing ability, with a strong genetic correlation between the SPI and self-reported singing ability. The shared environment showed a similar significant effect, with SEM indicating early childhood singing with family is a stronger predictor of ability than vocal training or current singing with family. Molecular analyses are underway in a number of families to identify genes of large effect.
Conclusions: Combined, these findings highlight the importance of robust phenotypes for uncovering the molecular genetic basis of singing ability, and point to an early sensitive period for its development that is equally influenced by the familial environment.

Neural architectures and adaptive processes underlying singing: A multi-level inquiry

Boris Kleber
Music in the Brain
Aarhus University, Denmark

Background: Human singing behaviour exhibits remarkable variations, rooted in complex interactions between genetic factors and experience-dependent neural plasticity. This talk aims to provide an integrated perspective on the neurobiology of singing, spanning structural brain differences, functional auditory-motor interactions, and meta-analytic findings on singing expertise.
Method: Focusing on neural differences associated with variations in human singing skills, four interrelated studies are presented: (1) Structural MRI exploring corpus callosum thickness, (2) Fixel-based analyses of diffusion data evaluating white matter pathways connecting dorsal and ventral larynx/phonation cortices, (3) fMRI employing a pitch-shifting paradigm to probe auditory-motor interactions, and (4) the first Activation Likelihood Estimation (ALE) meta-analysis concentrating on singing expertise.
Results: The first study reveals significant negative correlations between the age of first singing lessons and corpus callosum thickness in various sub-regions. The second identifies enhanced dorsal-ventral larynx/phonation cortex connectivity in more trained individuals. The third uncovers differential

functional activation patterns within the auditory-motor network, with unique contributions from professionals suggesting a role for enhanced interoception. The meta-analysis in the fourth study offers an overarching view, demonstrating a distinct neural network for singing expertise that both parallels and diverges from speech production.
Conclusions: These findings collectively illustrate the neural architectures and adaptability underlying singing ability. By integrating these multi-level insights, this talk advances our understanding of how both contribute to variations in singing skills and their broader implications for well-being and rehabilitation.

Group and solo singing effects on well-being

Dawn Merrett
Department of Psychology, International Laboratory for Brain, Music and Sound Research (BRAMS), University of Montreal; Canada

Background: The use of singing-based interventions for rehabilitation as well as choir participation for health and well -being across diverse populations has increased in recent years. However, the mechanisms by which singing impacts the brain, body, and behaviour have not yet been well-elucidated. This project focuses on putative mediators of the well-being effects of singing in different contexts (alone vs in a group), including expectations, motivation, perceived competence, group bonding, synchrony, and cardiovascular physiology.
Method: After assessing their beliefs about the benefits of singing for well-being, participants completed four weekly singing sessions (40 min each) either alone or in consistent (same each week) or unique (different each week) small groups. Before and after each session, self-report and objective measures of mood and salivary cortisol samples were obtained, in addition to measures of group belonging, motivation, and perceived competence after each session. Behavioural and physiological data recorded throughout include (i) audio recordings to assess vocal synchrony, (ii) accelerometers to assess movement synchrony, and (iii) physiological sensors to obtain simultaneous electrocardiograms (heart rate variability) and respiration.
Results: New tools for measuring multi-subject physiology (BRAMS Bio Box) and mood (FaceReaderTM) allow us to compare the impact of singing alone or in a group on objective well-being outcomes.
Conclusions: The findings will provide novel insights into the role of the singing context and the contributions of potential mediating variables and mechanisms of action to the well-being effects attributed to singing, which will assist in the optimization of singing-based interventions.

Neural basis of the preservation of singing and song learning in aphasia

Teppo Särkämö
Cognitive Brain Research Unit, Department Psychology and Logopedics & Centre of Excellence in Music, Mind, Body and Brain
University of Helsinki, Finland

Background: Aphasia is a common and highly debilitating disorder in stroke survivors. While persons with aphasia (PWA) struggle to produce fluent speech, their ability to produce words through singing can often be preserved. Although the preservation of singing in PWA was first documented in the 18th century, its neural basis has been explored only recently using modern neuroimaging methods.

Method: We combined multivariate lesion-symptom mapping, voxel-based morphometry and structural connectometry analyses to map the brain regions and white matter pathways associated with spontaneous speech and singing production and spoken and sung word repetition in 45 PWA at the chronic stage. The learning of novel song lyrics was also explored using fMRI before and after a 16-week training period.

Results: Whereas speech production was linked to multiple left frontal, temporal and parietal areas and both dorsal and ventral streams of the language network, the sung production of words was associated primarily with left superior and middle temporal gyri (STG/MTG) areas and the left ventral stream. After training, PWA showed enhanced production of the trained song lyrics, coupled with increased activation in the right STG. Analyses of the acoustic features of PWA singing and their neural correlates are currently ongoing.

Conclusions: These novel findings provide evidence that speech and singing share core neuronal circuitry within the left hemisphere, while distinct temporal region and ventral stream contributions underlie the preservation of singing in aphasia. Notably, the ability to learn novel sung verbal material seems to be preserved in the aphasic brain.

SYMPOSIUM 2

EFFICACY AND NEURAL MECHANISMS OF SINGING IN AGEING AND NEUROLOGICAL REHABILITATION

Chair: Aleksi Sihvonen
Speakers: Pascale Tremblay, Aleksi Sihvonen, Jeanette Tamplin, Christian Gold

With the rapid ageing of the population, the burden of ageing-related neurological and neurodegenerative diseases, such as stroke, Parkinson's disease, and Alzheimer's disease, is growing alarmingly, and effective tools are urgently needed to support healthy ageing and rehabilitation and slow down neurodegeneration. During recent years, there have been major advances in uncovering the power of singing as a viable and versatile tool to enhance auditory, vocal-motor, verbal, cognitive, and socioemotional well-being as well as brain structure and function in ageing.
Aligned closely with the conference theme, this symposium will explore singing in ageing both from the perspective of neuroplasticity and well-being. The symposium will feature four talks focusing on (i) how amateur singing can modify cognitive ageing trajectories and brain structure and function in healthy older adults, (ii) how vocal music listening and group singing can enhance cognitive, verbal and socioemotional recovery and induce both structural and functional neuroplasticity in persons with stroke and aphasia, (iii) how therapeutic singing interventions can enhance vocal-motor functions in persons with Parkinson's disease, and (iii) how group singing interventions can alleviate depression and neuropsychiatric symptoms and improve quality of life in persons with dementia.
This symposium will explore the neuroscience and clinical aspects of singing, examining its effectiveness and underlying neural mechanisms in healthy aging as well as in major aging-related brain disorders. By providing a detailed overview, this symposium aims to enhance our current understanding of the therapeutic benefits of singing and its role as a rehabilitation tool.

Can amateur singing modify cognitive aging trajectories?

Pascale Tremblay
Université Laval, Centre de recherche CERVO, Quebec, Canada

Background. Normal aging is associated with changes in brain structure and function that lead to cognitive and communicative decline that can affect social participation and quality of life. At the same time, the adult brain retains a remarkable capacity to modify its organization throughout the lifespan, as a correlate of skill acquisition, a phenomenon known as experience-dependent brain plasticity. Recent work suggests that different non-pharmacological approaches such as singing can reduce age-related cognitive and communication difficulties. Yet, little is known about how these two antagonistic forces, senescence and experience, can have a transformative effect on the mature human brain.

Methods. Across several studies, we recruited hundreds of healthy older adults with or without amateur singing experience. We measured their articulation, hearing, speech perception, phonological working memory, lexical access, and several components of "auditory cognition," such as sustained attention. We also measured brain aging using structural and functional magnetic resonance imaging.

Results. Our results show that amateur singers and non-singers differ at multiple levels. Behaviourally, we found dose-dependent singing benefits on speech perception in noise, as well as better articulation in challenging contexts, and better auditory conflict-resolution capacities. Analysis of MRI data revealed important structural differences in the grey and white matter of the arcuate fasciculus, as well as higher resting-state connectivity in the default mode network of singers compared to non-singers.

Conclusion. Our work suggests that amateur singing may be beneficial to older adults, but additional work is needed to understand the neurobiological mechanisms involved as well as dosage effects.

Vocal music listening and group singing as neural rehabilitation tools for stroke and aphasia

Aleksi Sihvonen
University of Helsinki, Department of Psychology and Logopedics, Cognitive Brain Research Unit & Helsinki University Hospital, Department of Neurology
Helsinki, Finland

Background: Previous studies suggest that daily music listening and singing can aid stroke recovery, but little is known about the specific effects of vocal music listening and choir singing after stroke, particularly in aphasia. We sought to determine if vocal music listening and group-based singing can improve cognitive and language recovery and neuroplasticity after stroke.

Methods: Two randomized controlled trials we carried out comparing the efficacy of (i) daily listening of vocal music to instrumental music and audiobooks in early post-stroke stage (N=83) and (ii) 4-month group singing intervention to standard care in chronic aphasia (N=54) using neuropsychological and language tests as well as s/fMRI evaluating neuroplasticity changes in grey matter volume (GMV), structural connectivity (SC) and functional connectivity (FC).

Results: Compared to instrumental music or audiobooks, vocal music listening enhanced the recovery of verbal memory and language skills, especially in aphasic patients. Vocal music also increased GMV in left temporal areas, SC in bilateral dorsal, ventral and frontal pathways, and FC in language and default mode networks. Compared to standard care, group singing improved everyday communication, speech production and psychosocial wellbeing, coupled with increased GMV in left frontal areas and SC in bilateral frontal and dorsal pathways, in patients with chronic aphasia. In both studies, the intervention-induced neuroplasticity changes correlated with behavioural gains.

Conclusions: Vocal music listening and group singing are beneficial rehabilitation tools in post-stroke aphasia, supporting cognitive and language recovery and promoting structural and functional neuroplasticity, and are widely applicable and scalable in rehabilitation."

ParkinSong: Therapeutic singing interventions to address communication impairments in Parkinson's disease

Jeanette Tamplin

The University of Melbourne, Melbourne, Australia

Background: Parkinson's disease (PD) is the fastest growing neurological condition affecting over 10 million people worldwide. Communication impairments such as quiet, monotone, breathy or hoarse voice quality, and imprecise articulation can significantly impact social participation and reduce quality of life for up to 90% of people with PD. Singing directly activates the musculature control systems associated with respiration, phonation, articulation, with higher respiratory support required than for speech. Widespread neural activation of many areas used for speech occurs during singing (ie. inferior precentral and postcentral gyrus, superior temporal gyrus, and superior temporal sulcus bilaterally). Singing in a group context offers additional social and emotional benefits, addressing non-motor symptoms such as apathy, anxiety, and depression due to the mood-enhancing effects of singing and its effect on arousal and reward systems.

Method: A controlled clinical trial examined the effects of a 12 -week ParkinSong group intervention on the primary outcome of voice loudness, and secondary outcomes including respiratory strength, quality of life, and wellbeing for 75 participants with PD. The ParkinSong intervention incorporates targeted vocal and respiratory exercises and singing songs designed to elicit high intensity vocal output and respiratory effort, with the aim of increasing respiratory pressure and voice intensity.

Results: Significant and clinically meaningful improvements in voice loudness (5.6 dB; $p=0.027$), maximum expiratory pressure (15cm/H20 $p=0.005$), and voice-related quality of life ($p=0.043$) were achieved following 12 weekly ParkinSong sessions compared to controls.

Conclusions: Intensive

therapeutic singing interventions can improve voice outcomes and communication-related quality of life for people with PD.

Lasting effects of recreational group singing on depressive symptoms in elderly care home residents: The multinational MIDDEL trial

Christian Gold

NORCE Norwegian Research Centre AS & University of Bergen, Norway;
University of Vienna, Austria

Background: Many older adults in care homes suffer from depression and dementia. Effective and scalable interventions are needed. Music interventions have shown promising effects, but we know too little about long-term effects. The MIDDEL trial (NCT03496675, middel-project.eu) aims to determine the effectiveness of two group music interventions on depressive symptoms and other outcomes.

Methods: In a pragmatic assessor-blinded 2X2 factorial cluster-randomised controlled trial, we randomised care home units to 6 months of group music therapy (GMT, using various music activities); recreational choir singing (RCS, primarily using singing); both; or neither. Depressive symptoms were assessed with the Montgomery-Åsberg Depression Rating Scale (MADRS) at 3, 6, and 12 months. Secondary outcomes included neuropsychiatric symptoms, quality of life, and care staff burden. Outcomes were analysed on an intention-to-treat basis.

Results: More than 1000 residents (86 units, 6 countries) were included and randomised. In 318 residents in Australia (20 units, the first cohort), beneficial and lasting effects of RCS were found on depressive symptoms (MADRS mean difference vs. standard care: 3 months: -4.14; 6 months: -4.25; 12 months: -5.48; all $p<0.05$), neuropsychiatric symptoms, and quality of life. Effects on GMT were less consistent.

Conclusions: Recreational choir singing is a simple, accessible, scalable, and effective intervention to improve depressive and neuropsychiatric symptoms and quality of life in care home residents, even with severe dementia. Behavioural activation, fun, low cognitive load, as well as large open groups seem to contribute to its effectiveness. Multinational results and sub-studies (biomarkers, barriers and facilitators) are expected in 2024.

SYMPOSIUM 3

MUSIC FOR PAIN: TOWARDS A MECHANISTIC UNDERSTANDING

Chair: Joke Bradt
Speakers: Stefan Koelsch, Mathieu Roy, Eduardo Garza-Villarreal, Joke Bradt

Music and music-based interventions (MBIs) are receiving increasing attention as promising approaches for pain management because of their favourable effects on pain, low cost, absence of negative side-effects and complications common to pharmacological and surgical/procedural treatments, and wide appeal to a large number of people. Yet, the mechanisms underlying music's pain-reducing effects remain largely unknown. This is problematic because without a clear model of underlying mechanisms, researchers and clinicians alike can only rely on trial and error to maximize MBI's full therapeutic potential. The aim of this symposium is to present the latest research on mechanisms of action related to music's pain-relieving effects. Presentations will focus on underlying mechanisms in four systems, namely the reward/ motivation system, affective system, motor system, and cognitive/mnemonic system. By doing so, the audience will gain understanding of the many ways in which music can wire and rewire the brain, thereby reducing suffering of people with pain and enhancing their overall well-being. Presentations will include different methodologies (neuro-imaging, neuro-physiological tools, and behavioural measures), different populations (healthy volunteers and people with chronic pain), and different levels of music engagement (passive music listening as well as active engagement). In addition, this symposium will introduce a newly established Music4Pain research network, funded by the National Institutes of Health, National Center for Complementary and Integrative Health (USA). The network aims to promote and support multidisciplinary research to enhance mechanistic understanding of music for pain reduction. This network will play a crucial role in advancing the mechanistic understanding of the hypoalgesic effects of music and, ultimately, improving patient care and well-being.

Increasing the therapeutic effects of music: Novel insights into pain reduction and emotional valence

Stefan Koelsch
Institute for Biological and Medical Psychology, University of Bergen, Norway

This presentation will offer new perspectives on the neural mechanisms underlying the therapeutic effects of music, primarily drawing from three of my recent studies. First, I will discuss how active sensorimotor synchronisation to music, such as tapping, significantly amplifies its analgesic effects. This finding suggests that the role of music in pain management can be enhanced through active engagement, leading to stronger therapeutic outcomes. Second, I will explore the neural mechanisms of how negative thoughts can manifest as physical pain. Utilising fMRI and music-evoked mind-wandering, we have found that specific regions within the Default Mode Network play a critical role in modulating the emotional valence of thought content, while also exhibiting valence-specific functional connectivity with the brain's putative pain network. Finally, I will delve into the neural correlates of music-evoked emotions, describing the pleasure- and pain-related networks in the brain, including the dopaminergic mesolimbic reward pathway, insula, somatosensory cortex, thalamus, cingulate cortex, and ventromedial prefrontal cortex. Critically, I will demonstrate that these two systems are interlinked, providing a neural basis for the anxiolytic and analgesic effects of music. This presentation aims to deepen our understanding of how music can wire, re-wire, and enhance well-being, offering promising avenues for future research and clinical applications.

Examining the impact of the emotional impact of music on pain perception

Mathieu Roy
McGill University, Montreal
Canada

In this presentation, I will examine the psychological and neural mechanisms underlying the effects of music on pain. Despite widespread recognition of music's therapeutic potential, the specific elements that contribute to its efficacy in pain management remain largely unexplored. Through a series of laboratory studies, this research aims to identify the specific attributes of music that contribute to its hypoalgesic (pain-reducing) effects. Findings from this research reveals that for music to effectively alleviate pain, it must be perceived as at least minimally pleasant by the listener, and possess qualities that induce relaxation. However, the most significant reduction in pain was observed when individuals listened to their preferred music, suggesting the existence of two distinct pathways through which music exerts its hypoalgesic effects: one mediated by relaxation and the other by a preference-induced flow state. This presentation not only highlights the importance of personal preference in music therapy but also opens new avenues for the application of music in clinical settings, offering a promising, non-invasive approach to pain management.

What are the macroscopic circuits involved in music-induced analgesia?

Eduardo Garza-Villarreal
Universidad Nacional Autónoma de México, Mexico City, Mexico

Music-induced analgesia is hypothesized to work within the descending pain modulatory system. Although the specific mechanisms are unknown, cognitive effects like distraction, emotion and placebo effects have been thought to be involved, as well as several neurotransmitters such as dopamine and endogenous opioids. A recent study by Lunde et al, 2022, showed that those last 2 neurotransmitters may not be involved in the effect, and instead expectations of pain relief played a major role in analgesia. Another recent study by Zhou et al, 2022, showed evidence for sound induced analgesia in mice, where they demonstrated that this effect was modulated by an auditory cortex-thalamic circuit. Therefore, is music-induced analgesia an effect of circuits or neurotransmitters, or both, or none? In this talk I will discuss the implications of these recent studies on mechanisms, the challenges studying healthy vs chronic pain population and proposals for the future.

Music therapy for chronic pain management in people with advanced cancer: A mechanistic clinical trial

Joke Bradt
Drexel University, Philadelphia, USA

Chronic pain is one of the most feared symptoms in people with cancer. Although music therapy is frequently used for pain management in cancer care, there is a lack of knowledge of underlying mechanisms. In this presentation, I will present the results of a multi-site randomized controlled trial aimed at examining mediators hypothesized to account for the pain-reducing effects of interactive music therapy (IMT) in adults with advanced cancer. I will demonstrate that mechanistic understanding is essential for optimization of music therapy treatment protocols. In this study, a total of 92 participants were randomized to 6 individual IMT or social attention control sessions. The mediators (anxiety, mood, pain-related self-efficacy and emotional support) and pain outcomes (pain intensity and pain interference) were measured at baseline, week 4, and week 6 using self-report measures. Self-efficacy was found to be a significant mediator for the effect of IMT on pain intensity and pain interference, while anxiety, mood, and perceived support were not. The findings suggest that music therapy interventions for chronic pain management in people with advanced cancer can be optimized by capitalizing on teaching music-based self-management techniques. I will also introduce the Music4Pain Network, a newly established multidisciplinary research network that brings together neuroscientists, music therapists, musicians, neuropsychologists, pain medicine specialists, rehabilitation scientists, psychophysiologists, and more. The primary goal of the Network is to forge new multidisciplinary collaborations to design and implement innovative and methodologically advanced research to advance mechanistic understanding of music for pain management.

SYMPOSIUM 4

RHYTHM, MUSIC AND SPEECH PROCESSING IN THE INFANT BRAIN: FROM THE INVESTIGATION OF INITIAL WIRING TO PERSPECTIVES FOR REWIRING

Chairs: Barbara Tillmann & Paula Virtala

Speakers: Sahar Moghimi, Usha Goswami, Jordi Costa-Faidella, Paula Virtala

This symposium presents research investigating music and speech processing in the infant brain, including its potential benefit and diagnostic value for typical and atypical developmental contexts. The first part focuses on rhythm processing in early infancy, building on previous evidence for shared cognitive and neural resources of rhythm processing in music and language for adults and children. Talk 1 includes new experimental evidence for rhythm processing in prematurely born infants who are deprived of the experience of rhythmic regularity that a full -term born infant has in the womb. Talk 2 presents research investigating the neural correlates of rhythmic regularity processing in healthy full-term infants for both music-like and speech material, also providing longitudinal data up to 30 months. The second part of the symposium focuses on the benefits of music exposure before and after birth on speech encoding. Talk 3 shows an association of neural processing of the fundamental frequency of speech stimuli at birth with daily music exposure in utero. Talk 4 presents positive effects of a vocal music listening intervention for infants at familial risk for the dyslexia, evidenced by enhanced neural discrimination of speech sound changes. Overall, the research presented in this symposium suggests that early music exposure and rhythm-based training interventions could benefit speech and language learning and contribute to preventing subsequent cascade effects leading to various impairments, including developmental language and reading disorders.

Rhythm processing: Development of neural coding during the third trimester of gestation

Sahar Moghimi
Université de Picardie Jules Verne & Inserm
Amien, France

The third trimester of gestation is marked by rapid structural and functional neural development. Around the beginning of the third trimester of gestation, the thalamic afferents arrive in the cortical plate, leading to the onset of sensory-driven cortical functioning with high plasticity, and preparing the newborn at term to enter a phase of interaction with a complex, multisensory environment. Rhythm processing is of high importance from the developmental point of view, for the development of language and musical capacities, as well as for communication and social affiliation. The prenatal auditory world is characterized by omnipresent maternal and environmental rhythmic sounds. How do neural capacities for rhythm processing develop? In a series of studies using electroencephalography in sleeping premature newborns between 28 and 36 weeks gestational age, we evaluated the development of the neural response to the hierarchy of rhythm. We present early traces of predictive temporal processing of auditory rhythm. We also discuss the neural coding of rhythmic hierarchy, with the neural response to fast periodicities arriving during earlier gestation compared to grouping of auditory events and neural coding of longer distance periodicities, which is observed during late gestational ages. Premature birth can result in sensory deprivation for patterned input in general, especially when confined to an incubator, which may impact the early development of neural hierarchies. Our studies suggest the importance of early auditory experience for infants born prematurely and that these infants could benefit from exposure to auditory rhythmic sequences in the Neonatal Intensive Care Unit.

Rhythm processing and language acquisition: A temporal sampling perspective

Usha Goswami
University of Cambridge, UK

This presentation will provide an overview of data gathered for the Cambridge UK BabyRhythm project, a study of 122 infants as they age from 2-30 months which was designed to test the Temporal Sampling theory of language acquisition. The project investigated infant cortical tracking and sensorimotor synchronisation to acoustic and visual rhythmic input, as well as to sung nursery rhymes, and measured later language outcomes. Temporal Sampling (TS) theory is a sensory-neural theory concerning the role of neural entrainment in lower EEG frequency bands related to rhythm perception (delta and theta) in building a language system. Rhythm has been described as a universal precursor of language acquisition. Infants in the BabyRhythm projectvisited the lab on 8 occasions during their first year, and listened to different rhythmic inputs (a syllable repeated at 2 Hz, a drumbeat), and to sung speech, presented in either the audio-visual modality, auditory only, or visual only. Individual differences in phase of entrainment to auditory-only rhythmic speech as young as 2 months of age, and to visual-only rhythmic speech as young as 8 months of age, predicted future language outcomes. For AV sung speech, individual differences in the fidelity of delta-band cortical tracking and in the temporal dynamics between delta- and theta-band responses predicted later language. The UK BabyRhythm data thus suggest that neural oscillatory temporal sampling of the speech signal in the delta and theta bands and phase of entrainment to rhythmic speech play key roles in early language development.

Enhanced neural representation of speech fundamental frequency in neonates exposed to music before birth

Jordi Costa-Faidella
Brainlab – Cognitive Neuroscience Research Group, Department of Clinical Psychology and Psychobiology, University of Barcelona
Institute of Neurosciences, University of Barcelona
Institut de Recerca Sant Joan de Déu, Esplugues de Llobregat,
Barcelona, Spain

Neonates exhibit linguistic and musical preferences shaped by their fetal hearing experiences. Studies performed at birth revealed that neonates prefer their native language; recognize their mother's voice; and show greater responsiveness to lullabies presented during pregnancy. A key component of the acoustic signal characterizing a speaker's tone, speech prosody and musical melody, able to reach the fetus despite the womb's low-pass filtering, is the fundamental frequency (F0) of a complex tone. The F0 is related to sound periodicity and to the perception of pitch, and its neural representation appears modulated by post-natal auditory experiences. We here studied whether the neural representation of F0 is also modulated by pre-natal auditory experiences, as this could underlie the shaping of auditory preferences via in-utero plastic changes. We recorded the frequency-following response (FFR; an auditory evoked potential faithfully reflecting sound periodicity at pitch rates) elicited to speech stimuli in a sample of 60 healthy term newborns during their first hours of life. We split the sample into two groups according to the degree of musical exposure during the last trimester of pregnancy (daily/not-daily), including free-field stimulation and mothers' singing. Our results reveal that neonates daily exposed to music exhibit larger spectral amplitudes at the stimulus F0 than neonates who underwent a lower exposure. This suggests that prenatal musical experiences tune fetal hearing to the tonal components of speech sounds, opening an avenue to study early musical intervention in favour of successful language acquisition, especially in individuals at risk of developmental disorders.

Effects of a music listening intervention on neural speech sound processing in dyslexia-risk infants

Paula Virtala
Cognitive Brain Research Unit, University of Helsinki, Finland

The foundations of language are built during infancy when native phonology is acquired. Supporting this development could benefit speech and language learning and prevent subsequent problems such as the reading deficit developmental dyslexia. Music is known to support auditory and speech processing as well as language and literacy, and it can be cost-effectively administered already in infancy. We investigated its potential benefits for infants at risk for developmental language and reading disorders by pseudo-randomizing 150 infants at risk for dyslexia to vocal or instrumental music listening interventions or no intervention. Electroencephalographic (EEG) mismatch responses (MMRs) elicited by speech-sound changes were recorded before and after the intervention conducted at 0-6 months and at 28 months when language and pre-reading skills were also evaluated.

MMR amplitudes to phoneme changes were enhanced in the vocal music listening intervention group after the intervention. Although direct intervention effects were no more found on language skills at 28 months, enhanced phoneme-MMR amplitude in infancy was found to be associated with better development in pre-reading skills in childhood. These results promote the use of vocal music in early infancy to support speech processing and subsequent language development in risk groups.

SYMPOSIUM 5

WIRING AND RE-WIRING THE BRAIN USING RHYTHM TRAINING

Chairs: Simone Dalla Bella & Jessica Grahn

Speakers: Simone Dalla Bella, Laurel Trainor & Chantal Carrillo, Simone Falk, Shinya Fujii, Jessica Grahn

Whether learning to speak, dance, play a musical instrument, or walking in response to an auditory signal when crossing the street, we adapt our actions to the perceived auditory environment. One form of perception-action coordination, auditory-motor skill learning, plays a critical role across the lifespan, in development and aging, for both healthy and atypical populations. Auditory-motor skills seem to develop effortlessly, with brain plasticity supporting acquisition of language, movement, social interaction, and cognitive abilities. However, failures in auditory-motor coordination relate to neurodevelopmental disorders, affecting speech and language (dyslexia, SLI, developmental stuttering), attention (ADHD), and motor coordination (developmental coordination disorder). Auditory -motor coordination is also affected by aging, sensory loss, brain injury, psychiatric and neurodegenerative disorders such as schizophrenia, Alzheimer's and Parkinson's disease. Rhythm training such as moving to the beat of music or speaking on a metronome appears as a viable strategy to enhance auditory-motor skill learning and relearning in different patient cohorts. Neuronal networks stimulated by rhythm training, essential for rhythm perception, performance, and auditory-motor integration, also overlap with pathways overseeing functions such as motor control, attention, memory, speech and language. Targeting these shared networks through rhythm training is thought to boost their associated functions, and thereby enhance learning or re-acquisition of abilities in specific patient populations.

The promise of rhythmic auditory-motor training for children with developmental coordination disorder (DCD): Let's dance!

Laurel Trainor
McMaster Institute for Music and the Mind, Hamilton, Canada

DCD is characterized by impairments in motor planning, prediction, error correction and automatization, leading to difficulties performing everyday tasks, increases in anxiety and depression, and decreases in academic performance and social adjustment. Given auditory rhythm processing relies on motor planning brain areas, we hypothesized children with DCD would also have auditory rhythm and time processing deficits. An initial study revealed deficits in time interval discrimination and detection of rhythmic deviations in auditory tasks with no motor components. Further, neural underpinnings of these deficits were evident in smaller and/or delayed event-related EEG responses. These findings may explain the high comorbidity between DCD, dyslexia and attention deficits, and suggest that DCD involves a more generalized timing and rhythm deficit. A follow-up study on auditory-motor coordination had children tap to a metronome, continue tapping after a metronome stopped, and tap to the beat of real music. While children with DCD showed impairments, the presence of an auditory stimulus boosted their motor timing performance similarly to typically developing children. Currently, we are analyzing gross motor synchronization where children synchronize a simple step-clap dance step to music. Together these studies show that motor performance in children with DCD benefits from the presence of rhythmic auditory cues, suggesting auditory-motor interventions may be more effective than motor interventions alone. Further, dance interventions are fun and can take place in motivating social settings, leading to greater treatment compliance. More research is needed, but the evidence to date indicates that dance interventions hold great promise for children with DCD.

Rhythmic capacities and stuttering: Potential of rhythm training for children who stutter

Simone Falk
Department of Linguistics and Translation, University of Montreal, Canada
International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal, Canada.

Stuttering is a neuro-developmental speech motor disorder that affects the fluency of speech and can severely impact communication in around 1% of the population. Untimely auditory-motor integration has been pointed out as one of the underlying mechanisms of stuttering, in relation with alterations in the basal-ganglia/cerebellar-cortical circuits. Compatible with the idea that general motor timing circuits are involved in stuttering, we previously found that children who stutter show alterations in rhythmic auditory-motor timing tasks beyond speech. Here, I present newly collected data from 120 children and adolescents who do and do not stutter to shed light on the links between auditory-motor synchronization skills, speech motor development and individual differences therein. Generally, children without stuttering who were more consistent when tapping along with music also showed more mature speech motor development. Importantly, children who stutter with higher precision in timing when tapping to a metronome were also those displaying less dysfluencies in speech. These results suggest that enhancing nonverbal auditory-motor synchronization skills in children may affect auditory-motor timing skills relevant for speech. We currently test this idea in a proof-of-concept study with adolescents who stutter participating in a 3-week rhythmic training at home via a rhythm-based serious video game. We present first results on the potential of this training to benefit non-verbal auditory-motor, articulatory skills or even stuttering itself. In sum, rhythmic auditory-motor skills are relevant to better understand individual differences in speech motor development. Thereby, rhythmic interventions hold promise for developmental populations with a speech motor deficit such as stuttering.

Rhythm processing in schizophrenia patients and in-ear EEG neurofeedback technologies to (re)wire the brain

Shinya Fujii
Faculty of Environment and Information Studies,
Keio University & Vie Style, Inc.
Kanagawa, Japan

This presentation will highlight the intricate relationship between rhythm processing and the pathophysiological characteristics of schizophrenia. The core pathophysiological mechanisms of schizophrenia are thought to be related to abnormalities in dopamine and glutamatergic neuronal systems. Using the Harvard Beat

Assessment Test (H-BAT), we identified significant rhythm perception and production deficits in schizophrenia patients, especially linked to cognitive impairments. Challenges in rhythm production were notably observed in treatment-resistant schizophrenia (TRS) cases, who exhibit different glutamate metabolite mechanisms. We also discovered an association between glutamatergic neurometabolite levels in the caudate and rhythm capabilities using Magnetic Resonance Spectroscopy (MRS) technology. Furthermore, we found that TRS patients displayed a decrease in gamma-band auditory steady-state response (ASSR), a frequency band associated with cognitive processing. Building on these insights, I will introduce new technologies, including the in-ear EEG neurofeedback system and gamma stimulation combined with music—tailored to amplify individualized sensations of chills and groove and to enhance gamma band ASSR. Collectively, these technological advances aim to harness therapeutic potential in wiring and rewiring the brain.

Wired for sound: Illuminating mechanisms of music on movement

Jessica Grahn
Dept. of Psychology
Brain and Mind
Western University, Canada

Music and metronomes are frequently used to improve the motor symptoms of movement disorders. For example, listening to music near walking pace can improve gait in Parkinson's disease patients. Currently, however, we do not know the mechanism by which music alters movement, either in healthy volunteers or in patients. The assumption is that auditory cues drive movement, which, for music, relies on beat perception, as movements are usually synchronized to the beat. However, beat perception ability varies amongst individuals, and is specifically compromised in some neurological disorders. I will therefore discuss how beat perception ability modulates the effects of music on movement. Features of the music also matter: high-groove music consistently affects gait more than low-groove music, but it is unclear whether this may be through beat salience, enjoyment, or both. Data disentangling the effects of groove, beat salience, and enjoyment on gait parameters will be presented. Finally, I will present novel work testing the effects of mobile neurostimulation technology, such as transcranial direct current stimulation (tDCS), in combination with RAS, to enhance music's effects on movement.

SYMPOSIUM 6

MUSIC IMPROVISATION AS A TOOL TOWARDS UNDERSTANDING THE BEHAVIOUR AND BRAIN PROCESSING OF HUMAN CREATIVITY

Chair: Psyche Loui
Speakers: Martin Norgaard, Peter Vuust, Psyche Loui, Anna Palumbo

Musical improvisation is an excellent example of human creativity, involving moment-to-moment auditory-motor interactions within the brain and shared between individual musicians. An improvising musician has to play, listen to what the other musicians are playing, and evaluate the overall musical output, while enacting new phrases on the spot based on expertise, stylistic experience, and embodied knowledge.
Hence, improvisation lends itself well to studies of brain dynamics, and of brain wiring and rewiring. In addition, many musicians consider improvising a highly playful and pleasurable musical activity contributing strongly to mental well-being. As such, improvisation is being used as a tool for rehabilitation and development of creative skills across the lifespan.
This symposium will demonstrate four thought-provoking aspects of musical improvisation and its influence of brain wiring, rewiring and well-being centered around Loui's model of musical improvisation (Loui, 2018, 2023), showing how improvisation involves predictive processes (Vuust et al, 2022) and taps into the reward system. Using corpus analysis and tools from network science, Norgaard will delve into the auditory-motor patterns in the improvisation vocabulary of expert improvisers, revealing cognitive constraints underlying improvisations in different traditions. Using manipulations of such cognitive constraints in combination with whole-brain modeling of fMRI and MEG, Vuust shows how different brain networks alternate during improvisation. Loui will discuss how brain networks for improvisation overlap with more domain-general creative tasks, and introduce a music intervention paradigm using an unfamiliar musical system, to link these creative processes with learning and plasticity. Finally, Anna Palumbo will show the link between increased reward and enhanced motor output during music improvisation, combining behavioural and neuro-physiological markers.

Structural regularities of extant improvisations reveal cognitive constraints and motor associations

Martin Norgaard
Georgia State University, USA

Extant improvisations serve as a record of a creative act originally conceived under real-time constraints. Therefore, analyzing transcriptions of improvisations may reveal cognitive underpinnings that shaped creation.

Classic work by Pressing (1988) predicted that improvisations would contain series of concatenated musical gestures or patterns. Indeed, my analyses of both corpora of improvisations from individual and groups of jazz improvisers show strong evidence of repeated patterns that do not appear by chance simply due to underlying tonal rules (Norgaard, 2014; Norgaard & Römer, 2022). Looking further at structural regularities, we investigated whether a phenomenon seen in language where "easier" words appear at the beginning of sentences may also apply to improvisations. We show that musical phrases in a collection of 456 iconic jazz improvisations begin with more frequent and less complex sequences, allowing incremental planning later in the same phrase (Beaty et al., 2021). Pressing also predicted that individual improvisers would develop a vocabulary of musical patterns linked to associated motor movements. We compared improvisations by one artist-level jazz pianist recorded live with a control corpus consisting of improvisations by 24 different advanced pianists. Though both corpora contained many recurring patterns, the single-player corpus showed stronger links between pitch patterns and motor programs in that within-pattern timing and velocity correlations were significantly higher than the control corpus (Norgaard et al., 2023). Finally, I will discuss results from two ongoing studies investigating how developing improvisers build individualized musical vocabularies and how pattern organization within long-term memory can be modeled using network science.

The dynamical wiring and rewiring of the improvising brain

Peter Vuust
Center for Music in the Brain, Dept. of Clinical Medicine, Aarhus University
The Royal Academy of Music, Aarhus/Aalborg, Denmark

Building on the predictive coding framework laid out in our 2022 NRN review (Vuust et al, 2022), I will show the results from three studies using different scanning methods to unravel the dynamics of how brain processing evolves during improvisation under different sets of constraints. In the first study (da Mota et al, 2023), we performed functional magnetic resonance imaging on 16 skilled jazz pianists performing the jazz standard "The Days of Wine and Roses" with different levels of improvisational freedom: playing the melody from memory (byHeart), improvising on the melody (iMelody) and freely improvising (iFreely). The different levels were reflected behaviourally by increased numbers of notes and entropy, and decreased predictability. Whole-brain analyses revealed that increasing levels of improvisational freedom corresponded to significantly higher probability of occurrence of brain networks predominantly comprising auditory, sensorimotor and posterior salience networks. Additionally, the highest level of improvisational freedom was characterized by higher occurrence of a specific brain substrate including default mode, executive control and language networks. Additional whole-brain modeling of the brain wiring provided causal evidence that the transition from just reproducing a melody to higher levels of improvisation only occurred when increasing the level of noise in specific brain regions. These regions are important for creativity, including the planning of complex behaviour, decision making, emotional/arousal regulation, semantic processing, memory, imagery and motor control. Furthermore, I will report the results of two ongoing experiments that compares imitation and improvisation in melodically and rhythmically highly constrained conditions using fMRI and MEG

From improvisation to the perception of creativity: Time-sensitive models and equitable predictions

Psyche Loui
Music, Imaging, and Neural Dynamics Laboratory (MIND Lab), Northeastern University, Boston, USA

While musical improvisation is a real-time act of creativity, it draws upon a knowledge base of learning, memory, autobiographical experiences, and mental representations. I start by conceptualizing a multilevel model of musical creativity as a complex system that embodies this knowledge base, with predictions over different timescales at the centre of the complex system (Loui, 2018, 2023). Studies in musical improvisation have traditionally focused on western classical and jazz improvisation genres, comparing musicians with different levels of improvisation training, mainly due to its relative ease of access to researchers in lab-based, experimentally controlled environments. Here I introduce BP sequencer: an experimental interface for generating and evaluating music in the Bohlen-Pierce (BP) scale. BP sequencer yields empirical, computationally tractable data, while requiring relatively low levels of domain-specific knowledge for the user, thus lowering the barrier-to-entry for understanding creativity by making it accessible to those with minimal training. I will then report three experiments in which we quantify the number of sequences generated by each individual and isolate the musical-informatic features that were rated as creative. Participants showed a wide range of fluency in generating novel sequences. Sequences rated as more creative were generally longer, had more unique pitches, and had higher interval entropy. Furthermore, using electrophysiology (EEG) we quantified three distinct candidate biomarkers: frequency-tagged activity (power spectral density), intrinsic frequency-based activity (alpha), and early and late phases of time-based (ERP) activity, that together contribute to prediction and positive prediction error, both of which are central to the perception of creativity.

Reward and motor neurophysiological correlates of live music improvisation

Anna Palumbo
New York University, USA

Reward plays an important role in motor performance and learning (Wulf, 2016). In everyday life, music provides an abstract reward that is frequently combined with exercise and athletic training. I will review the results of a series of studies comparing the effects of improvisation and live accompaniment in a music-playing task. Participants played a drum along with piano accompaniment by either (1) maintaining the beat or (2) improvising a beat (i.e., changing the beat as they desired for personal expression). Piano accompaniment was either (1) played from a recording or (2) performed live by a music therapist. Electrodermal activity (EDA), heart rate, accelerometry, electromyography (EMG), and behavioral responses were recorded. Results showed that the combination of improvisation and live accompaniment lead to increased accelerations of hand movement while playing the drum, coupled with increased amplitude of muscle contractions in wrist flexor and extensor muscles (EMG). Importantly, increased movement correlated with increased reported reward while improvising, but not while maintaining the beat. We also show that improvisation (with or without live accompaniment) leads to increased autonomic arousal (i.e., increased tonic EDA and decreased HR variability) and increased reported challenge. I will also describe an fMRI extension of this experiment. Together, these findings suggest a mechanism by which combined improvisation and live accompaniment increase reward and motivate increased motor activity, while improvisation increases challenge. These findings have implications for enhancing reward, engagement, and motor performance during music playing tasks that support exercise and physical rehabilitation.

SYMPOSIUM 7

THE PLEASURABLE URGE TO MOVE TO MUSIC: SEARCHING FOR NEURAL MECHANISMS AND DEVELOPMENTAL ORIGINS

Chair: Maria Witek
Coordinator: Virginia Penhune
Speakers: Connor Spiech, Daniel Cameron, Erin Hannon, Tomas Matthews

The pleasure and social connections we derive from music can potentially enhance music-based clinical interventions. Pleasurable music has been found to reduce the experience of pain and depression, and can promote improvements in language and movement for people following a stroke. Musical rhythms appear to facilitate perception of sound and production of accurate movements, which has led to a wave of recent research on the use of rhythms to improve reading, speech production, and walking gait. One of the most powerful effects of rhythms is the experience of a pleasurable urge to move to music, sometimes called the sensation of "groove." Interest in understanding both the cognitive and neural underpinnings of this experience has expanded rapidly. However, the neural basis of groove is still not well understood, despite such a mechanistic understanding being critical for efficient applications to clinical problems. Furthermore, until recently there have been relatively few studies examining the developmental or social determinants of this experience across the lifespan, or in clinical populations. Therefore, the current symposium will bring together researchers whose work looks at possible neural mechanisms of groove and how the pleasurable urge to move to music differs in children, older adults, and in Parkinson's Disease, and how groove may relate to social development.

Quenching the Groove: The Effects of SMA cTBS on the Pleasurable Urge to Move to Music

Connor Spiech
Department of Psychology, Concordia University, Montreal, Canada

The pleasurable urge to move to music (termed "groove" by music psychologists) has been shown to be greatest for music with moderately complex rhythms. This is thought to occur because temporal predictions from the motor system reinforce our perception of the beat when there is a balance between expectation and surprise. The supplementary motor area (SMA) has been identified as the potential origin of these temporal predictions based on both neuroimaging and computational modeling studies. Thus, to causally test the role of the SMA in the experience of groove, we used transcranial magnetic stimulation to disrupt activity in this region while non-musicians listened to and rated clips of commercially recorded music that varied in rhythmic complexity and perceived groove. Continuous theta burst stimulation was delivered over left SMA and a control location in primary visual cortex (V1) at 80% of participants' active motor orphosphene threshold. Following stimulation over left SMA, but not V1, participants showed reduced ratings of pleasure and wanting to move to music with moderate to high rhythmic complexity. These preliminary results suggest that when the rhythm of the music becomes more complex, the left SMA is recruited to actively find or maintain the beat. Therefore, when left SMA function is inhibited, participants experience less desire to move to the beat. In summary, these findings provide causal evidence that the SMA plays a critical role in generating temporal predictions for embodied rhythm processing

Assessing the development of the syncopation-groove relationship in infants and children

Daniel Cameron
Department of Psychology, Neuroscience & Behaviour, McMaster University, Canada

An essential function of musical rhythm is that it motivates us to move. Adults feel the strongest urge to move (groove) when hearing rhythms that have some, but not too much, syncopation. But, we do not know whether this syncopation-groove relationship is shaped in development, or, rather, is relatively stable from infancy. We assessed the syncopation-groove relationship in infants (6 -18 months) and children (3-6 years) in a series of experiments. First, children listened to pairs of rhythms differing in syncopation and chose which was "better for dancing". Separately, they danced to the same rhythms. In both tasks, children showed a bias for medium over low syncopation rhythms. In two sets of experiments, infants either interacted with a touchscreen to choose to hear rhythms with either low or medium syncopation, or had those same rhythms presented to them while they were free to move. Preliminary results suggest a possible dissociation between movement and preference biases for syncopation: infants tended to move more for medium syncopation than low syncopation rhythms (as older children did) but chose to listen to low syncopation more than medium syncopation rhythms when they had control over what rhythms they heard. Together, these results suggest that some but not all aspects of the syncopation-movement relationship may be relatively fixed from infancy. Understanding the development of how rhythm structure motivates movement is critical for more fully understanding the underlying neural mechanisms of music, and for optimizing the use of rhythm for practical and therapeutic interventions in children.

Development of groove and the effects of musical, social, and cognitive abilities

Erin Hannon
Psychology, University of Nevada, Las Vegas, USA

Groove is the pleasurable urge to move in time to moderately complex, syncopated music. This experience likely plays an important role in motivating people to engage in group musical and dance activities, which in turn may help signal in-group social cohesion. It has been proposed that the feeling of groove may be dependent on the challenge of making predictions about events in musical rhythms, an ability that gradually changes during childhood and adolescence. However, relatively little is known about the development of groove itself, nor how it is determined by closely related abilities such as beat and meter perception, or more general musical, cognitive, and social abilities. We measured the experience of groove, musicality, social development, and general cognitive function in children 6-17 years of age. To assess musicality and music perception skills, children completed child-friendly versions of the Barcelona Music Reward Questionnaire (BMRQ) and Goldsmiths Musical Sophistication Index (Gold-MSI), as well as a test of beat and meter perception. To measure social and general cognitive ability, children completed the Self-Perception Profile for Children, and the Wechsler Abbreviated Scale of Intelligence (WASI-II), respectively. Finally, children listened to 20 drum patterns ranging in complexity and indicated on a 4-point Likert scale the extent to which that song would be good for "dancing at a party." We will present preliminary results with the goal of examining the extent to which music-specific versus more general cognitive and social abilities predict groove perception. .

Predictive processes shape the effects of age and parkinson's on the relation between syncopation and the urge to move to music

Tomas Matthews
Center for Music in the Brain, Aarhus University, Denmark

The pleasurable urge to move to music (PLUMM) shows an inverted U-shaped relation with syncopation. A predictive processing account hypothesizes that moderately syncopated rhythms maximize precision weighted prediction errors (PE) and thus elicit the strongest urge to minimize PEs via movement. We tested this hypothesis by combining computational modelling with a large sample of PLUMM ratings. We also investigated whether metrical model strength (MMS) drives the effects of age, musical training, and Parkinson's disease (PD) on PLUMM.

PLUMM ratings were collected from 73 PD patients and 515 healthy controls (HC) with large ranges in age (17-80) and years of musical training (0-46). As an index of precision weighted PE, surprisal values were calculated

from a Bayesian model that inferred which of two underlying templates (metric, uniform) was active as the rhythms unfolded. PE minimization was modeled as the difference in surprisal between rhythms with and without a metronome, which served as a proxy for synchronized movement. Two parameters capturing distinct aspects of MMS were fit to the per-participant ratings.
Rating results showed that both PD and age flattened the inverted U while musical training led to the opposite effect in HCs. Simulations showed that moderately syncopated rhythms maximize reducible PEs. Parameter fitting results showed that MMS accounted for the effects of age and PD but not musical training.
These results suggest that PLUMM is driven by the affordance to reduce PEs and that age and PD weaken the representation of meter leading to an altered PLUMM response.

SYMPOSIUM 8

MUSIC, MEMORY, AND IMAGINATION IN THE BRAIN: INSIGHTS FROM MULTI-MODAL NEUROPHYSIOLOGY

Chair: Elvira Brattico
Speakers: Alejandro Blenkmann, Philippe Albouy, David Quiroga Martinez, Leonardo Bonetti

Memory plays a fundamental role in our well-being. By "wiring and re-wiring" the brain, memory is essential for learning, forming our sense of self, recalling the past and imagining the future. Music provides unique insights into the complexities of memory processes within the human brain. Constructed upon hierarchical sequences of sounds, music engages multiple memory sub-systems for learning, recognising, and mentally holding and manipulating sounds. Several studies investigated the brain mechanisms underlying music memory and imagination, widely using functional magnetic resonance imaging (fMRI) and electroencephalography (EEG). These studies shed light on spatial and temporal brain features separately. Building on this, the symposium will present the latest advances in the multi-scale neurophysiology of musical memory and imagination. These works have made use of brain signals at different scales, including magnetoencephalography (MEG), intracranial EEG (iEEG) and single-unit activity (SUA), to bring unique spatiotemporal detail and provide a comprehensive understanding of the neural basis of music memory and imagination. The symposium will cover the latest studies on different musical memory sub-systems, ranging from automatic sensory memory and mismatch responses, to working, short- and long-term memory, and their role in imagination. Finally, we will discuss the clinical implications of this line of research, from aging and brain damage to stimulation and brain-computer interfaces.

Electrophysiological correlates of auditory regularity expectations and violations at short and long temporal scales: Studies in intracranial EEG and prefrontal cortex lesion patients.

Alejandro Blenkmann
RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion(PSI), University of Oslo, Norway

We modified the classical Local-Global paradigm (Bekinschtein et al., 2009) to study the neurophysiological mechanisms supporting predictions at local (short) and global (long) temporal scales. We recorded intracranial EEG (iEEG) in 7 drug-resistant epilepsy patients, and scalp EEG in 12 orbitofrontal lesion patients (OFC), 10 lateral prefrontal lesion patients (LPFC), and 14 healthy controls.

Five-tone sequences were repeatedly presented to form Global regularities, while within-sequences tones also contained Local regularities. The last tone of the sequences was occasionally changed or omitted to violate Local and/or Global regularities.

OFC patients showed altered MMN and P3a ERPs for the Local and the Local+Global deviant conditions, while the LPFC group had no significant alterations relative to the control group. The P3b to Global deviants seemed preserved in all groups.

Regarding higher-level expectations, controls and LPFC patients had a CNV modulated by the likelihood of Global deviant occurrences. Crucially, this modulation was not present in the OFC group. The result was supported by iEEG recordings in the OFC, showing a CNV-like component modulated by expectation.

Finally, in the iEEG cohort, we analyzed the responses to omitted expected sounds when patients attended to the auditory stream or performed a distracting task. We observed a widespread effect of predictability in frontal, temporal, and parietal areas in the attended state, that was constrained to temporal areas in the unattended condition.

Altogether, the neurophysiological mechanisms supporting auditory predictions at different temporal scales are intricate, involve a network of brain areas, and are modulated by selective attention.

Cross-frequency coupling and replay as markers of working memory functions in humans

Philippe Albouy
Cervo Brain Research Centre, School of Psychology, Université Laval, Canada

Prior studies using magnetoencephalography (MEG), electroencephalography (EEG) and stereo-electroencephalography (SEEG) have shown that local brain oscillations and large-scale connectivity in multiple frequencies are associated with working memory functions in humans. These studies have notably suggested that memory maintenance of visuo-spatial mental contents relies on an ordered activity of cell assemblies implemented under the form of cross-frequency coupling in the human hippocampus. However, to date, very little is known about the role of cross-frequency coupling in auditory and hippocampal regions during the retention of auditory (melodies) information in memory. I will first discuss our recent studies, using SEEG recordings in humans, showing that theta-gamma phase amplitude coupling in auditory and hippocampal regions is an appropriate marker of memory functions for melodic material. Second, I will present our recent MEG and SEEG studies investigating how individual memorized items can be the segregated of into distinct neural activity patterns during working memory maintenance. In these studies, we hypothesized that item-specific brain oscillatory patterns are internally replayed/reactivated to support WM performance. Replay consists in the reactivation of learning-related neural activity during offline brain states. It has been observed in humans during decision making, motor learning or episodic memory. However, the relationship between replay and working memory performance is still unclear. I will show how working memory replays can be identified via the application of machine-learning pattern classification algorithms to MEG and SEEG recordings. This work provides significant insights into the comprehension of the mechanisms supporting working memory functions in humans.

The neural representation of imagined melodies

David Ricardo Quiroga Martinez
Knight Lab, University of California, Berkeley, USA

Imagine a song you know by heart. With little effort you could sing it or play it vividly in your mind. However, we are only beginning to understand how the brain represents, holds, and manipulates these musical thoughts. Here, we decoded listened and imagined melodies from MEG and intracranial EEG brain data to show that auditory regions represent the sensory properties of individual sounds, whereas cognitive control (prefrontal cortex, basal nuclei, thalamus) and episodic memory areas (inferior and medial temporal lobe, posterior cingulate, precuneus) hold and manipulate the melody as an abstract unit. Furthermore, the mental manipulation of a melody systematically changes its neural representation in both association and auditory areas, reflecting the volitional control of auditory images. Our work sheds light on the nature and dynamics of auditory representations, paving the way for future work on neural decoding of auditory imagination and possible applications in brain-computer interfaces.

Multi-scale neurophysiology of musical recognition: network hierarchies and perspectives on aging

Leonardo Bonetti
Aarhus University, Denmark
University of Oxford, UK

Long-term memory is a fundamental aspect of human cognition, occurring by wiring and re-wiring the brain during encoding and recognition of information. Its precise functioning plays a pivotal role in our daily life, thereby exerting a profound influence on overall well-being. While the neural processing of visuospatial patterns has been extensively studied, much remains to be discovered about the hierarchical brain mechanisms underlying recognition of auditory sequences such as musical melodies. In a series of magnetoencephalography (MEG) studies involving nearly 300 participants, we investigated the brain activity during recognition of both original and systematically varied melodies. We revealed that auditory cortices played a central role by sending feedforward signals to the ventromedial prefrontal and inferior temporal cortices, hippocampus, and medial cingulate gyrus, while also receiving backward signals from these regions. Although the hierarchical architecture of the brain remained consistent, the temporal dynamics of brain activity sharply differed between the recognition of original and varied melodies. To complement these whole-brain MEG studies, we recorded local field potentials (LFPs) with intracranial electroencephalography (EEG) in patients affected by epilepsy. The LFPs corroborated our MEG findings and offered further insights, highlighting high gamma bursts originating in the auditory cortices in response to each tone of the melodies, coupled with theta responses in the medial temporal lobe. In conclusion, I will present the current perspectives on the age -related brain changes during auditory long-term memory and show the potential of musical memory paradigms to predict the trajectory of ageing, distinguishing between successful and pathological outcomes.

SYMPOSIUM 9

PERSPECTIVES ON THE MATURATION OF AUDITORY, COGNITIVE AND EXECUTIVE SKILLS ASSOCIATED WITH MUSIC TRAINING DURING CHILDHOOD: CONSENSUS AND UNRESOLVED QUESTIONS

Chair: Assal Habibi
Speakers: Miriam Lense, Franziska Degé, Vesa Putkinen & Katri Saarikivi, Assal Habibi

Musically trained individuals consistently demonstrate superior performance in various domains of auditory and cognitive function, encompassing language, attention, working memory, and executive control. Additionally, neuroimaging and electrophysiological investigations have revealed notable distinctions in the neural engagement of auditory and executive networks between musicians and non-musicians. Yet there are individual differences in the development of musical behaviours and a scarcity of studies that extend their observations of musical engagement and training from early childhood through adolescence. Indeed, some evidence suggests that the so-called "musician advantage" may be more pronounced when introduced at an earlier stage of development. In essence, the timing of musical training and experiences is a critical factor when considering response to intervention, and the trajectory of change may vary significantly depending on individual characteristics and developmental stage. In alignment with the conference theme, "Wiring, Re-wiring, and Well-being", this symposium aims to comprehensively explore longitudinal research that encompasses both natural history and intervention designs - allowing us to investigate the potential of music-based interventions in facilitating the maturation of auditory, attentional, and executive skills during infancy and childhood. Speakers will engage in a broad discussion regarding how the timing of experience with music and the overall developmental timeline intersect, shedding light on the potential mechanisms through which music experiences and interventions may offer advantages to cognitive skills during critical developmental periods. Furthermore, they will examine how these advantages may be particularly relevant in the context of neurodevelopmental disorders, such as autism and communication disorders.

Longitudinal changes in attention during infant-directed singing in autistic and non-autistic infants: Considerations for intervention mechanisms

Miriam Lense
Vanderbilt University Medical Center , Nashville, USA

Over the first year of life, neurotypical infants engaged with infant-directed speech (ID-speech) transition their gaze from the eyes to the mouth of the caregiver, as the mouth contains audio-visual cues that support language development. This increase in mouth-looking is enhanced for ID-song due to song's expansion of many ID-speech features. However, whether this effect occurs in autistic infants and its relationship with language development is unknown, despite song's faciliatory effects on infant attention.

In a series of eye-tracking studies, non-autistic and autistic infants' visual attention was assessed while infants were engaged with ID-speech and ID-song across the first year of life. Attention to the singer/speaker's mouth increased with age and was potentiated in song versus speech across diagnostic groups. However, overall mouth-looking increased at a slower rate in autistic infants with higher versus lower language outcomes.

Additionally, the stimuli features that drove mouth-looking differed by diagnosis: Greater mouth-looking was predicted by slower tempo, increased audiovisual synchrony, increased smiling, and increased rhythmic predictability in non-autistic infants; by tempo and rhythm in autistic infants with higher language outcomes; and by tempo and smiling in autistic infants with lower language outcomes.

The differing trajectories and sensitivities associated with mouth-looking in non-autistic and autistic infants with varying language outcomes suggests differing processes regarding whether and how mouth-looking adaptively supports language development across diagnostic groups. Individual differences in feature sensitivity may impact optimal timing of and response to early language interventions that involve singing and suggest differing mechanistic processes to be targeted.

Do behavioral advantages diminish while neural differences persist? Longitudinal studies on executive functions in musically trained and untrained children and adolescents

Vesa Putkinen & Katri Saarikivi
University of Helsinki, Finland
(on-site presentation)

Purposeful action requires overriding intuition and instinct, command over attention, and the ability to change behavioral and thought patterns as the environment and contextual requirements change. These abilities are called executive functions and typically divided into the subcomponents of inhibitory control, working memory and cognitive flexibility Studies suggest that musically trained children and adolescents show advantages in executive function tasks and exhibit distinct brain responses during such tasks. However, whether these group differences persist throughout life remains unclear. Here, we present a series of longitudinal studies examining the impact of musical training on cognitive development in children and adolescents, focusing on working memory, selective attention, inhibition, and set-shifting. Our results reveal that musically trained children outperform their untrained peers in behavioral tests of these functions particularly during school-age. However, as they progress into adolescence, the group differences in performance gradually diminish for some of these tasks. Intriguingly, despite the narrowing of behavioral differences, our results revealed enduring group differences in event-related potentials (ERPs) and functional magnetic resonance imaging (fMRI) measures of the neural mechanisms underlying these cognitive functions. These results suggest that while the behavioral advantages associated with musical training may wane with age, the neural substrates supporting these functions remain distinctive. Collectively, these findings underscore the potential influence of musical training in enhancing executive functions, especially during childhood, and highlight the dynamic interplay between behavioral and neural changes during development.

Inhibition mediates the influence of music training on IQ in 5- to 7-year-old children

Franziska Degé
Max Planck Institute for Empirical Aesthetics, Frankfurt, Germany

The question which mechanism explains the impact of music lessons on cognitive abilities has intrigued researchers. We put forward the idea that executive functions, which are involved in successful completion of cognitive tasks and can be enhanced by music training, might be the potential explanatory mechanism. Indeed, research demonstrated first support that the association between music lessons and IQ might be mediated by executive functions (but see Schellenberg, 2011). However, causality has not been shown so far. Therefore, our study investigates with an intervention design whether the impact of music training on IQ is mediated by inhibition. We randomly allocated n = 109 children aged between 5 and 7 years to a music group (n = 36), a painting group (n = 36) and a waiting control group (n = 37). Children were trained for 8 months (waiting control group after post-test). We assessed socioeconomic status as control variable. In pre- and post-tests, we measured inhibition and IQ. A total effect of music training on IQ (B = 0.866, p = .008) could be demonstrated. Music training showed also an effect on inhibition (B = 0.178, p = .016). Inhibition had an effect on IQ (B = 1,338, p < .001). When inhibition was entered as a mediator the direct effect of music training on IQ (B = 0,627, p = .043) decreased considerably. Our results suggest that inhibition partially mediated the impact of music training on IQ. Hence, our data support the idea of executive functions as explanatory mechanism.

The brain's crescendo: how music training enriches child neurocognitive development. Evidence from longitudinal and cross-sectional studies

Assal Habibi

University of Southern California, Los Angeles, USA

Learning to play a musical instrument is a complex multisensory, cognitive and motor experience. The mastering of this rich and demanding process requires regular and intense practice, often from a young age. While a growing body of evidence supports the idea that music training enhances neurocognitive development in childhood, the question remains: do these advantages persist throughout development? In early childhood, musically trained children typically exhibit higher accuracy and greater efficiency in various auditory, language, and cognitive control tasks, suggesting an enhanced maturation of these systems.

Here, we share findings from a series of longitudinal and cross-sectional studies exploring the impact of musical training on the development of auditory, cognitive, and executive skills during childhood. Our collective results demonstrate that music training in school-age children leads to improvements in auditory skills including enhanced speech perception. Moreover, we observe neuroplastic structural and functional changes in the associated auditory regions, as evidenced by magnetic resonance imaging (MRI) and event-related potentials (ERPs). Additionally, our research highlights music training's positive association with executive function, specifically in terms of inhibition control, manifesting as differences in both behavioral outcomes and neural responses.

However, as participants in our studies transitioned from childhood, the differences between musically trained and untrained groups, while still observable, became less pronounced. This suggest that music training may expedite the maturation of auditory, cognitive, and executive skills in childhood. However, it may be the case that the benefits acquired through music training may gradually diminish as certain skills reach their developmental peak.

SYMPOSIUM 10

MUSIC-RELATED NEUROPLASTICITY OVER THE LIFESPAN: LONGITUDINAL STUDIES

Chair: Rebecca Schaefer
Speakers: Lara Wierenga, Florian Worschech, Rebecca Schaefer, Takako Fujioka

Neuroplastic changes, or re-wiring of the brain related to musical activities have been reported in a range of settings. Notably, the nature of these neural changes likely depends on variables such as life stage and brain health, but also the specific musical activity. When considering life-span effects, music-related neuroplastic changes will interact with naturally occurring changes, affecting how the healthy brain matures. In contrast, the recovering brain, such as after a stroke, may depend on plasticity to regain function, increasing the need for a better understanding of the predictors of music-related plasticity. Musical activities previously reported to lead to neuroplastic changes include formal music training targeting musical skill increase, music-cued motor learning, and music therapy targeting specific clinical goals. While these activities differ in terms of their potential for re-wiring, the symposium aims to add a life stage perspective to this discussion. Moreover, the correlates of brain changes with subjectively experienced aspects of well-being are crucial to evaluate the real-world relevance of these findings to participants and patients.

In this symposium speakers bring together studies of longitudinal brain measures in observational settings, randomised controlled studies, and clinical treatment at different life stages. While all speakers will discuss neural changes over time, the musical activities vary from music instruction in children and elderly, to musically cued motor learning in younger and older adults, to music therapy after stroke. Importantly, related well-being measures are included where possible, to signify the relevance of neuroplastic changes to daily life.

How music alters brain plasticity: A longitudinal twin study on sensorimotor synchronization and brain developmental patterns

Lara Wierenga
Leiden Consortium of Individual Development (L-CID),
Leiden University,
The Netherlands

There are individual differences in brain developmental patterns, yet it is unknown to what extent these may be driven by enriched experiences. Moreover, it is not well known whether enriched experiences may result in attenuated or accelerated brain development. Studying the relation between music performance and the brain using a large longitudinal twin study provides a framework for better understanding the genetic and environmental effects on brain development in childhood. The present region-of-interest study tested whether individual differences in an auditorily cued finger tapping task are related to individual differences in developmental brain trajectories and if this relation was genetically or environmentally driven. The present study included a longitudinal twin design with up to 3 MRI waves of data (7-14 years old; N=485). In line with our preregistered hypotheses, results showed that attenuated patterns of brain development in 27% of motor and affective ROIs were associated with SMS performance independent of socio-economic status effects. Furthermore, brain-behavior associations were at least partly driven by shared and unique environmental/measurement error effects, in addition to genetic influences. Possibly, attenuated brain development may be indicative of prolonged brain plasticity related to enriched environmental experiences, such as musical training, in addition to predisposing genetic factors.

Healthy aging with music: Practicing piano to promote brain plasticity and quality of life in older adults

Florian Worschech
Institute of Music Physiology and Musician's Medicine, Hanover University of Music, Drama and Media,
Hanover, Germany

Background: The rapidly aging population impacts the whole society, and requires urgent action to prevent or delay age-related deterioration. In order to support healthy aging, effective interventions must be identified. Playing a musical instrument holds particular potential for inducing brain plasticity and improving quality of life. However, evidence is still limited and further longitudinal studies and, in particular, randomized controlled trials (RCTs) are needed.

Method: The data in this presentation come from the longitudinal study Train the brain with music: brain plasticity and cognitive benefits induced by musical training in elderly people in Germany and Switzerland. We conducted an RCT of 156 retired older adults who received either piano lessons or music listening for 12 months. Subjects were tested at 4 time points (0, 6, 12, and 18 months), including a comprehensive neuropsychological test battery and MRI. An additional follow-up was conducted approximately 3 years after the intervention (48 months) to assess quality of life (QoL) and musical activity.

Results: I will report results on functional and structural brain plasticity and changes in QoL. A self-reinforcing relationship between music making and QoL will be discussed, with music improving some dimensions of QoL and especially physical QoL promoting musical engagement. Conclusion: Making music is one way to promote brain plasticity and QoL in older people, and should therefore become an important policy focus to promote healthy aging in the population.

Musically embedded motor learning and brain plasticity over the life span

Rebecca Schaefer
Institute for Psychology, Health, Medical, and Neuropsychology Unit, Leiden University, The Netherlands

Previous studies indicate that musical activities provide exceptional potential for neuroplasticity. While this elucidates brain development and possible correlates with functional and well-being measures, this is also highly relevant to clinical settings where neural reorganization can be crucial to recovery. However, the working mechanism underlying this potential for plasticity is not fully understood, and may also differ substantially depending on life stage. The current study aims to test one hypothesized working mechanism, namely the perceptual embedding of movement, indifferent age groups. Specifically, we test the influence of multimodal sensory perception by comparing motor learning in audiovisual musical conditions with a visual-only condition, using a randomized multi-week training paradigm with pre-and post-training behavioral assessment and MRI measures (grey matter (GM), diffusion-weighted MRI (d-MRI), and resting state fMRI (RS-fMRI). Crucially, the most common age groups for musical interventions targeting neural reorganization are older than most previously studied populations. Therefore two age groups are assessed and compared, namely adults between 18-35 (n=30) and over 60(n=50, currently in progress). Whiled-MRI measures were already found to increase diffusivity along the arcuate fasciculus only for the music group contralateral to the trained hand in young adults, these findings will now be extended to other MRI modalities and age groups. In the older adults, additional measures of cognitive-motor interference, neuropsychological, and well-being measures are included. This symposium talk contributes randomized controlled MRI findings on the effect of music on learning-related plasticity in two age groups, with implications for movement rehabilitation

Plasticity of beta and gamma-band neuromagnetic oscillations of the sensorimotor systems in chronic stroke: Comparison between music-supported therapy and manual training

Takako Fujioka
Department of Music and Wu Tsai Neurosciences Institute Stanford University, USA

This presentation will feature longitudinal MEG data from an RCT (Clinical Trials: NCT01721668) in chronic stroke patients with a hemiparetic hand who went through either music-supported therapy of drumming and keyboard playing or conventional physiotherapy training for manual actions with everyday objects for ten weeks. Specifically, we focus on the various sensorimotor neural oscillations and their changes post-interventions. Previously, we reported the music group’s advantage in improved mood, well-being, and rhythm perception. Here, our data show (1) the post-intervention increase of the gamma-band harmonics of the somatosensory steady-state responses (SSSR) at the beta-band (~20Hz, the frequency of the vibrotactile stimulation). (2) the music-group specific enhancement of the auditory-motor coupling for predictive timing processes by examining the induced event-related desynchronization (ERD) at the beta-band frequency in the auditory cortex during passive listening of the metronome clicks (400, 800, and 1200ms intervals) (3) the network changes in the resting MEG recording in beta to gamma frequency bands. The gamma-band SSSRs showing group x session interaction suggest the compensatory functional contributions of the contra-lesional brain. The increased beta ERD in the bilateral auditory cortices aligns with our pilot cases and their behavioral rhythm perception improvement. The resting state network analyses are ongoing to extract phase-coherence data through sensor- and source spaces using synthetic aperture magnetometry (SAM) in the frequency-band specific manner to further advance our interpretation of the local and global changes. Our findings contribute to understanding the frequency-specific functions of the auditory, sensory, and motor systems communications.

Exploring genetic factors influencing musical ability in the Indian population: A preliminary study using the Musical Ear Test

Deepika Karthik Kumar1; Shantala Hegde2; Govindasamy Kumaramanickavel3; Narayana Nethralaya4; Sonja Kotz1

1 Maastricht University, Maastricht, The Netherlands; 2 Music Cognition Laboratory, Department of Clinical Psychology, National Institute of Mental Health & Neuro Sciences, Bengaluru-560029, India; 3 GenVams Trust, Chennai, India; 4 Bangalore, India.

Subtheme A - Genetics and Evolution

Introduction and Aim. Measuring musical ability accurately requires a reliable, easy, and versatile test that can be used across many cultures to identify the influence of both genetics and environment. Most studies on musicality have focused on the western world, with no such studies in India. Various music assessment measures created worldwide to characterize research participants may have limitations when used on Indians due to the reliance on relative pitch in Indian music. Our study focuses on exploring the genetic factors influencing musical ability in the Indian population. We chose the Musical Ear Test (MET) for the initial musical evaluation of Indian musicians due to its self-administered questionnaire nature, simplicity, absence of flooring or ceiling effects, and features such as pitch and contour violations in the melody section and intricate rhythm patterns, which are challenging for both Indian and Western musicians. Methods. Twelve musicians and eleven non-musicians, recruited by verbal snowball sampling, took the MET (a 20-minute hearing exam focusing on melody and rhythm) remotely. Additional clarifications were provided individually through phone calls or face-to-face interactions. The participants' responses were evaluated based on the correct answers provided in the MET kit. Results. Musicians outperformed the non-musicians subject group by 17.73%, 16.29%, and 14.2% in melody, rhythm, and total scores of MET, respectively. The statistical analysis using a two-tailed T-test revealed significant p-values of 0.0001, 0.001, and 0.00001 for the three categories, respectively. Conclusions. The MET is a dependable method for assessing musical ability, regardless of variations in musical education and cultural backgrounds. Our study has shown that melody, rhythm, and total MET scores are significantly better in the musicians' group. This study is further exploring the impact of factors such as years of musical training, exposure to dance, participant age and gender, and musical involvement on musicality using MET.

The Stability of the Speech-to-Song Illusion

Rodica R. Constantine; Erin E. Hannon.
University of Nevada, Las Vegas, USA

Subtheme B - Auditory, Motor and Sensory Integration

In the Speech-to-Song (STS) illusion, multiple repetitions of a natural spoken utterance can give rise to a perceptual switch wherein the stimulus begins to sound like song to the listener. Anecdotally, once a speech excerpt transforms to song, listeners say they experience it as song-like when they reencounter it even after long delays, suggesting the STS illusion is temporally stable. However, the long-term stability of the STS illusion has not yet been empirically tested. In our study, we measured the STS illusion by presenting listeners with excerpts known to induce its elicitation and asking them to rate the degree to which each repetition sounded song-like across delays from 0-56 days. Additionally, we measured how readily stimuli transform to song at both sessions and the change in average rating at both sessions. Our results empirically demonstrate the stability of the STS illusion, since at session 2, stimuli initially rated as “song” during session 1 were rated significantly more song-like than those initially rated as “speech, regardless of delay condition. Furthermore, cross-session correlations show that ratings are consistent across sessions at the stimulus level, which is supported by a decreased change in average rating from session 1 to session 2, with no variation by delay. Finally, the number of stimuli rated as song-like and the speed with which stimuli transformed increased from session 1 to session 2 across participants. Overall, we provide strong support for the notion that the STS illusion is not only stable over delays of up to 56 days, but may even increase with further repetition. More generally, our findings support that the STS illusion is a widespread phenomenon experienced by human listeners, as has been shown in prior research.

Neuromelanin level in the substantia nigra is associated with the groove experience

Takahide Etani (1,2,3), Shinichiro Nakajima* (4,5), Ryosuke Tarumi (4,6), Shiori Honda (4), Saki Homma (1), Yuka Kaneko (7), Sakiko Tsugawa (4), Sotaro Kondoh (1), Sotaro Moriyama (4), Yui Tobari (4), Guillermo Horga (8), Clifford Cassidy (9), Hiroyuki Uchida (4), Yoshihiro Noda (4), Shinya Fujii* (10),
(1) Graduate School of Media and Governance, Keio University, Kanagawa, Japan, (2) School of Medicine, College of Medical, Pharmaceutical, and Health, Kanazawa University, Ishikawa, Japan, (3) Advanced Research Center for Human Sciences, Waseda University, Saitama, Japan, (4) Department of Neuropsychiatry, School of Medicine, Keio University, Tokyo, Japan, (5) Department

of Psychiatry, University of Toronto, Toronto, ON, Canada, (6) Seikei-Kai Komagino Hospital, Tokyo, Japan, (7) Faculty of Policy Management, Keio University, Kanagawa, Japan (8) Department of Psychiatry, Columbia University, New York, NY, US, (9) Cellular and Molecular Medicine, University of Ottawa, Ottawa, ON, Canada, (10) Faculty of Environment and Information Studies, Keio University, Kanagawa, Japan, *correspondence author

Subtheme B - Auditory, Motor and Sensory Integration

The pleasurable sensation of wanting to move the body to music is called "groove." Recent research indicates that high-groove music can increase activation in brain regions associated with both movement (e.g., the premotor cortex) and reward (e.g., the medial orbitofrontal cortex) (Matthews et al., 2020), suggesting the underlying neurochemical basis related to dopamine activity during the groove experience. This study aimed to examine the relationship between the degree of experienced groove and the level of neuromelanin (NM), a product of monoamine metabolism, in the substantia nigra (SN), by utilizing NM-sensitive MRI (NM-MRI). NM level in the SN reflects dopamine function. We hypothesized that NM levels in the SN would positively correlate with the degree of experienced groove. Twenty-three healthy subjects (mean age = 46.3312.5 years old, females = 7 [30.4%]) participated in the study. They listened to four high-groove and four low-groove musical excerpts selected from Janata et al. (2012) and rated their "desire to move" and "pleasure" using a 5-point Likert scale. NM-MRI was employed to measure NM levels in the SN. Partial correlation analyses were performed to assess the relationship between NM levels in the SN and the average ratings of "desire to move," as well as "pleasure," controlling for age and sex as covariates. We found a positive correlation between "pleasure" ratings and NM levels in the SN ($r = 0.48$, $p = 0.02$). No significant correlation was found between "desire to move" ratings and NM levels in the SN. These results suggest that the "pleasurable" aspect of the groove experience, but not the "desire to move" aspect, is associated with dopaminergic function; individuals with higher dopaminergic activity may derive greater pleasure from music.

Learning and transmission of rhythmic information is associated with working memory and sensorimotor synchronization skill

Marcelo Kakihara1; Mathilde Martin2; Jelle van der Werff3; Andrea Ravignani3; Maria Celeste Fasano4; Morten Storm Oversgaard4; Peter Keller4; Massimo Lumaca4.

1 Kyoto University, Kyoto, Japan; 2 ESPCI Paris, Paris, France; 3 Sapienza University of Rome, Rome, Italy; 4 Aarhus University, Aarhus, Denmark

Subtheme B - Auditory, Motor and Sensory Integration

How musical rhythms culturally evolved in the forms that we know today? One emerging view in the cognitive science suggests that limitations in perceiving and reproducing rhythms are amplified over generations, introducing regularities observed in music cross-culturally. One key paradigm used to test this theory is known as “iterative learning” (Ravignani et al. 2016), which consists of measuring errors in rhythmic transmission across generations of participants. Research using this paradigm indicates that regularization is associated with variability in individual neurophysiological characteristics (Lumaca et al., 2018). However, it is not completely understood how core cognitive and perceptuo-motor skills such as sensorimotor synchronization, rhythmic discrimination, and working memory affect rhythmic learning and regularization. Our study assesses rhythm transmission through a single cross-generation iterative task in a sample of non-musicians in Denmark. In addition, phonological working memory is assessed with the WAIS-IV digit span test, sensorimotor synchronization through a tapping test paradigm based on the ADAM model from van der Steen and Keller (2013), and music ability with the rhythmic subtest of the Music Ear Test (Wallentin et al., 2010). Results show a significant contribution of ADAM timekeeper and motor noise parameters to explain the accuracy in learning and transmitting rhythmic information. Both were negatively associated with response deviations in tempo and asynchrony, suggesting that rhythmic regularities emerge according to noise in the central and peripherical nervous system. Motor noise and working memory had stronger correlations with tempo deviation in slower trials. Finally, MET scores contributed to explain regularization and were associated with timekeeper noise. It is proposed that cognitive and sensory-motor variability in a population is associated with the emergence of new rhythmic variants, which may propagate through cultural evolutionary mechanisms to produce rhythmic universals.

Temporal and Multisensory Integration of Cardiac and Auditory Signals: Implications on Interoception, Cardiac Function, and Emotion

Ricardo Silva; Joana Coutinho; Adriana Sampaio.
School of Psychology, University of Minho

Subtheme B - Auditory, Motor and Sensory Integration

The ability to integrate sensory information from the environment (exteroception) and internal physiological states (interoception) – intero-exteroceptive integration – is a key aspect of our consciousness, resulting in a multisensory representation of our body in the world. By coordinating its neural activity to intero-exteroceptive dynamics, the brain produces temporal-based responses to adapt to their complexity through temporal synchronization, modulating the physiological, emotional, and cognitive dynamics of our individual and social spheres of experience. Abnormalities in these processes may thus result in uncertainty about bodily states and maladaptive emotional states and cognitions. Recent interventions employing cardiac biofeedback, mindfulness, and music listening have shown promising results in this respect. The goal of this study was to develop a biofeedback-based interactive music system and explore its effect on interoception, cardiac function, and subjective emotional states. This system translates cardiac signals into auditory feedback via generative musical algorithms, creating an ambient music environment that is temporally synchronized to and dynamically modulated by one's cardiac dynamics. A sample of 24 healthy participants was divided into three experimental groups, each performing a single-session attention task: heartbeat mindful attention (interoceptive), non-interactive music listening (exteroceptive), and interactive music listening (intero-exteroceptive). Measures of self-report and task-based interoception, cardiac function, and subjective emotional states were assessed. Significant differences were found in interoceptive accuracy in the intero-exteroceptive group, as well as improvements in cardiac function and reduction of negative affect in all groups. Moderation analyses revealed that the improvements in interoceptive accuracy were more effective in conditions of HR attenuation and HRV suppression. Together, these results demonstrated the effectiveness of interactive music systems in improving aspects of interoception, cardiac function, and subjective emotional states, suggesting that this approach may facilitate intero-exteroceptive integration and temporal synchronization, enhancing one's certainty about bodily states, while inviting mindful attention and calm emotional and physiological states.

Tuning into languages: Exploring individual differences in the ability to perceive melodic elements in foreign languages

Markus Christiner1,2,3* and Christine Groß2;
1 Section Music, Brain and Cognition, Department of Psychology, University of Graz, Glacisstraße 27, 8010 Graz, Austria; markus.christiner@uni-graz.at; 2 Jazeps Vitols Latvian Academy of Music, K. Barona Street 1, LV-1050 Riga, Latvia; christine.michaela.gross@jvlma.lv 3 Austrian Academy of Sciences Corresponding Author: markus.christiner@uni-graz.at

Subtheme C - Perception and Performance

Positive transfer from music to language has been of considerable interest. Research has demonstrated that musical abilities have a positive impact on language skills. In previous research we provided evidence that individuals who perceive new natural languages as more melodic and pleasant-sounding also exhibit significantly better performance in pronouncing foreign languages compared to those who recognize lower melodic elements in foreign languages. Building upon previous research, which identified that certain individuals consistently tend to perceive foreign languages as sounding more melodic compared to others, our study aimed to uncover the factors influencing such varying perceptions. We recruited 110 adults who were instructed to answer questions which focus on the extent to which individuals perceive substantial or minimal presence of melodic elements in foreign languages. In addition, the participants had to report their ability to remember melodies in songs, their actual singing behaviour, their singing behaviour during childhood, and their musical capacity. Furthermore, the participants were also tested for their musical ability, their reading ability and their ability to perceive unfamiliar languages (tone and non-tone languages). Preliminary correlational analysis revealed that the ability to perceive melodic elements in foreign languages is associated with song memory ability, singing behaviour, music exposure, tonal and mistuning perception ability. In addition, the ability to perceive melodic elements in foreign languages was also associated with the ability to discriminate tone languages but not with non-tone language ability. The findings of this study represent a new dimension on the overlaps between music and language and suggests that individuals with higher musical ability and training seem to recognize more melodic elements in foreign languages. This observation implies a fundamental connection between musical proficiency/ ability and heightened phonetic abilities, unveiling a previously unexplored dimension in the relationship between music and language perception.

The Influence of physical and musical training on melodic and temporal components of music perception

Fabíola Mano1; Carina Freitas2; Maria Vânia Silva Nunes1

1 Universidade Católica Portuguesa, Faculty of Health Sciences and Nursing, Lisbon, Portugal; 2Faculty of Health Sciences - University of Madeira, Funchal, Portugal, Center for Interdisciplinary Research in Health - Universidade Católica Portuguesa, Lisbon, Portugal

Subtheme C - Perception and Performance

Music perception is a complex process that involves the recognition of patterns over time and has a hierarchical structure where complex acoustic characteristics are processed. However, individual differences in musical perception remain a significant challenge to understand. The main goal of this study is to explore the impact of musical training, physical training, and both combined on the performance of the melodic and temporal components of musical perception. There were 120 volunteer participants aged between 18 and 32 years, with a standard of 14 years of education. The participants were categorized into groups of musicians, athletes, dancers, and a control group. The Montreal Amusia Assessment Battery (MBEA) was used to evaluate the participants' performance in standard music processing components, such as scale, contour, interval, rhythm, meter, and musical memory. The results of the study showed that there is a differential impact of physical and musical activity on the performance in all battery tests, including at the respective global index. Although the overlap scores between groups were similar, the slight differences were not statistically significant. The dancers present better average performances in the temporal components of musical perception than all the others. Conversely, the group of musicians has better average results in melodic aspects. The study also found relevant correlations between performance and the years of practice, the age at which it started, the number of weekly hours practised, and the regularity with which participants listen to music weekly. The study suggests that embodiment may play a crucial role in human metric perception. These findings can have implications for music educators and therapists in understanding the role of physical and musical training in enhancing musical perception.

Boosting language ability: Creativity through musical talent and its relationship to language capacity

Christine Groß1*; Markus Christiner 1,2,3

1 Jazeps Vitols Latvian Academy of Music, K. Barona Street 1, LV-1050 Riga, Latvia; 2 Section Music, Brain and Cognition, Department of Psychology, University of Graz; 3 Austrian Academy of Sciences Corresponding Author

Subtheme C - Perception and Performance

Creativity is a vital skill that facilitates solving problems across various aspects of life. Research has shown that listening to music improves problem-solving performance by broadening thought processes. This effect is attributed to music's ability to foster diverse perspectives and innovative solutions. In previous research we asked individuals to indicate how melodic languages sounded to them. Interestingly, individuals who perceived languages as more melodic also pronounced these languages significantly better. Being able to perceive melodic aspects in languages is based on creative and imaginative processes. Therefore, we wanted to uncover whether musical abilities influence creative processes in problem solving, which, in turn, may contribute to enhanced language skills. We recruited 150 participants for this study and developed a comprehensive scale assessing creativity in problem-solving. Furthermore, we utilized various musical and language measures from previous research. The language measures included tasks that assessed language perception and pronunciations skills and also included questionnaires that provided information about individual differences in language background, in the ability to perceive melodic aspects in foreign languages, in the ability to retain languages in their mind. The music measures included questionnaires on melody memory, music (including singing) background and exposure as well as a variety of different musical ability tests. First correlational results showed that creativity in problem solving is associated with the ability to retain languages in their mind, perceptions of musical elements in foreign languages, memory for melodies, music exposure, music practice and singing behavior. Our findings suggest that creativity in problem-solving is related to both musical capacity and to language-related variables. We speculate that musical training not only enhances creativity in solving tasks within a musical context but also extends to language.

From 17 to 70: A Preliminary Study of Tempo Variability in Selections From Peter Serkin's Recordings of the Goldberg Variations (1965-2017)

Tracy Lipke-Perry1; Darren J. Dutto2.
1 Crane School of Music, State University of New York at Potsdam, Potsdam, NY, USA; 2 Department of Health and Human Performance, Eastern Oregon University, La Grande, OR, USA.

Subtheme C - Perception and Performance

Tempo variability in music is a distinguishing characteristic that may improve understanding of relationships among musical structure, sensorimotor performance across the lifespan, and live vs. recorded performance experience. The purpose of this project was to discern persistent vs.distinguishing timing characteristics across 53 years of performing. METHOD. Repertoire: Aria and 5 variations from Peter Serkin's 1965, 1986 (live), 1994, and 2017 (live) Goldberg Variation recordings. Data collection, Tempo data were extracted from audio recordings. Beat tracking was undertaken via Sonic Visualizer. Plugins, Tap Snap, and Dyn-A-Matic were utilized to refine determination of beat onsets. Analysis. Average inter-beat interval (IBI) was calculated for each excerpt. Coefficient of variation (CoV) was calculated as an indicator of performance variability across recordings. Utilizing absolute timing of each beat, a least-square straight line fit was determined, facilitating calculation of expected beat onset time and subsequently, the deviation of timing from the measured onset (s). Euclidean distance was calculated as a measure of error. The contribution of each measure to overall timing deviation was determined (%). RESULTS, Exemplar data are reported for Variation 1, A section. IBI (s) by year (ascending order) was (M = .66 3 .04), (M = .50 3 .02), (M = .56 3 .02), and (M = .68 3 .03). Euclidean distance was (M = .70 3 .62), (M = .47 3 .36), (M = .173 .14), and (M = .31 3 .44). Percent timing error for the 1st/last measure of this excerpt was (22%, 2%, 33%, 9%) and (12%, 40%, 5%, 0.2%), respectively. CONCLUSIONS, IBI differences suggest different tempi across recordings. Differences in Euclidean distance distinguish timing flexibility across performances and unique pacing strategies within-performance. Emergence of performance 'fingerprints' warrants continued longitudinal analysis to tease central vs. artistic determinants of variability and their relationship to perception and potential health/aging implications.

Bilingualism, Music Perception and Singing: The Influence of Speaking two Languages on Musical Ability

Maria Schneider1; Valdis Bernhofs1; Christine Groß 1+;Christiner Markus 1,2,3,*,+;
1 Latvian Academy of Music, Jazeps Vitols Latvian Academy of Music, LV-1050 Riga, Latvia; 2 Centre for Systematic Musicology, University of Graz, A-8010 Graz, Austria; 3 Austrian Academy of Sciences; * Corresponding author; +equally contributing last authors

Subtheme C - Perception and Performance

Research has shown that musical ability influences language capacity on multiple domains. However, going the opposite direction we wanted to look at whether bilingualism influences musical ability and singing. Therefore, we selected monolingual and bilingual non-musicians and musicians (N= 263) between 9 and 17 years of age. The participants performed a perceptual musicality test. In addition, they had to indicate how much they enjoy singing and to self-assess their singing voice. Results revealed that musicians performed significantly better in perceptual musicality measures irrespective of whether they were monolinguals or bilinguals. This suggests that the bilingual benefit which has generally been reported in language research has no influence on music perception ability in our sample. In marked contrast, we detected that bilinguals reported to like singing more than monolinguals, as well as they judged themselves to be better singers. In previous research we also detected that singing ability is associated with productive language behaviours such as faking accents, tone language ability, the number of foreign languages spoken and the pronunciation in various typologically different languages (Coumel et al. 2023 and Christiner et al. 2022a). Based on the findings of our studies we want to evaluate the bilingual's singing abilities and its relationship to language capacity in more detail. Therefore, we use a number of different singing measures which were developed in the past decade. These include familiar and unfamiliar singing tasks, measures of singing background, singing training, singing behaviour during childhood and singing self-estimation (Christiner et al. 2022b). In addition, we integrate multiple language measures to provide detailed information about bilinguals' language ability and its relationship to singing capacity in more detail. Preliminary results have shown that bilinguals were not only better in language skills but also in singing.

The performance anxiety in music

Giorgia Vitale
Ministero dell'istruzione italiano Ragusa (RG)- Conservatorio della Svizzera Italiana, Lugano (CH)

Subtheme C - Perception and Performance

Does performing more frequently help reduce the level of anxiety? The present study aims to investigate a potential correlation between the frequency of public performances and the level of performance anxiety. The initial section of the text will elucidate the primary theories on the subject. A dedicated segment focuses on the data collection process conducted in two phases: initially, a questionnaire comprising semi-structured questions was administered to a sample of musicians from the Conservatorio della Svizzera Italiana (enrolled in Bachelor's or Master's programs). The questionnaire aimed to gather information regarding their musical background, the extent of performance anxiety experienced, strategies employed to mitigate it, and the frequency of concerts performed in the past year and month. Subsequently, the Music Performance Anxiety Inventory Test (MPAI) by Diana Kenny was utilized to directly investigate performance anxiety within the musical context. Finally, the results obtained from the MPAI and those derived from the interviews, particularly regarding the frequency of concerts per month and year, were subjected to statistical analysis, including linear regression. The concluding section is dedicated to the discussion of the findings.

Psychosocial factors in the development of musicality: Cross-sectional results from a cohort of secondary school pupils in Latvia

Tatjana Voitova1; Daniel Müllensiefen1,2; Reinis Maurītis1; Valdis Bernhofs1.
1 Department of Systematic Musicology, Jāzeps Vītols Latvian Academy of Music, Riga, Latvia; 2 Department of Psychology, Goldsmiths, University of London, London, UK

Subtheme C - Perception and Performance

Background: Active engagement with music is considered to have a significant impact on personal, social, and intellectual development of young people (Asztalos & Csapó, 2017). Psychosocial skills are closely linked to musical abilities and academic performance in adolescence (Müllensiefen et al., 2015). However, it is yet unclear to what extent psychosocial factors interact with aspects of musicality.
Aim: This study aims to determine the relationship between psychosocial factors and musical listening abilities in adolescents with and without intensive music training in Latvia.

Methods: The longitudinal study involves two types of schools: general secondary schools and schools with an intensive music training curriculum. In total, 237 pupils (age range 11-20 years) participate in the research.
Data is collected through the LongGold test battery (www.longgold.org) which has been translated and adapted for the Latvian population, comprising tests of musical listening abilities, cognitive tasks, and self-report questionnaires on psychosocial variables, demographics, and musical background.
Each participant takes part in three rounds of testing spaced six months apart.
Two testing waves have already been carried out; the 3rd wave is scheduled for May 2024.
Results: An initial cross-sectional analysis indicates positive associations among musical listening ability on one hand and several predictor variables on the other hand, including musical training ($p < .001$), working memory ($p < .001$), and age ($p<.001$). In addition, various psychosocial factors are closely linked to musical listening ability, i.e., Children's grit scale ($p < .001$), Children's hope scale ($p<.01$), and prosocial skills ($p<.01$).
Conclusion: The cross-sectional data model already suggests the importance of psychosocial variables above and beyond the expected influence of cognitive and musical training variables.
A quantitative model of the interaction between psychosocial factors and musical development in adolescents based on longitudinal data will be computed once data collection is complete.

Short-term practice and rhythm complexity: Modulation of cardiac dynamics in auditory -motor synchronisation

Shannon E. Wright1,2; Caroline Palmer1
1 Department of Psychology, McGill University, Montreal, Canada; 2 Department of Psychology, University of the Fraser Valley, Abbotsford, Canada

Subtheme C - Perception and Performance

Long-term musical training leads to more accurate and less variable timing in music performance tasks. Additionally, performers' cardiac rhythms tend to be less regular during production of more complex auditory rhythms. Effects of short-term training and rhythm complexity on music performance and cardiac dynamics have yet to be identified. We investigated how short-term training and rhythm complexity affect auditory-motor synchronisation and cardiac dynamics. Forty-two adult participants (all levels of musical training) synchronised their taps with a computer-generated stimulus to form a complex rhythm with 2:3 duration ratio (stimulus duration:tap duration) or 3:2 duration ratio (tap rate held constant across rhythms). Participants practiced producing each rhythm for either one minute of training or three minutes of training. Then they completed five trials with each rhythm in which they synchronised their sounded taps with the stimulus rhythm. Cardiac activity was recorded throughout the synchronisation task. Tap synchronisation was more accurate and less variable for the 2:3 rhythm than the 3:2 rhythm. Linear measures of cardiac activity showed greater high-frequency variability for the 2:3 rhythm than the 3:2 rhythm. Correspondences between behaviour and cardiac activity emerged with more training: Participants' tap synchronisation variability correlated positively with their cardiac variability only for the 3 -minute training condition. Stable individual differences in nonlinear cardiac measures were observed across training amounts: Individuals whose cardiac signals were most recurrent and predictable following the 1-minute training also had the most recurrence and predictability following the 3-minute training. These findings demonstrate rhythm complexity effects on behaviour and cardiac activity during auditory-motor synchronisation. They also demonstrate stable individual differences in musicians' cardiac dynamics, pointing to a new source of individual variability that should be further investigated in music performance.

Characterization of oscillatory dynamics supporting associative learning in humans using MEG and SEEG.

Arthur Borderie1; Shiva Sedghi1; Laurence Martineau2; Paule Lessard Bonaventure2; Philippe Albouy1.
1 CERVO Brain Research Center, School of Psychology, Laval University, Québec, G1J 2G3, Canada; 2 CHU de Québec - Laval University, Québec, G1J 1Z4, Canada

Subtheme D - Memory and Cognition

Background Theta (4-8Hz) power and theta-gamma PAC (2 .5-5 Hz / 34-130 Hz) in the hippocampus appears to be a marker of many memory processes. However, the role of theta-gamma PAC and the global fluctuations of oscillatory power related to associative learning still needs to be specified. In this study, we investigated if brain oscillatory power and theta-gamma phase-amplitude coupling can characterize associative learning in humans. Methods MEG recordings in 30 healthy participants and Stereotaxic EEG recordings were obtained in 12 pharmaco-resistant epileptic patients. The participants performed 5 tasks consisting in: i) The sound perception block: participants passively listened to five complex sounds presented sequentially. ii) The letter perception block: they passively observed five letters displayed sequentially on a screen. iii) The associative learning task: Participants learned to associate each sound with a specific letter, presented in pairs They then performed two testing phases: iv) Phase 1: a sound was played and the participants were required to indicate the corresponding letter; and v) Phase 2: a letter was displayed, and participants mentally generated the corresponding sound. After a 1-s delay, a sound was played, and participants were required to indicate whether the sound matched or mismatched with the letter that was initially presented. After MEG and SEEG pre-processing, phase-amplitude coupling was computed using Brainstorm's tools. Results. In Both MEG and SEEG data, phase-amplitude coupling analyses revealed learning-associated functional changes in phase and amplitude in function of regions. We observed networks including auditory areas, the orbitofrontal cortex, the IFG, hippocampus and other regions. Conclusion. This result suggests that processing associated memory could rely on two mods, one with a low frequency for phase and one with a high frequency for phase. This research will expand our knowledge of the role of cross-frequency coupling as a biological mechanism for brain information processing.

The Impact of Yoga and Meditation on Cognitive Processes: A Study on Auditory P300

Bollera Gangu Chengappa; Dr. Nisha K V; Dr. Prashanth Prabu
Department of Audiology, All India Institute of Speech and Hearing, Mysuru, India

Subtheme D - Memory and Cognition

The ancient art of yoga and meditation, which originates from India, have been associated with various cognitive and mental health benefits such as improvements in attention and focus. P300 is a cognitive electrophysiological measure that is considered to be a potential depicting attention, memory and discrimination, where in a peak is elicited by a rare stimulus in an odd-ball paradigm. The neural generators are the auditory cortex, portions of the frontal lobe and the parietal lobe. This study aimed to assess cognitive processes by examining the auditory P300 in practitioners of yoga and meditation. Methods: The study included 10 normal hearing participants who have been practicing yoga and meditation for a minimum of 1 year and a regime involving basic stretches, Asanas (postures), Pranayama (breath work) and meditation. The control group consisted of 10 individuals who do not follow such practices. P300 was carried out on consenting participants. A 3 stimulus oddball paradigm containing two blocks using 3 active electrodes (FZ, CZ, PZ).

In block /ta/, /ta/ served as the target while /da/ was the distracters. In the block containing /da/, /da/ were the targets, and /ta/ were the distracters. /ba/ severed as standard in both blocks. Results: t-test revealed that there was no significant differences ($p > 0.05$) between the groups or electrodes in both amplitude and latency. Discussion: The lack of difference between the groups in peak amplitude and latency measures of P300 can be attributed to limitations of conventional peak measures such as priori bias in a specific time period. The results could also be due to the limited sample size and the test not being carried out during an active meditative state (during yoga). Conclusion: In conclusion, no significant differences in P300 measures were observed between the groups.

Neural Correlates of Processing Sung Versus Spoken Words in Healthy Individuals: ALE Meta-Analysis

Annie Chu; Claude Alain; Michael Thaut.
University of Toronto, Canada

Subtheme D - Memory and Cognition

Accumulating empirical evidence indicates that neural activations during the perception of verbal stimuli vary depending on whether the words are sung or spoken, although the specific brain areas involved remain ambiguous. Following an extensive review of the literature, we conducted an Activation Likelihood Estimation (ALE) analysis encompassing data from 10 neuroimaging studies, involving 116 foci and 266 participants. The objective was to discern consistently activated brain regions in healthy adults when exposed to sung words, in comparison to spoken words or an equivalent condition. The findings unveiled a bilateral cortical-subcortical co-activation pattern, delineating three significant clusters localized within the right insula (BA 13), left superior temporal gyrus (BA22), and right superior temporal gyrus (BA42). The bilateral STG played a crucial role in language comprehension, acoustic-phonetic aspects of consonants and vowels, and dynamic cues related to intonational pitch. The claustrum/insula emerges as a pivotal component in auditory processing, functioning as a hub that integrates sensory and limbic information to (sub) cortical structures. This intricate network underscores its integral role in the orchestration of cognitive processes related to verbal perception and underscores the significance of the claustrum/insula in facilitating the integration of sensory and emotional aspects of auditory experiences within the broader (sub)cortical framework. In conclusion, peak activations identified in studies examining sung and spoken words were categorized into four paradigms: passive listening, discrimination tasks, detection tasks, covert verbal response, and memory-related tasks. Our outcomes are deliberated in the context of the potential dependence of sung word processing (i.e., meaningful words, pseudowords, phrases, etc.) on the dorsal stream, sensorimotor integration, and spatial processing. The interplay of this pathway with the inferior parietal lobe and premotor cortex establishes a fundamental framework for the acquisition of vocal skills in both speech and song, implicating the potential facilitation of working memory and singing in verbal learning.

Therapeutic musical improvisation and its relationship with social cognition: perspectives on musical analysis models for research voice data

Ivan Moriá Borges; Renato Tocantins Sampaio; Sérgio Freire Garcia.
Universidade Federal de Minas Gerais

Subtheme E – Language and Social Interaction

Based on a previously literature review (Moriá, 2021), it appears that the discussion on social cognition (CS) is still not sufficiently investigated in music therapy literature, and studies in Music and Medicine are mostly developed through receptive musical intervention, such as the studies found on social cognition and music developed by Koelsch (2009). In this work we will present a musical intervention approach that develops mainly from interactive musical improvisation, a technique widely used in music therapy sessions in Brazil, identified in the practice of spontaneous and joint musical creation between client and music therapist, using musical instruments and the voice, and its possible relationship with social cognition, in order to develop a music therapy assessment tool on this domain. Investigating ways of analyzing improvisation data in music therapy, we noticed a difficulty in using the Music Therapy Toolbox (Erkkilla, 2007) due to the use of the voice as an improvisation instrument. This work proposes a discussion on alternatives for analyzing vocal information, in addition to the midi information of the musical instruments used. With this methodological practice it was possible to observe the social elements that emerge in a musical improvisation, which are many and complex. Authors such as Green (2008) define CS in domains such as theory of mind and processing and perception of emotions. The results of this work point to the relationship between some of these domains with joint attention to rhythmic, melodic and harmonic synchrony. These are elements that require a spatial understanding of both the musical stimuli developed and also intrapersonal stimuli such as feelings, memories and emotions expressed in the music verses. The variety of elements found in this type of practice allows a broader view in relation to SC, as they recruit various cognitive processing structures to adapt to musical proposals.

Whole-brain turbulent dynamics is altered in patients with chronic post-stroke aphasia

Lars Rass1; Yonatan Sanz-Perl1; Anira Escrichs1; Anni Pitkäniemi2,3; Sini-Tuuli Siponkoski2,3; Nella Moisseinen2,3; Linda Kuusela4,5; Johanna Pekkola5; Susanna Melkas6; Aleksi J. Sihvonen2,3,6,7; Teppo Särkämö2,3; Noelia Martínez-Molina1,2,3 *; Gustavo Deco1,8 *.
1 Department of Information and Communication Technologies, Universitat Pompeu Fabra, Barcelona, Catalonia, Spain; 2 Department of Psychology and Logopedics, University of Helsinki, Helsinki, Finland; 3 Centre of Excellence in Music, Mind, Body and Brain, University of Helsinki, Helsinki, Finland; 4 Department of Physics, University of Helsinki, Helsinki, Finland; 5 Department of Radiology, Helsinki Central University Hospital and University of Helsinki, Helsinki, Finland; 6 Department of Neurology, University of Helsinki and Helsinki University Hospital, Helsinki, Finland; 7 School of Health and Rehabilitation Sciences, Queensland Aphasia Research Centre and UQ Centre for Clinical Research, The University of Queensland, Brisbane, Australia; 8 Institució Catalana de la Recerca i Estudis Avançats (ICREA), Barcelona, Catalonia, Spain,

Subtheme E – Language and Social Interaction

Current evidence indicates that healthy neural dynamics operate in a turbulent regime, which is thought to optimize the brain's information processing capabilities. Whole-brain turbulent-like dynamics extends the traditional concept of metastability by calculating the brain's synchronization locally at different spatial scales. Moreover, the turbulent-like dynamics framework also allows the characterization of brain states in the clinical population including patients with focal brain damage. However, it still remains unknown how whole-brain turbulent dynamics is affected in patients with post-stroke aphasia (PSA) at the chronic stage and, importantly, what is the relationship with clinical speech outcomes. Here, we applied the whole-brain turbulent-like dynamics framework to resting-state fMRI data (rs-fMRI) from N=25 patients with chronic PSA and N=35 demographically-matched healthy controls (HCs). We found increased global turbulence at long and intermediate spatial distances. Focusing on these distances, we also found increased information cascade flow and information transfer. The increase in information transfer was associated with better performance in a responsive speech index combining naming and repetition capabilities. Furthermore, most of the nodes showing increased turbulence in the patients with PSA as compared with HCs were located in the control, default and limbic networks at long and intermediate distances. Overall, these results suggest that increased turbulence at long and intermediate distances, especially involving the executive control network, might represent a compensatory mechanism after left-hemisphere damage. Our findings are in agreement with the variable neuro-displacement theory and could help us to better understand the neural mechanisms underlying recovery from PSA. Crucially, this knowledge could be used to tailor future music-based interventions for speech rehabilitation.

Sociomusical interaction in children with autism and echolalia

Melissa Lima1,2; Diana Santiago2.
1 Bahia Association of Music Therapy; 2 Federal University of Bahia, Brazil.

Subtheme E – Language and Social Interaction

This poster presents an ongoing Master's research in Music Education, "Sociomusical interactions in children with autism and echolalia: a multi-case study based on fragmented and repetitive songs". The musical phenomenon studied occurs in verbal children, with Autism Spectrum Disorder – ASD, who present echolalia. The type of musical performance in question is something unique and draws attention because it consists of a small excerpt, spontaneously chosen by the child, and sung repetitively. This qualitative research is a multi-case study, with musical interventions applied to three children within the aforementioned profile. Validating the importance of involving the family, a semi-structured interview will be carried out, in which the mother or father will be able to report on: how this song appears at home; how they deal with the child while they sing it; whether there is identification of the melody; the intelligibility of the lyrics; and whether there is an adult's provocation in completing the passage and the child's reaction. Each speech therapist who already treats the children will contribute additional data such as classification of the type of echolalia, mitigation potential, and the description of verbal and musical interactions with the child when the singing appears during consultation. The objectives of the research are to investigate the possibilities of socio-musical interaction based on these songs, analyze the facilities and difficulties of the family in recognizing repetitively sung fragments, observe the musical outcomes derived from the completeness of the song, and observe any performance inflexibility that does not allow for fluency. The study has potential to add information to scientific, family and professional circles. For the autistic community, the aim is to welcome and validate these songs, including this form of musical language in the repertoire of cognitive and psychosocial development.

The Music for Childhood Well-Being Initiative: Leveraging Group Singing and Breathwork to Support Children's Health and Well-Being Globally

Dr. Sarah Bartolome1; Dr. Nicole St. Jean2,3
1 Northwestern University Bienen School of Music; 2 Feinberg School of Medicine; 3 Center for Child Trauma Assessment, Services, and Systems Integration

Subtheme F - Emotion and Well -being

The Music for Childhood Well-being Initiative (MCWI) examines the use of music as an intervention for mitigating stress and increasing the well-being of children globally. This pilot study explored the impact of an 8-week group singing and breathwork intervention on children aged 9-11 (N=67) in the US (n=27), England (n=20), and Mexico (n=20). Our interdisciplinary team integrated biometric, psychological, and behavioral methodologies to provide a holistic, biopsychosocial understanding of the impact of group singing and breathwork on children. We ultimately aim to provide evidence of how this music intervention might be used to enhance well-being among children around the world. This study employs wearable, mechano-acoustic sensors to track heart rate variability (HRV) during sessions as a proxy for stress. Participants use an app (www.wellcheq.com) to report mood using emojis before and after sessions. Participants also complete the State-Trait Anxiety Inventory for Children at the beginning and end of each session to track changes in state anxiety. After sessions, participants are interviewed and a closing focus group is held after the final session. Two additional measures (Belonging Scale and Sense of Community Scale) are administered at the mid-point and end of each cohort to track emergent group cohesion. Preliminary biometric analysis suggests a small trend in increased HRV from the beginning to end of sessions. Psychological and WellCheq data reveal slight trends toward more positive mood following sessions. No changes in sense of belonging or community are evident, perhaps owing to the structured activities which limit peer-to-peer interaction. Interview data revealed participants' enjoyment of activities and reports of feeling "energized," "relaxed," or "chill" after sessions. Before sessions, students were more likely to report feeling "stressed" or "tired." Preliminary findings are reported here but more granular analysis will continue through June 2024. Eight additional cohorts of participants (n=80) are slated for AY2024-2025.

Hands-on Undergraduate Experience with Auditory Neurofeedback Research Using Low-Cost Electroencephalography (EEG) Devices

Lincoln G. Craton 1, John McCoy2

1 Department of Psychology, Stonehill College, Easton, MA

2 Department of Psychology & Neuroscience Program, Stonehill College, Easton, MA

Subtheme F - Emotion and Well -being

Undergraduate students have limited access to the expensive equipment used in cognitive neuroscience. We have adapted commercial low-cost portable EEG devices, designed to assist laypeople in their meditation practice, for the purposes of facilitating student-driven experiments in our lab. Students (n = 9) pursuing independent research helped design and implement several experiments exploring how music and other auditory stimuli modulate cortical oscillations. Here, we describe the EEG headband and the configuration of interface devices employed by one student team to explore auditory neurofeedback protocols intended to facilitate cortical oscillations in the alpha (8-13 Hz) and theta (4-7 Hz) spectra, which are broadly associated with calm focus. Consistent with the known benefits of active, project-based learning, students reported that this hands-on experience was valuable and exciting. EEG sonification has been used to provide auditory neurofeedback since the 1960s (Lutters & Koehler, 2016; Sitaram et al., 2017). The evidence that neurofeedback systems can promote calm focus in nonclinical populations is mixed (Hunkin et al., 2021; Svetlov et al., 2019). To explore this further, student researchers used the MUSE headband (Interaxon, 2022; Segawa, 2019) to measure signals from two sensors on the forehead, corresponding approximately to AF7 and AF8 in the 10/20 international placement system. Signals from these sensors were sent via Bluetooth to a smartphone which displayed real-time signals and recorded the session data in comma separated value (CSV) format using the Mind Monitor app (mind-monitor.com/ $14.99). The free demo version of Ableton Live 11 Suite (https://www.ableton.com/en/trial/) on a laptop was then used to sonify participants' EEG activity. A pair of devices that work within Ableton Live 11 (Muse Port 1.3.1 and Midi Generator: $10) allowed Mind Monitor to stream sensor signals to the laptop. This triggered a Midi instrument in the program which was played through the laptop speakers.

Electrophysiological approaches to evaluate music preference: Electroencephalography and Heart Rate

Soojin Kang1; Junghwan Moon2; Jiyun Han2; Jihwan Woo2; Kyung Myun Lee1, 3, 4, 5
Advanced Institute of Science and Technology, Daejeon, Korea; 2 University of Ulsan, Ulsan, Korea; 3 School of Digital Humanities and Social Sciences, Korea; 4 Advanced Institute of Science and Technology, Daejeon, Korea; 5 Graduate School of Culture Technology, Korea

Subtheme F - Emotion and Well -being

Music is prevalent in our lives for fun, relaxation, therapy, etc. Previous literature demonstrates that listening to preferred music could affect a listener's stress reduction. Emotion to audio-visual stimuli could be classified utilizing machine learning using electrophysiological responses. These machine-learning studies focused on classification accuracy. Therefore, comprehension of neural features for music-involved emotion is relatively insufficient. We investigated electrophysiological responses to music preference, especially with electroencephalogram (EEG) and electrocardiogram (ECG). Ten subjects were involved in tasks, which included listening to 20-second music clips and scoring preference levels with a Likert scale while acquiring EEG and ECG. Each subject provided 3 preference and 3 non-preference music pieces for this study. The genre of music was mostly K-pop. A total of 60 clips were used for acquiring electrophysiological responses. Preference and non-preference EEG were classified based on scores greater than six or lower than two, respectively. We used temporal response function (TRF) and power spectral density (PSD) to analyze EEG responses. For TRF analysis, results indicated that EEG to preferred music had significantly larger activation in the frontal lobe than EEG to non-preference music during 100~200ms after onset ($p<0.05$). For PSD analysis, results revealed that alpha activity for preferred music is lower than that of non-preference music during a period of 15~20s after onset, statistically ($p<0.05$). Heart rate (HR) was calculated using the Pan-Tomkins algorithm and R-peak detection. The difference between HR when listening to preference and non-preference music was compared using ΔHR data that is calculated from the period before the stimulus onset and listening period. The heart rate for preferred music was statistically higher than for non-preference music ($p<0.01$). These results suggest significant features of music preference as reflected in electrophysiological responses. Further studies with more subjects are needed to confirm validity of the electrophysiological approach to evaluate music preference.

Can musical instrumental practice improve emotional competence?

Matarrelli B.1; Carraturo G.1; Pauri M.2; Lippolis M.1; Quaranta L.1; Curci A.1; Lanciano T.1; Vuust P.3; Brattico E.1,3.

1 University of Bari Aldo Moro, Bari, Italy; 2 Music Secondary School Giuseppe Verdi, Milano, Italy; 3 Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Aarhus, Denmark

Subtheme F - Emotion and Well -being

Musicians spend many years learning to understand and interpret the musical syntax with the aim to convey its intentional and emotional content. Therefore, they hone their ability to reason about complex emotional musical information and to produce appropriate gestures capable of fully internalize and express emotions. Neuroimaging studies confirm that music training is associated with changes in emotion-related brain structures such as the ventromedial prefrontal cortex and limbic system. Hence, we aimed to test the hypothesis that musicians would possess a superior emotional competence than other professionals and a similar level of competence than professionals specifically trained in emotional skills such as psychologists. We measured emotional intelligence conceptualized as a set of emotional abilities with the performance test Mayer Salovey Caruso Emotional Intelligence Test (MSCEIT) in three groups: 1) professional musicians or music students from the last years of the conservatory, as well as students of music therapy schools; all had at least ten years of instrumental practice (n=48); 2) non-musicians or amateur musicians/music therapists (n=52) with less than ten years of training; 3) psychologists (n=36) including undergraduate students, graduated psychologists and psychotherapists. Data collection was carried out through an online platform in small-group sessions led by the experimenter. Compared to the second group, expert musicians showed an enhanced "strategic" use of emotions involving conscious and higher-level emotional processes to understand emotions. Remarkably, musicians did not differ from psychologists in emotional skills. These preliminary findings confirm our hypothesis concerning the superior emotional competence, specifically cognitive regulation of emotions, in expert musicians with at least ten years of instrumental practice, not differing from psychologists. A future longitudinal study will determine whether this emotional trait selects who becomes musician or whether it derives from music training itself.

Musical Empathizing and Systemizing and Abilities of Adolescents on the Autism Spectrum

Alexa Servant; Marie de la Sablonnière; Hadas Dahary; Julia Donahue; Dr. Eve-Marie Quintin
McGill University, Montreal, Canada;

Subtheme F - Emotion and Well -being

The Empathizing-Systemizing (ES) theory describes cognition on a continuum: empathizing (recognizing others' mental states) and systemizing traits (analyzing and constructing systems), and suggests that people on the Autism Spectrum (AS) excel in systemizing. This study aimed to assess musical-systemizing and -empathizing abilities of adolescents on the AS. We hypothesized that adolescents on the AS would show enhanced musical-systemizing, but comparable musical-empathizing abilities compared to typically developing (TD) adolescents. The study included 34 participants (14 adolescents on the AS and 20 TD adolescents; 9-16 years old) who completed a musical empathizing task (recognizing music-evoked happiness, sadness and fear emotions in melodies) and a musical systemizing task (distinguishing between same and different melodies with one or several notes altered within the diatonic (difficult condition) or chromatic (easy condition) scale) and questionnaires on musical experience, autism symptoms (socialization and repetitive behaviours/interests), and intelligence quotient (verbal and visual-spatial skills) to control for these variables (as covariates). A two-way ANCOVA showed significantly greater accuracy on the sad condition of the musical empathizing task for the AS group ($p = .035$), but no other significant difference between groups on the other musical-empathizing conditions (happiness and fear) and musical systemizing task ($p > .05$). Interestingly, both the AS group and TD group were significantly better at empathizing than systemizing ($p < .001$). Intelligence scores and socialization measures were significant covariates ($p < .05$). Our findings suggest enhanced recognition of music-evoked emotions, especially sadness, but not enhanced musical perception for adolescents on the AS. These results are in line with previous work showing intact or enhanced music-evoked emotion recognition for people on the AS. This study supports the therapeutic use of music to improve emotion recognition and regulation of adolescents on the AS.

Live music stimulates the affective brain and emotionally entrains listeners in real time

Wiebke Trost, Caitlyn Trevor, Natalia Fernandez, Florence Steiner, Frühholz
Cognitive and Affective Neuroscience Unit, Department of Psychology, University of Zurich, Zurich, Switzerland
Neuroscience Center Zurich, University of Zurich and ETH Zurich, Zurich, Switzerland; Department of Psychology, University of Oslo, Oslo, Norway

Subtheme F - Emotion and Well -being

Live music performances have a special appeal, as the dynamic between musicians and audience may lead to an immersive and powerful emotional experience. In the brain the amygdala has an important functional role in the neural network for detecting the affective significance of musical sounds. Previous studies have shown rather inconsistent results in terms of amygdala responses to musical emotions, which may originate from the non-adaptive nature of recorded music mostly used. In contrast, live music can be dynamic and adaptive in response to audience feedback to maximize emotional responses in listeners. In this study, we introduced a novel setup for studying emotional responses to live music in a closed-loop neurofeedback setup. This setup linked live performances by musicians with the affective neural processing in listeners, whereby listeners' amygdala activity was fed back to musicians in real-time. Brain activity was measured using functional MRI, and amygdala activity was recorded in real time for the neurofeedback signal. It was found that live performed piano music in response to amygdala neurofeedback from listeners was acoustically very different from comparable recorded music and elicited significantly stronger amygdala activity. Moreover, higher activity was also found in a broader neural network for emotion decoding during live compared to recorded music. This included novel observations of the functional predominance for aversive coding in the ventral striatum while during unpleasant music and involvement of the thalamic pulvinar nucleus presumably for regulating attentional and cortical flow mechanisms. Live music also stimulated a dense functional neural network with the amygdala as a central node in this network to influence other brain systems. Finally, only live music showed a strong and positive coupling between musical features, perceptual evaluations and brain activity of the listeners pointing to real-time and dynamic entrainment processes.

Electroencephalographic Activity Associated with Positive and Pleasurable Emotions Induced by Music-Color Stimuli in Depressed Women

Pablo Valdés-Alemán 1, Bruma Palacios-Hernández 2, Bernarda Téllez-Alanís 3,
1 Laboratory of Neuropsychology and Cognitive Neuroscience of the Transdisciplinary Research Center in Psychology (CITPSI) of the UAEM; 2 Center for Transdisciplinary Research in Psychology, in the Autonomous University of the State of Morelos (CITPsi-UAEM) in Cuernavaca, Mexico; 3 Autonomous University of the State of Morelos (CITPsi-UAEM) in Cuernavaca, Mexico.

Subtheme F - Emotion and Well -being

Depression is a major global health issue that often requires alternative therapeutic strategies beyond traditional pharmacotherapy and psychotherapy due to varied patient social contexts and individual responses. Music and color can induce positive emotions and may sometimes be used to improve mental health. Since we know that music and color have an emotional link, this study examines the efficacy of personalized music-color stimuli as a potential bimodal therapy for depression, guided by electroencephalographic (EEG) evidence of parietal brain functional changes in depressed individuals. To that matter, 16 Mexican women (M = 25.5

years, SD = 4), with clinically confirmed moderate depressive symptoms (BDI; M = 22.3, SD = 3.7), were randomly divided into three stimulation groups: (A) personalized music-color stimuli, (B) a validated positive music-color stimulus, and (C) a control group exposed to white noise and a fixation point. Emotional responses towards the stimulus were measured using bipolar scales for Valence, Arousal, and Pleasure. Mood assessments via the Profile of Mood States (POMS) questionnaire and the Valence and Arousal dimensions were conducted pre- and post-stimulation. EEG recordings at P3 and P4 were performed, extracting the alpha power (8—13 Hz). Results showed that only group A experienced significantly more positive and pleasurable emotions towards their personalized stimulus compared to the control group. Furthermore, all participants reported greater positively-valenced emotions and a reduction in depressive mood state (POMS) after stimulation. Finally, ratings of valence and pleasure towards the stimulus positively correlated with greater activation (alpha suppression) at the right parietal region (P4). These findings highlight the potential of personalized music-color stimuli as an adjunct therapy for depression, emphasizing the importance of individualized treatment approaches and providing insight into the neural mechanisms underlying their effectiveness. Further research is needed to explore the long-term benefits and applicability of this therapy across different populations.

A case study of recovering well-being and health after using Brainspotting

Barbara Pastuszek-Lipińska
Academy of Humanities and Economics in Lodz, Poland

Subtheme F - Emotion and Well-being

Brainspotting therapy is a therapy that uses spots in a person's visual field to help them process trauma. The therapy was discovered in 2003 by Dr David Granda, who was able to improve the performance of an ice skater who had difficulty showing her skills during sporting events, while she was doing well during training. According to Dr Grand's discovery, the technique can access trauma trapped in the subcortical brain, the area of the brain responsible for movement, awareness, emotion and learning. Grand observed that the eyes of people with trauma stored in the brain ‘stuck’ at certain points. By stopping the eyes longer in the positions where the eyes 'get stuck' they enter more deeply into their experience and can achieve balance and symptom release and, as a result, improved functioning better than ever before. A component of the therapy is the application of special music to enhance the attunement and therapy process. One of the advantages of the therapy is that there is no need to 'relive' the trauma to facilitate its release from the body and achieve well-being. To test the effectiveness of the techniques, they were applied to a patient in long-term therapy with an equivocal diagnosis and suspected bipolar affective disorder or borderline personality disorder. After periodic improvements in functioning, the patient returned to a difficult childhood that discouraged him from work, therapy and life. The presentation describes the therapeutic process that led to the release of stored anger in the body. The record made life difficult for the patient, while periodically recurring in the form of lumbar pain of unknown origin. Therapy resulted in a rapid deterioration of the patient's physical condition, followed by a three-month recovery process. As a result, the patient recovered mentally and also physically without recurring lumbar pain.

Effects of singing on brain plasticity, mood, and quality of life in individuals with, or at risk for, Alzheimer's disease (ALMUTH): Preliminary findings

Tobias Bashevkin
Institute for Biological and Medical Psychology (IBMP), University of Bergen, Bergen, Norway

Subtheme G - Development and Aging

The number of people living with dementia is expected to increase twofold in Europe and threefold globally by 2050; thus, developing treatments to improve the trajectory of decline and the quality of life in patients at risk of and living with dementia is of high importance. The Alzheimer's and Music Therapy (ALMUTH) study is a 12-month randomized controlled trial implementing two different active non-pharmacological therapies, music therapy and physical activity, for patients with or at risk of developing Alzheimer's disease. Participants were randomized into one of three groups (music therapy, physical exercise, or passive control group), with the two active interventions offering weekly sessions (up to 40 sessions over 12 months). With post-intervention tests to be completed in June of 2024, we expect a final pre/post-test comparison sample of over 105 participants. We will present preliminary findings related to the efficacy of music therapy for reducing cognitive decline and whether there are indications that the interventions contribute to less loss of hippocampal volume and slowed brain aging in our current preliminary sample when compared to passive controls.

Music engagement, cognitive reserve and healthy aging.

Lee Wolff1; Yixue Quan2; Gemma Perry1; William Forde Thompson1

1 Bond University, Gold Coast, Queensland, Australia; 2 Macquarie University, Sydney, New South Wales, Australia;

Subtheme G - Development and Aging

Music engagement is a ubiquitous activity that is thought to have a range of cognitive benefits for the aging population. In the absence of robust treatment approaches for age- or disease-related cognitive decline, interest has emerged surrounding modifiable lifestyle-enriching activities, like exercise and music engagement, to build cognitive reserve across the lifespan and preserve neurocognitive function in older adults. The present review evaluates evidence of neurocognitive preservation arising from lifelong music engagement with respect to the cognitive reserve hypothesis. Drawing upon protocols for search strategies outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P), we collated a body of neuroimaging, behavioural and epidemiological evidence to adjudicate the benefits of music engagement, training or expertise for cognitive reserve. The findings suggest that music engagement should be considered in tandem with other well-established cognitive reserve proxies as a contributor to differential clinical outcomes in older populations at risk of age-related and neuropathological cognitive decline.

Paired Neurologic Music Therapy and Transcranial Direct Current Stimulation for Upper Extremities Following Stroke

Caputo C.C.1, Loria T.2, Kowaleski J.B.1, Thaut M.H.1,3;

1 University of Toronto, Music and Health Science Research Collaboratory, Faculty of Music, Toronto, Canada; 2 Washington State University, Department of Kinesiology & Educational Psychology, Pullman, USA; 3 University of Toronto, Faculty of Music, Faculty of Medicine, Institute of Medical Sciences, & Rehabilitation Science Institute, Toronto, Canada

Subtheme H - Interventions in Educational and Clinical Settings

Introduction Neurologic Music Therapy (NMT) uses music to induce changes in non-musical brain and behaviour function. Patterned Sensory Enhancement (PSE), an NMT technique for motor function, is beneficial for upper extremity (UE) rehabilitation. PSE uses music to provide temporal, spatial, and force cues for movement. The auditory and motor systems couple, bringing about a driving force from the heard cue to facilitate desired movements. Transcranial direct current stimulation (tDCS) used in stroke populations may speed up motor recovery by rebalancing damaged interhemispheric networks. Objectives This study aims to determine any benefits to pairing tDCS and PSE for UEs following stroke when compared to PSE alone (with sham stimulation). This study aims to contribute to the advancement of stroke rehabilitation methods, Neurologic Music Therapy advocacy, and the clinical use of non-invasive brain stimulation. Patients & Methods Eligibility criteria includes adults (18-80) with motor limitations due to stroke. Exclusion criteria includes severe cognitive deficits, apraxia, or neglect; neurodegenerative or psychiatric disease; and contraindications for tDCS. This study uses a randomized, sham-controlled treatment whereby participants receive 20 minutes of 1mA anodal, bilateral tDCS stimulation to the primary motor cortex during six PSE sessions for UEs. Baseline, immediate effect, and retention are assessed using UE assessments and motion captured kinematics. Results. tDCS and PSE may improve UE function following a stroke. Trends in the initial behavioural data demonstrate that there may be improvements in UE function following participation in both the paired tDCS/PSE and sham-tDCS/PSE protocols. Kinematic data continues to be processed. This poster will share the initial results from the novel research that is currently underway. Conclusion There lies potential to enhance the current state of tDCS and NMT research and clinical practice by combining tDCS and PSE to optimize UE recovery following a stroke.

Can art be a medicine? music and drawing interventions promote well-being and mitigate suffering in an oncology ward - a qualitative study

Joao Graca1; Pedro Meireles1; Rita Conde2; Diana Pessoa1; Carolina Pereira1; Salome Magalhaes3

1 Portuguese Oncology Institute (IPO), Lisbon, Portugal; 2 Institut Jules Bordet, Hôpital Universitaire de Bruxellles; 3 McGuill University, Montreal, Canada

Subtheme H - Interventions in Educational and Clinical Settings

A bimontlhy art intervention consisting of simultaneous live music and drawing sessions was performed at the Portuguese Oncology Institute in Lisbon. The music was played in a small room for an average of 13 patients per session. For each session, a group of 2 or 3 talented musicians were selected to play their own repertoire (world music). Sketch artists made drawings during the concert and exhibited them immediately afterwards. In 2023, a qualitative study was conducted to understand the impact of these interventions in that setting. Patients, healthcare professionals and families were interviewed in 6 focus groups (n=26). The main themes were: (1) music induced well-being (abstracting from the disease, achieving a state of relaxation, promoting hope) and alleviated suffering (reducing depression, anxiety and physical pain), (2) this artistic intervention promoted the humanization of healthcare, (3) despite some resistance, it alleviated sadness in healthcare professionals treating seriously ill cancer patients, (4) the intervention was particularly useful for patients who have been in hospital for a long time, patients who had previously listened to music, depressed patients and immigrants. Arts interventions can have a major impact on healthcare care by promoting a positive psychological state, both for patients, families and healthcare professionals.Knowing what works in each situation is a valuable tool for optimising these interventions and facilitating their implementation.

Enhancing Self-Esteem of Adolescents on the Autism Spectrum through an Inclusive Music-Making Program

Mira Kaedbey1; Alexa Servant1; Hadas Dahary1; Mohamed Ghoul2; Nathanaël Labrèche2; Eve-Marie Quintin1.
1 Behavior, Autism, and NeuroDevelopment (BAND) Research Group, McGill University; 2 Département d'éducation et formation spécialisées, Université du Québec à Montréal.

Subtheme H - Interventions in Educational and Clinical Settings

This study investigates the impact of an inclusive school-based music program on adolescents, focusing on social inclusion and self-esteem among those on the autism spectrum (AS). Music-making, with its inherent communication potential, offers promise for enhancing social interactions and communication skills. Group music-making, particularly, fosters cooperation and teamwork, potentially promoting social inclusion. Moreover, music programs have been linked to improvements in self-esteem among adolescents and young adults on the AS, which in turn influences perceived social support. The study involved 49 participants, including both autistic (n=23) and non-autistic (n=26) adolescents, in a high school setting. Participants were divided into three conditions: AS group (n=7), non-AS group (n=16), and two inclusive groups (AS: n=5, non-AS: n=5;

AS: n=9, non-AS: n=5). Over a 16-week period, students engaged in a music-making curriculum primarily focusing on djembe and other percussion instruments. Pre- and post-intervention assessments were conducted using the Social Support Appraisals Scale and the Rosenberg Self-Esteem Scale. Non-AS students also completed the General Social Subscale of the Shared Activities Questionnaire. Results from a repeated measures mixed ANOVA revealed a significant increase in self-esteem scores among autistic students in both the non-inclusive ($M = 2.71$, $SE = 0.60$, $p < .001$) as well as for the inclusive group ($M = 5.00$, $SE = .42$, $p < .001$) and this change was more pronounced in the inclusive group. There were no significant changes in perceived social support or peer acceptance among autistic students in either condition. These findings suggest that inclusive music-making positively impacts the self-esteem of autistic adolescents without adverse effects on social support or peer acceptance. The study advocates for the implementation of inclusive interventions like music programs in various settings, including educational, community, and mental health contexts, to promote social inclusion and positive outcomes for neurodivergent adolescents.

The role of music listening in students' cognitive and emotional development

Daniel-Alex Milencovici
West University of Timisoara, Romania.

Subtheme H - Interventions in Educational and Clinical Settings

The literature claims that music has over dozens of functions that develop the child when it is taught according to didactic principles by the teacher (Schäfer, et al., 2013). With the present study I aim to review the literature on the role of music listening in the cognitive and emotional development of children studying music in special schools and those studying music in general schools. Active music listening is the didactic means, as well as the method, that the music education teacher can use in the classroom to develop children's musical competence, to make the interdisciplinary/ transdisciplinary link between music and other fields of study, and for the emotional well-being of children, especially those in pre-school, primary and secondary school. Thus, I want to create a hierarchy of the most important benefits of listening to music in children's development, citing literature from the last 20 years.

NEUROPIANO; didactic methodology and strategies for teaching piano performance based on the contributions of cognitive neuroscience

Natalia Ollora-Triana
University of La Coruña, Spain; University of Burgos; University of La Rioja, Spain.

Subtheme H - Interventions in Educational and Clinical Settings

The current context increasingly demands a renewal of educational action in any area in order to adapt it to the needs of the future. Neuroscience provides teachers with information and knowledge of the functioning of the brain in learning processes and the influence of vital functions on emotions and higher mental processes. The pedagogical practices for learning a musical instrument must have a holistic character and be based on a deep analysis of the human being, thus, the action in the classroom must be the result of this exhaustive analysis that considers the learning process from within the individual, with the interaction of all its components. The first objective is to learn about and organise the knowledge gained from our own experience and educational praxis as professionals in the field, which has been contributed by neuroeducation as influential in the learning process of the musical instrument. The second objective is to propose didactic strategies for instrumental teaching that will serve for implementation in music classrooms to train autonomous students, who self-manage the learning process and are capable of obtaining technical resources with which to face the study of new works with their musical instrument through the adaptation and flexibility of these resources, who are capable of self-evaluation, of evaluating the process, of collaborating in the development of activities and of having a participatory attitude in the classroom. In conclusion, we offer resources for use in the instrumental learning classroom that can be implemented and evaluated as a prospective study. Keywords: neuropiano, neuro-interpretation of music; neuro-education in music; methodology for music; innovation in music education.

Effect of Mozart's music on patients with disorders of consciousness: analysis of vital signs and galvanic skin response

Amanda Candido Moriconi*; Júlia Mateus de Bei*; Isabela Ayumi Yamashita*; Luisa Helena Mangile*; Ana Cláudia Giesbrecht Puggina*.

Faculdade de Medicina de Jundiaí, Jundiaí, Brazil.

Subtheme H - Interventions in Educational and Clinical Settings

Introduction: Consciousness disorder comprises diverse conditions featuring cognitive impairment, altered consciousness, and arousal disturbances. Clinical states like coma, vegetative, and minimally conscious vary in behavioral and neurological aspects. Objectives: (1) Describe behavioral and neurological profiles of patients with consciousness disorder; (2) Compare changes in vital signs and skin galvanic response before and during stimulation with Mozart's song. Method: This intervention study utilized Mozart's song alongside assessments using the Coma Recovery Scale-Revised (CRS-R) and Glasgow Coma Scale (GCS). Vital signs were recorded every four minutes during periods of silence and musical intervention, with each phase lasting 24 minutes and 17 seconds. Descriptive and inferential analyses were conducted with p<0.05 for statistical tests and a significance threshold of p-values between 0.05 and 0.10. Results: The study included a sample of 10 participants with a mean age of 59 (317.04) years. Half of the participants were male, married, and had a preference for country music. Etiological factors included ischemic stroke (40%) and cranioencephalic trauma from vehicular accidents (20%). The majority exhibited behaviors consistent with a vegetative state (80%) according to the CRS-R, with 80% scoring 3 points on the GCS. Although no statistically significant differences were observed, several parameters approached significance: systolic blood pressure at 2 minutes (p=0.082), heart rate at 6 minutes (p=0.066), respiratory rate at 10 minutes (p=0.088), oxygen saturation at 14 minutes (p=0.054) and 18 minutes (p=0.058), and skin galvanic response at 10 minutes (p=0.059). Conclusions: The majority of participants were assessed to be in a vegetative state with severely impaired consciousness during the intervention. Despite the lack of statistical significance, exposure to Mozart's song was associated with increased systolic blood pressure, heart rate, respiratory rate, oxygen saturation, and skin galvanic response at various time points during data collection.

A musical intervention for rhythmic regularity in send people: regular and non-regulated temporality

Natanael de Souza Ourives[1, 2]; Diana Santiago[2]
[1] Feira de Santana State University, Brazil; [2] Federal University of Bahia, Brazil.

Subtheme H - Interventions in Educational and Clinical Settings

This paper presents percussion teaching strategies used as part of the interventions proposed in an ongoing research for a Doctorate in Music Education. The interventions have been designed for a person with SEND (intellectual disability and comorbidities), and were inspired by the Support Systems defined by Shalock at al. (2021). Intellectual disability can be linked to sensory, cognitive, and motor disorders, factors that affect the performance of musical activities that require rhythmic precision. This means that the person cannot achieve, in different contexts, a temporal regularity that meets rhythmic prerequisites valued as satisfactory. The proposed interventions were designed in two phases: regular temporality and non-regulated temporality (respecting the student's particular temporality). For the first moment of the intervention, didactic-pedagogical and musical support categories were established. These were defined based on an ongoing assessment of the student's needs for support to meet long-term goals: playing target songs. These needs were classified in four levels, ranging from "a lot of need for support" in a given activity, to the achievement of "autonomy". Among the categories of didactic-pedagogical support, the following stand out: use of physical contact, teacher-student imitation, sounds following verbal indication, non-verbal sound performance, visual symbolic, and performance without support (student already autonomous). Among the categories of support of the musical type, the following stand out: without support, student with metronome, with the teacher, with software containing a loop of the rhythm of the target song, with prepared playback (e.g. only voice and percussion of the target song), and "next to the full song" (e.g. playing along with Spotify). The articulated use of these strategies, especially when applied gradually, has so far demonstrated to be effective in developing temporal regularity. This is one of the practical outcomes of this doctoral research on Special Music Education for Inclusion of Neurodivergent Students.

Musical Theatre Eye Movement Desensitization Reprocessing (MT-EMDR) for Promoting Neuroplasticity, Mental Health Recovery, and Well-Being

Nicolas D. Silva
University of Texas at El Paso, College of Health Sciences, Interdisciplinary Health Sciences PhD Program, El Paso, Texas, USA

Subtheme H - Interventions in Educational and Clinical Settings

A queer Latine person of El Paso, Texas in the United States -Mexico border region is treated for treatment resistant bipolar disorder type II, major depressive disorder, post-traumatic stress disorder, generalized anxiety disorder, and panic disorder with a traumatic history of chronic illness and self-esteem challenges. Utilizing music-based interventions such as musical theatre eye movement desensitization reprocessing (MT-EMDR) therapy led to the client to live in remission of mental health conditions. While the patient is still managing life-altering symptoms with their chronic illnesses, they have strengthened their coping skills and therapeutic alliance while queering clinical social work. Songs such as "Frank Mills" from Hair, "Let it Go" from Frozen, "Suddenly Seymour" from Little Shop of Horrors, "Some Enchanted Evening" from South Pacific, "Dance With You" from The Prom, and "You'll Never Walk Alone" from Carousel lay the foundation for songs that can be utilized for healing, comfort, positive emotion building, and trauma rewiring. This poster is call to action in the fields of medicine, neuroscience, psychology, social work, music, society, and therapy to promote more resources and research to be used and conducted to ensure authentic queer stories and healing on Broadway, the West End, and beyond, including in the homes and hospital rooms of sick children to help people of all backgrounds and experiences. Music had immediate pain, mental health, and emotional regulation benefits on the patient. Modalities included either listening to personalized "music medicine" pieces, or singing acapella, or improvisationally performing, or engaging in karaoke in the context of clinical social work and MT-EMDR. Utilizing evocative autoethnography and the theoretical framework of "queer futurity" by the late José Esteban Munoz, this qualitative case study reflects practice that imagines and lives a new queer clinical social work reality and promotes the queer futurisms of neuromusic.

Supporting sensory profiles to encourage participation in ecological contexts: from music therapy to "Io non ballo da solo" [I don't dance alone] project

Daniele Ferrarazzo1; Laura Bravaccini1; Erica Volta2; Silvano Solari3

1 Accademia Pedagogica Philos, Genova, Italy; 2 Educational Technology Institute - Italian National Research Council, Genova, Italy; 3 Department of Education Sciences, University of Genova, Italy

Subtheme H - Interventions in Educational and Clinical Settings

In this poster, we introduce an integrated rehabilitative and educational approach rooted in sensory profiling, evolving from music therapy sessions to the 'Io non ballo da solo' (I don't dance alone) project, fostering socialization in ecological settings like discos for young individuals with Autism Spectrum Disorder (ASD) in Genoa, Italy. Engaging individuals with ASD in ecological contexts poses challenges, underscoring the significance of commencing with sensory mapping. This process, informed by Tomchek et al. (2007) and Simpson et al. (2019), delineates specific sensory characteristics, elucidating how these patterns impact participation in environments. Our methodology draws on the Ecology of Human Performance (EHP) model (Dunn et al., 1994; Dunn, 2007) and the DIR-Floortime model (Greenspan et al., 2008; Boshoff et al., 2020), highlighting the interplay of individual, context, and activity in intervention planning. Child development facilitates a seamless transition from rehabilitative to educational interventions, with the emotional/social domain becoming increasingly pivotal. This journey culminates in participation in ecological contexts. Examining music therapy in adolescence prompts questions about purpose, group dynamics, and therapists' roles post-stimulus processing and interaction development. Amidst diverse professional realms, the disco emerges as a potent social motivator, transcending sensory disparities for non-verbal communication, spontaneous movement, and group identity. It offers a genuine avenue for individual expression and social/affective experiences, resetting differences in favor of shared elements. Observations from the adolescents and young adults from Philos Foundation, after a year-long disco project involvement, reveal that social motivation and affective engagement support sensory challenges. Neurological thresholds seemingly rise, aiding those sensitive to loud sounds. The disco's environment promotes varied communication channels, emphasizing non-verbal elements, fostering diverse social interactions and relationships.

Neural encoding of musical expectations in a non-human primate

Roberta Bianco,1, Nathaniel J. Zuk,2 Felix Bigand,1 Eros Quarta,3 Stefano Grasso,3 Flavia Arnese,1 Andrea Ravignani,4,5,6 Alexandra Battaglia-Mayer,3 and Giacomo Novembre1;
1Neuroscience of Perception & Action Lab, Italian Institute of Technology, Rome, Italy; 2Department of Psychology, Nottingham Trent University, Nottingham, UK; 3Department of Physiology and Pharmacology, Sapienza University of Rome, Rome, Italy; 4Comparative Bioacoustics Group, Max Planck Institute for Psycholinguistics, Nijmegen, the Netherlands;5Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music, Aarhus, Denmark; 6Department of Human Neurosciences, Sapienza University of Rome, Rome, Italy

Subtheme A - Genetics and Evolution

The appreciation of music is a universal trait of humankind. Evidence supporting this notion includes the ubiquity of music across cultures and the natural predisposition toward music that humans display early in development. Are we musical animals because of species-specific predispositions? This question cannot be answered by relying on cross-cultural or developmental studies alone, as these cannot rule out enculturation. Instead, it calls for cross-species experiments testing whether homologous neural mechanisms underlying music perception are present in non-human primates. We present music to two rhesus monkeys, reared without musical exposure, while recording electroencephalography (EEG) and pupillometry. Monkeys exhibit higher engagement and neural encoding of expectations based on the previously seeded musical context when passively listening to real music as opposed to shuffled controls. We then compare human and monkey neural responses to the same stimuli and find a species-dependent contribution of two fundamental musical features—pitch and timing—in generating expectations: while timing- and pitch-based expectations are similarly weighted in humans, monkeys rely on timing rather than pitch. Together, these results shed light on the phylogeny of music perception. They highlight monkeys' capacity for processing temporal structures beyond plain acoustic processing, and they identify a species-dependent contribution of time- and pitch-related features to the neural encoding of musical expectations.

Genome-wide variation associated with active music engagement in mid- to late-life is positively correlated with resilience to mental illness

Henechowicz, T.L. (1,2), Coleman, P.L. (4), Nitin, R.(4), Mekki, Y.N.(3,4), Felsky, D., (2), Gordon, R.L (3,4,5,6).
1. Music and Health Science Research Collaboratory, Faculty of Music, University of Toronto; 2. Krembil Centre for Neuroinformatics, Centre for Addiction and Mental Health; 3. Music Cognition Laboratory, Department of Otolaryngology–Head and Neck Surgery, Vanderbilt University Medical Center; 4. Vanderbilt Genetics Institute, Vanderbilt University Medical Center; 5. Vanderbilt Brain Institute, Vanderbilt University; 6. Department of Psychology, Vanderbilt University

Subtheme A - Genetics and Evolution

Introduction Intervention studies, although inconclusive, suggest music engagement may have some benefits for mental health. However, large-scale epidemiological studies revealed a greater risk for mental illness in musicians compared to controls (Niarchou et al., 2022; Wesseldijk et al., 2023). Indeed, active music engagement is heritable, with estimates ranging from 78% from twin models to 12% via SNP-based approaches. The study leverages genomic methods to investigate the genetic architecture of active music engagement and examine its relationship to neurobiological function and resilience to mental illness. Methods We conducted a genome-wide association study (GWAS) in unrelated Europeans in the Canadian Longitudinal Study of Aging to examine common genetic variation (6,725,254 variants) associated with playing an instrument or singing in a choir several times per year or more (n=3956 cases), compared to no musical engagement (n=15,566). We used functional annotations to ascertain genomic loci and associated functions and investigated genetic correlations with 11 GWAS for mental illness traits. Results. SNP-based heritability for active musical engagement was 8.41%, 95%CI [0.05,0.12], p=3.49 x 10-7, N=19522, power = 1. GWASyielded 31 genomic loci with 36 mapped genes including several mapped genes related to neurobiological function: CDH12 (rs10518914, p=9.71 x 107), ZNF536 (rs193058357, p=5.09 x 106), LSAMP (rs189907653, p=1.65 x 106), and PCDH9 (rs4493636, p=7.53 x 10-6). Thirteen genes showed differential gene expression in the Frontal Cortex (BA9) (p=5.17 x 10-4, p.adj=2.79 x 10-2). The GWAS of active music engagement was significantly negatively correlated with risk for major depressive disorder (qFDR=0.024), alcohol use disorder(qFDR=0.009), cannabis use disorder (qFDR=0.009), schizophrenia (qFDR=0.016), autism spectrum disorder(qFDR=0.024), Tourette syndrome (qFDR=0.009), and bipolar

disorder(qFDR=0.009). Discussion. Our results provide evidence for the significant heritability of active music engagement and several associated genomic loci linked to neurobiological function. Contrary to previous population -level research, active music engagement in mid- to late- life, specifically, is associated with resilience to mental illness.

Perceptual and vocal pitch matching demonstrate genetic pleiotropy in Australian twins

Daniel Yeom 1 *, Isabelle Peretz 2, Yi Ting Tan 1 3, Miriam A. Mosing 1 4 5, Michael S. Hildebrand 6 7, Samuel F. Berkovic 7, Gary E. McPherson 3, & Sarah J. Wilson 1 7.
1 Melbourne School of Psychological Sciences, University of Melbourne, Melbourne, Australia; 2 International Laboratory for Brain, Music and Sound Research and Department of Psychology, University of Montreal, Montreal,Canada; 3 Melbourne Conservatorium of Music, University of Melbourne, Southbank, Australia; 4 Department of Neuroscience, Karolinska Institutet, Stockholm, Sweden; 5 Department of Medical Epidemiology and Biostatistics, Karolinska Institutet, Stockholm, Sweden; 6 Murdoch Children's Research Institute, Royal Children's Hospital, Parkville, Australia; 7 Department of Medicine, Epilepsy Research Centre, University of Melbourne, Austin Health, Heidelberg, Australia

Subtheme A - Genetics and Evolution

Musicality describes a set of cognitive traits that are shaped by biology, but our understanding of the genetic architecture of musicality and its constituent traits is limited. The extent to which the same genes may contribute to ability across traits is even less understood. One fundamental aspect of musicality is the ability to perceive and produce musical pitches. Emerging evidence from genetics studies suggests that both pitch perception and production are moderately heritable, but the genetic relationships between these skills is not known. Neuroimaging evidence suggests a dissociation in sensorimotor networks for pitch perception and production in amusia, implying distinct underlying causes. Studies with genetically informative samples provide another way of exploring the perception-production relationship. We examined single note pitch perception and production in a large, well-characterised sample of Australian twins (N = 1189) using the online Melbourne Singing Tool. Participants matched a series of single notes, first using a perceptual slider modelled on the human voice, and then by singing back the note. The tasks were designed to be identical in terms of stimuli and presentation except for the mode of response (slider versus voice). This design ensured the two tasks relied on similar cognitive processes aside from the mode of response, and therefore enabled direct comparisons between perception and production. Bivariate genetic modelling indicated a high genetic correlation between single pitch perception and production (rG = .92), with shared genetic variants accounting for 57% of the phenotypic correlation. These findings suggest there is high genetic similarity between the ability to perceive and sing single notes in tune, adding to growing evidence that the genetic architecture of musicality is pleiotropic in nature. Specifically, shared sensorimotor mechanisms between the two tasks may indicate that sensorimotor mechanisms are crucial to the genetic architecture of music perception and production.

Spectro-temporal acoustical markers differentiate speech from song across cultures

Philippe Albouy1,2,3*, Samuel A. Mehr2,4,5, Roxane S. Hoyer1, Jérémie Ginzburg6, and Robert J. Zatorre2,3,7*;
1 CERVO Brain Research Centre, School of Psychology, Laval University, Québec, Canada; 2 International Laboratory for Brain, Music and Sound Research (BRAMS), Montréal, Canada; 3 Centre for Research in Brain, Language and Music and Centre for Interdisciplinary Research in Music, Media, and Technology; Montréal, Canada; 4 School of Psychology, University of Auckland, Auckland, New Zealand; 5 Child Study Center, Yale University, New Haven, USA; 6 Lyon Neuroscience Research Center, Lyon, France; 7 Cognitive Neuroscience Unit, Montreal Neurological Institute, McGill University, Canada

Subtheme B - Auditory, Motor and Sensory Integration

Humans produce two primary forms of cognitively complex vocalizations: speaking and singing. What is the basis for these two categories? Is the distinction between them based primarily on culturally specific, learned features, or do consistent acoustical features exist that reliably distinguish speech and song worldwide? Some studies have suggested that music can be distinguished from speech based on spectro-temporal modulation patterns, but this conclusion is based on Western music, leaving open the question of whether such a principle may apply more globally. Here, we studied the spectro-temporal modulation patterns of vocalizations produced by 369 people living in 21 urban, rural, and small-scale societies distributed across six continents. We show that specific ranges of spectral and temporal modulations differentiate speech from song in a consistent fashion, and that those ranges overlap within categories and across societies. Machine-learning analyses confirmed that this effect was cross-culturally robust, with vocalizations reliably classified as song or speech solely from their spectro-temporal modulation patterns across all 21 societies. Western listeners unfamiliar with most of the cultures could classify these vocalizations using similar spectro-temporal cues to those used by the classifier and with similar accuracy patterns as the machine learning algorithm. Finally, we show that spectro-temporal features are better able to discriminate song from speech than a broad range of other acoustical variables (pitch, formants, vowel rates, intensity, rhythmic measures etc.), suggesting that spectro-temporal modulation content accounts for a fundamental difference between speech and song, beyond general acoustic cues. The findings support the idea that the human nervous system is specialized to produce and perceive two distinct ranges of spectro-temporal modulation in the service of the two distinct modes of complex human vocal communication.

In sync: Effects of frontotemporal theta synchronization on musical pleasure and motor learning

Albury A.W.(1,4,5), Deosdad Díez M.(2), Fàbrega Camps G.(2), Ara A.(2,3,5), Marco-Pallares J.(2), & Penhune V.B.(1,4,5)
1) Concordia University, Montreal, Canada 2) University of Barcelona, Barcelona, Spain 3) McGill University, Montreal, Canada 4) Brams: International Laboratory for Brain Music & Sound Research, Montreal 5) Centre for Research on Brain Language and Music (CRBLM), Montreal, Canada

Subtheme B - Auditory, Motor and Sensory Integration

Music is a multi-faceted phenomenon that influences numerous aspects of cognition and behavior, including emotional arousal, action planning, and fine motor movements. Music has been demonstrated to induce reward as a result of predictive processes and the same predictive processes are recruited to plan movements during musical performance. One mechanism that has been proposed to coordinate the varied cognitive processes during music cognition is synchronization of neural oscillations. Synchronization of slower oscillations such as theta is thought to represent interaction between more distant brain areas. Previous research has shown that increased theta synchronization of frontotemporal areas is related to increased pleasure during music listening. Following this, we designed a study to investigate the joint effects of theta synchronization and reward on motor learning in music. 30 non-musicians listened to and rated 9 short melodies while 64-electrode EEG was recorded, and then learned to play the endings of these melodies using a simulated piano keyboard. Across 7 trials participants heard each melody in full and then heard just the first 4 bars while they completed the last 2 from memory. Performance was evaluated by accuracy and asynchrony of keypresses. Participants successfully

learned the melodies as demonstrated by increased accuracy and decreased asynchrony across trials. Planned analyses will calculate theta phase coherence between frontal and temporal electrodes and compare this coherence to participant liking ratings with the expectation that increased theta synchronization between frontotemporal sites will be associated with more liked melodies. Phase coherence between frontotemporal and premotor areas will also be calculated. We expect phase coherence to be predictive of motor performance on the piano task such that increased theta synchronization across frontotemporal and premotor areas is related to better melody learning performance.

Music, Stress, and Childhood Trauma – Are Stress-Networks Involved in the Pathophysiology of Musician's Dystonia?

Stine Alpheis 1; Christopher Sinke 2; Julian Burek 3; Tillmann Krüger 4; Eckart Altenmüller 5; Daniel S. Scholz 6;
1 Institute of Music Physiology and Musicians' Medicine, Hannover University of Music, Drama and Media, Germany; Department of Musicians' Health, University of Music Lübeck, Germany; Institute of Medical Psychology, CBBM, University of Lübeck, Germany; 2 Clinic of Psychiatry, Social Psychiatry and Psychotherapy, Hannover Medical School, Hannover, Germany; 3 Hannover Medical School, Hannover, Germany; Institute of Music Physiology and Musicians' Medicine, Hannover University of Music, Drama and Media, Germany; 4 Clinic of Psychiatry, Social Psychiatry and Psychotherapy, Hannover Medical School, Hannover, Germany; 5 Institute of Music Physiology and Musicians' Medicine, Hannover University of Music, Drama and Media, Germany; 6 Department of Musicians' Health, University of Music Lübeck, Germany; Institute of Medical Psychology, CBBM, University of Lübeck, Germany

Subtheme B - Auditory, Motor and Sensory Integration

Objective: Musician's dystonia (MD) is characterised by involuntary muscular cramps whilst playing a musical instrument. It is associated with a loss of motor inhibition and defects in sensorimotor integration, which have recently been argued to be caused by alterations of large-scale networks, including basal ganglia, cerebellar and limbic loops. Psychologically, adverse childhood experiences (ACE) and stress are discussed as risk factors. This study investigates whether MD patients have experienced more ACE and therefore show increased stress reactivity and neural vulnerability to movement disorders. We expect altered activation in stress-related and motor networks, and in areas related to cognitive control and self-evaluation. Methods: During functional magnetic resonance imaging, the Montreal Imaging Stress Task was administered to

40 musicians’ dystonia and 39 matched healthy musicians. Whole-brain analysis as well as Regions of Interest (ROI) analysis were performed. Parameter estimates from the ROI analysis and subjective stress levels were compared between groups and correlated with the Childhood Trauma Questionnaire. Results: MD patients reported significantly higher childhood trauma scores than healthy controls, but they did not differ in their subjective stress experiences. Altered stress-related activity of limbic areas was neither found in the whole sample nor between the two groups. Instead, increased activity of visual association and temporal areas was observed, but this activation did not differ between patients and healthy musicians. Analysis of the parameter estimates from the ROI analysis revealed reduced activity of the precuneus in dystonia patients, and a negative correlation between adverse childhood experiences and precuneus, thalamus and substantia nigra activity across all participants. Conclusion: Musicians’ dystonia patients and healthy musicians did not differ in their limbic reaction to stress, nor in their subjective stress experience. However, MD patients reported more adverse childhood experiences and showed a tendency towards reduced precuneus activity under stress.

Music processing in epilepsy: a systematic literature review

Asdikian Rita 1; Papadopoulou Maria 2; Caclin Anne 3;
1 UCBL, Lyon, France, Centre de Recherche en Neurosciences de Lyon (CRNL), Equipes "Cognition Auditive et Psychoacoustique" (CAP) et "Perception Attention Mémoire" (PAM); 2 Hospices civils de Lyon- Hôpital Femme-Mère-Enfant – Service Epilepsie-Sommeil, Lévêque Yohana, Centre de Recherche en Neurosciences de Lyon, Equipe Cognition Auditive et Psychoacoustique (CAP)-Université Lyon I- Institut des Sciences et Techniques de Réadaptation (ISTR), 3 Institut National de la Santé et de la Recherche Médicale- Centre de Recherche en Neurosciences de Lyon, France, Equipe Perception, Attention, Mémoire

Subtheme B - Auditory, Motor and Sensory Integration

Brain pathologies, such as temporal lobe seizures, can cause cerebral network rewiring, impacting several related circuits and respective behaviors, including language lateralization, attention problems, learning difficulties, and amusic features among other cognitive sequalae. Consequently, this pathology can lead to difficulties in music perception and processing, a cerebral capacity that shares common neural circuitry with language and memory. In this context, investigating the use of music interventions becomes particularly relevant. Music interventions have been shown to improve cognitive abilities in both typical and clinical populations, such as those with language disorders, stroke, and traumatic brain injuries. However, there is a paucity of research on music perception and hence its interventional use in epilepsy. Therefore, this review aims to delve into the neurophysiological and cognitive aspects of music processing in epilepsy to pave the way for the design of tailored treatments. A PubMed search with keywords ''(epilepsy OR seizure) AND (music OR pitch OR beat) AND (perception OR processing OR production OR singing)''; then ''auditory P300 AND epilepsy AND EEG'', yielded 273 results and 51 results respectively. The papers were filtered to accommodate the topic in concern. The inclusion criteria for studies in this review comprised of clinical studies focusing on evaluating music processing in epileptic patients, accompanied or not by brain lesions. There were no restrictions regarding partici-pants' age, gender, language, but studies needed to involve at least two groups of patients, or patients and controls. Alterna-tively, if only one group of patients was involved, the measures collected had to be compared to established clinical norms. This literature review highlights the diversity of music pro-cessing deficits encounter-red in epilepsy, revealing impor-tant limitations in the topics and patient populations tested so far, with very few studies in children and only a few studies on rhythm processing.

Exploring the role of complexity and modality in pleasurable polyrhythm perception

Joshua S. Bamford 1, 2; Dhwani Sadaphal 3, Patti Nijhuis 1 .
1 Centre of Excellence in Music, Mind, Body and Brain, Department of Music, Art and Culture Studies, University of Jyväskylä, Finland; 2 Institute of Human Sciences, Department of Anthropology and Museum Ethnography, University of Oxford, UK ; 3 Department of Behavioural and Cognitive Biology, University of Vienna

Subtheme B - Auditory, Motor and Sensory Integration

People appear to like synchrony. It is used in a range of social contexts but is epitomised in music and dance. Much has been written about the social bonding effects of synchronised action, which may underlie the social benefits of joint music making. However, real music rarely features total synchrony between all parts. Furthermore, it remains uncertain why people like synchrony, with one theory suggesting that synchrony is aesthetically pleasing because it is easier to process than non-synchrony, although this theory still has limited empirical support. Polyrhythms provide a means of addressing both concerns. Polyrhythms are ubiquitous across various musical genres worldwide. They involve the juxtaposition of contrasting rhythms, each dividing the measure into distinct subdivisions, creating a complex rhythmic interplay.

The relative complexity of a polyrhythm may be expressed as a ratio. Simple ratios (e.g. 2:3) are more commonly found in music than complex ratios (e.g. 4:5). Crucially, they exemplify a rhythmic relationship which is coordinated but not in perfect synchrony, and provide a systematic way of varying the complexity (and processing load) of a rhythmic relationship. In an online psychophysics experiment, we present stimuli consisting of two figures moving with accompanying sounds in different coordination modes. The stimuli have seven different levels of complexity (1:1, 1:2, 1:3, 2:3, 3:4, 4:5, and irregular), to three participant groups (musicians, dancers, control), in audio-only, visual-only, and audio-visual conditions, measuring their response time and accuracy in identifying each polyrhythm, as well as subjective aesthetic ratings for liking and groove. Preliminary results suggest that participants are best at identifying the simple ratio polyrhythms, however the subjective aesthetic ratings show an inverted-U curve. This provides a framework to study the effects of complex interpersonal coordination, beyond simple 1:1 synchrony, and demystifying the social role of music and dance.

Impaired Temporal Processing in Multiple Sclerosis

Charles-Étienne Benoit1, Szymon Palubinski2, Piotr Kałowski2, Simone Dalla Bella3,4,5, Nicholas EV Foster3,4,5, Aleksandra Podlecka-Piętowska6, Joanna Rychter6, Joanna Flis6 & Beata Zakrzewska-Pniewska6. 1. Univ Lyon, University Claude Bernard Lyon
1. Inter-University Laboratory of Human Movement Biology, Villeurbanne, France; 2. Faculty of Psychology, University of Economics and Human Sciences in Warsaw, Warsaw, Poland; 3. International Laboratory for Brain, Music, and Sound Research (BRAMS), Montreal, Canada; 4. Department of Psychology, University of Montreal, Montreal, Canada; 5. Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada; 6. Department of Neurology, Medical University of Warsaw, Warsaw, Poland

Subtheme B - Auditory, Motor and Sensory Integration

Multiple sclerosis (MS) is a chronic inflammatory autoimmune disease of the central nervous system. MS eventually results in neuronal damage both in grey and white matter, ultimately decreasing the efficiency of neural transmission. Volumetric MRI studies showed that among the cerebral regions affected in MS, subcortical regions including the basal ganglia (BG) seem prominently susceptible to neurodegeneration early in the course of the disease. Increased tissue anisotropy and microstructural damage of the BG have been reported in all subtypes of MS, which in turn lead to dysfunction of BG functional connectivity. It is well known that the BG play an important role in temporal processing, and that focal lesions in the BG have a disruptive effect on rhythm perception and sensorimotor synchronization with an auditory stimulus. It is expected that MS will similarly reveal disrupted synchronization and impaired perceptual timing. Twenty-three patients (14 females) with relapsing-remitting MS were tested with the tablet version of the Battery for the Assessment of Auditory Sensorimotor and Timing Abilities (BAASTA). They completed perceptual tasks (i.e., duration discrimination, anisochrony detection with tones, and the Beat Alignment Test - BAT), and motor tasks via finger tapping (i.e., unpaced and paced tapping with tones and music). Data were compared to normative data obtained with this version of BAASTA. The results showed that patients largely deviated from the norms by showing higher motor variability in unpaced tapping, and lower synchronization consistency for paced tapping to a slow tempo, a result mostly apparent in synchronization to music. At the perceptual level, patients displayed lower performance as compared to the norm in the BAT; their performance correlated significantly with the Expanded Disability Status Scale, a method of quantifying disability MS. Altogether, these findings provide compelling evidence that MS patients exhibit impaired timing and rhythmic abilities.

The Development of Musical Groove and Its Relationship to Musical Skills and Other Auditory Affective Experiences

Dan H. Berkowitz, Joel S. Snyder, & Erin E. Hannon
Department of Psychology, University of Nevada, Las Vegas, Las Vegas, Nevada, USA

Subtheme B - Auditory, Motor and Sensory Integration

Musical groove is the pleasurable urge to move in time to the beat of music. It has been proposed that moderately complex, syncopated music elicits the highest degree of groove in adults, perhaps because it is most likely to engage motor and reward networks in the brain. The feeling of groove may be dependent on listeners' ability to infer and maintain a strong sense of the timing of musical rhythmic events (i.e., beat and meter). This skill changes gradually throughout childhood and adolescence potentially due to increased exposure to syncopated music and may consequently predict individual differences in perception of groove. Additionally, increased musical exposure could lead to heightened feelings of reward while grooving, which may correlate with other rewarding musical experiences. Despite this, little is known about how groove develops, or its relation to other skills, such as beat and rhythm perception, or other emotional experiences of music and sound, such as musical chills or autonomous meridian sensory response (ASMR). We measured the experience of groove, musical skills, and auditory-affective responses to a variety of stimuli in children 6-17 years of age. To assess musicality and music perception skills, children completed child-friendly versions of the Barcelona Music Reward Questionnaire (BMRQ) and Goldsmiths Musical Sophistication Index (Gold-MSI), as well as a test of beat and meter perception. We also asked children to watch videos meant to elicit musical chills or ASMR and press a button every time they felt an emotional response. Although data collection for this project remains ongoing, preliminary data show that some kids report more groove for moderately complex music, just as adults have been shown to, and that this preference gets stronger throughout childhood. Preliminary results also suggest that there is a relationship between preference for moderately complex music and experiences of musical chills.

Similarities in processing simple and complex rhythms: behavioral and fMRI evidence

Ceren Battal#1,2, Tomas Lenc#2, Sylvie Nozaradan2;
1. Institute of Research in Psychology (IPSY), University of Louvain, Louvain-la-Neuve, Belgium; 2. Institute of NeuroScience (IoNS), University of Louvain, Brussels, Belgium; #Contributed equally

Subtheme B - Auditory, Motor and Sensory Integration

When listening to musical rhythm, humans perceive and spontaneously move to a periodic pulse-like beat. Previous studies suggested the internal representation of a beat to be mainly driven by low-level properties of the acoustic stimulus, especially the prominence of a periodic pulse in the arrangement of sound onsets. This view has been motivated by the evidence for a functional sensorimotor network preferentially activated by simple rhythms containing prominent acoustic periodicities corresponding to the perceived beat, compared to complex rhythms that do not contain prominent acoustic periodicities and are assumed to weaken beat perception. However, prior studies often used short rhythmic sequences and behavioral tasks that might have confounded the data. Here, we challenge this view by showing that simple and complex rhythms played in longer ecologically-valid sequences lead to comparable performance in tapping along with the perceived beat. The same sequences were also played to the participants while performing an orthogonal task in separate functional MRI sessions. In line with tapping, both rhythm categories elicited similar activation of the auditory, premotor, and supplementary motor areas, despite the different amounts of temporal regularity in the stimulus. This lack of difference was not due to a limited sensitivity, as we obtained high signal-to-noise ratio when comparing all rhythmic sounds to silence. In addition, we observed robust pitch selectivity driven by modulating the pitch of the sound instead of rhythm category in a control experiment. Finally, the lack of difference between rhythm categories were not due to a lack of information content, as we could successfully differentiate simple and highly jittered/irregular rhythms in the auditory cortex. Together, our findings indicate that humans can build a robust internal representation of beat in the absence of unequivocal periodic cues, and that these temporally degraded stimuli equally activate the sensorimotor network.

Temporal hierarchy of cortical responses reflects core-belt-parabelt organization of auditory cortex in musicians

Jan Benner (1), Julia Reinhardt (2,3), Markus Christiner (4,5), Martina Wengenroth (6), Christoph Stippich (7), Peter Schneider (1,4,5), Maria Blatow (8),
(1) Department of Neuroradiology and Section of Biomagnetism, University of Heidelberg Hospital, Heidelberg, Germany. (2) Department of Cardiology and Cardiovascular Research Institute Basel (CRIB), University Hospital Basel, University of Basel, Basel, Switzerland. (3) Department of Orthopedic Surgery and Traumatology, University Hospital Basel, University of Basel, Basel, Switzerland. (4) Centre for Systematic Musicology, University of Graz, Graz, Austria. (5) Department of Musicology, Vitols Jazeps Latvian Academy of Music, Riga, Latvia. (6) Department of Neuroradiology, University Medical Center Schleswig-Holstein, Campus Lübeck, Lübeck, Germany. (7) Department of Neuroradiology and Radiology, Kliniken Schmieder, Allensbach, Germany. (8) Section of Neuroradiology, Department of Radiology and Nuclear Medicine, Neurocenter, Cantonal Hospital Lucerne, University of Lucerne, Lucerne, Switzerland.

Subtheme B - Auditory, Motor and Sensory Integration

Human auditory cortex (AC) organization resembles the core

-belt-parabelt organization in nonhuman primates. Previous studies assessed mostly spatial characteristics; however, temporal aspects were little considered so far. We employed co-registration of functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG) in musicians with and without absolute pitch (AP) to achieve spatial and temporal segregation of human auditory responses. First, individual fMRI activations induced by complex harmonic tones were consistently identified in four distinct regions-of-interest within AC, namely in medial Heschl's gyrus (HG), lateral HG, anterior superior temporal gyrus (STG), and planum temporale (PT). Second, we analyzed the temporal dynamics of individual MEG responses at the location of corresponding fMRI activations. In the AP group, the auditory evoked P2 onset occurred ~25 ms earlier in the right as compared with the left PT and ~15 ms earlier in the right as compared with the left anterior STG. This effect was consistent at the individual level and correlated with AP proficiency. Based on the combined application of MEG and fMRI measurements, we were able for the first time to demonstrate a characteristic temporal hierarchy ("chronotopy") of human auditory regions in relation to specific auditory abilities, reflecting the prediction for serial processing from nonhuman studies.

Music-based fine motor rehabilitation in Parkinson's patients: feasibility, efficacy and neural correlates

Isabelle Buard 1, Lucas Lattanzio 1, Karrie Hardin 1, Michael Thaut 2, Benzi Kluger 3
1 University of Colorado Denver – Anschutz Medical Campus. Aurora, CO, USA; 2 University of Toronto – Faculty of Music. Toronto, Canada; 3 University of Rochester – Medical Center. Rochester, NY, USA

Subtheme B - Auditory, Motor and Sensory Integration

Our study explores the potential of Neurologic Music Therapy (NMT) in improving fine motor abilities in Parkinson's disease (PD). PD often leads to difficulties in everyday tasks due to both gross and fine motor impairments. While NMT has shown benefits for gross motor skills, its impact on fine motor skills has not been extensively studied. We hypothesized that NMT could enhance fine motor abilities by increasing auditory-motor connectivity in the beta and gamma frequency bands. Sixty PD patients, including 21 controls, underwent a 5-week NMT course focused on fine motor training. Assessments before and after the therapy included the Unified Parkinson's Disease Rating Scale (UPDRS), Grooved Pegboard Test (GPT) scores, and Magnetoencephalography (MEG). Adherence to NMT was high for those who completed the study. Results showed a significant improvement in PD motor symptoms, with a reduction in motor scores in both hands. Dominant hand dexterity also improved significantly compared to a waitlist group. MEG results on a sub cohort indicated increased beta power in the motor cortex and improved connectivity between auditory and motor regions post-NMT, as well as a distinct neurophysiological profile for the high vs. non responders to the NMT intervention. The study suggests that NMT could be a feasible and promising approach to enhance fine motor skills in PD patients by influencing cortical patterns. Furthermore, the varying responses among individuals and the neurophysiological differences among them present an opportunity to customize music therapies specifically for PD patients. However, due to the limited number of participants in our study, we believe it is essential to conduct further research in this area. Last, using MEG could deepen our understanding of the neuropathophysiology associated with these diseases and shed light on the mechanisms behind successful NMT interventions for upper extremity rehabilitation.

Neural synchronization to the musical beat relates to the experience of groove

Alexandre Celma-Miralles (1), Tomas E. Matthews (1), David Quiroga-Martínez (2), Jan Stupacher (1), Peter Vuust (1).
(1) Center for Music in the Brain, Department of Clinical Medicine, Aarhus University and Royal Academy of Music Aarhus/Aalborg, Denmark
(2) Helen Wills Neuroscience Institute, University of California Berkeley, United States of America

Subtheme B - Auditory, Motor and Sensory Integration

Background. Behavioral research shows that moderately syncopated rhythms are rated as more pleasurable and movement-inducing than unsyncopated and highly syncopated rhythms. Electroencephalographic studies show that syncopated rhythms elicit neural activity synchronized to beat-related periodicities. Here, we test whether the experience of groove, defined as the pleasurable urge to move to music (PLUMM), is related to greater neural synchronization to the beat of moderately syncopated, as compared to unsyncopated and highly syncopated rhythms, within reward- and rhythm-related brain networks, and whether this depends on musical training. Methods. We recorded magnetoencephalograms and electroencephalograms of 46 participants (26 musicians) performing a tempo discrimination task on auditory

stimuli with distinct syncopation levels: isochronous, low, medium and high. Participants listened to a rhythm presented at 96 BPM, followed by a 5-second silence and the same rhythm again presented at either 93, 96 or 100 BPM, and responded whether the latter was slower, identical or faster. We measured steady-state evoked potentials (SSEPs) in the frequency domain and compared their amplitudes across rhythmic categories, groups, and brain sources. Participants also provided PLUMM ratings. Results. Scalp-averaged SSEPs of moderately syncopated rhythms showed a selective enhancement of neural activity at beat-related frequencies compared to frequency amplitudes of the sound envelope. Source localization suggests that this effect is driven by brain regions associated with rhythm and reward processing and is not influenced by musical training. Highly syncopated rhythms reduced tempo discrimination accuracy. PLUMM ratings followed an inverted U-shape over syncopation and correlated with SSEPs. Discussion This study provides a plausible neural signature of the predictive processes thought to drive the inverted U-shape associated with PLUMM. When we listen to moderately syncopated rhythms, our brain selectively enhances beat-related frequencies. Future research should focus on beat maintenance during the silent period and include time-frequency analyses of sound onsets to assess beat-based predictions.

Cross-Modal MVPA Reveals Common Brain Representations of Action and Perception of Newly Learned Melodies

Yu-Hsin (Fiona) Chang (1, 2), Fredrik Ullén (1, 2), Örjan de Manzano (1, 2)
1. Department of Cognitive Neuropsychology, Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany; 2. Department of Neuroscience, Karolinska Institutet, Stockholm, Sweden

Subtheme B - Auditory, Motor and Sensory Integration

Playing a musical instrument requires not only the control of finger movements but also coordination with auditory feedback. Studies indicate that with training, a seemingly inseparable relationship can be established between action and perception. This is known as action-perception coupling. Supporting evidence shows that when musicians observe a piano-playing hand silently, there are nonetheless activations in the auditory cortex.

Moreover, our own previous work illustrated that when non-musicians listened to melodies they had learned to play, the corresponding patterns of activity in the superior temporal gyrus and dorsal premotor cortex could be used to distinguish between them.

To extend on these previous results, we here used fMRI to investigate whether brain representations are similar when non-musicians (a) play two learned melodies on the piano while imagining the sound and (b) listen to the same melodies while imagining the finger movements. In total, 22 participants with no previous musical training participated in the experiment. Conjunction analysis revealed that both auditory and motor-related regions were active in both conditions. Multivariate pattern analysis (MVPA) showed that a classifier could differentiate between the brain patterns associated with the melodies in both the superior temporal gyrus and premotor cortex during the listening condition. However, only activity patterns in the premotor cortex distinguished the two melodies when the participants were playing. Additionally, cross-modal classification showed that representations generalized across conditions in the right premotor cortex. Notably, there were substantial individual differences in classification accuracies across regions and tasks.

Serious gaming to investigate mechanisms of synchronization and sonification in motor learning.

M. Coers [1,2], M.F.L. Ruitenberg [1,2], R. Bidarra [3], C.J.M. van der Ham [1,2], R.S. Schaefer [1,2,4],
1. Institute of Psychology, Health Medical and Neuropsychology, Leiden University, Leiden, NL; 2. Leiden Institute for Brain and Cognition, Leiden, NL; 3. Computer Graphics and Visualization, Delft University of Technology, Delft, NL; 4. Academy of Creative and Performing Arts, Leiden University, Leiden, The Netherlands.

Subtheme B - Auditory, Motor and Sensory Integration

Auditory-motor coupling techniques have relevance for (re)learning of movements in both rehabilitation and sport settings. Prior studies indicate that such (re)learning is enhanced when movements create sounds, providing auditory feedback (sonification), compared to moving to auditory cues (synchronization). However, most models of brain mechanisms underlying learning neglect the influence of auditory environment (either sonification or synchronization) and of reward, yet both are considered crucial in music-based movement. To demonstrate their involvement, a serious game was developed that includes both auditory-motor learning mechanisms, which can be adjusted in difficulty to personalize learning. In this game, pinch grip sequences are practiced, either while cued by, or also while creating musical sounds, using sequences varying in finger order and spatial location on the screen.

Movement tracking is achieved using a webcam, avoiding wearables that can be burdensome for neurological populations. Preliminary evaluations (n=17) indicate that this game induces a sense of agency and is rated as being engaging and fun to play. An evaluation of learning increase that is currently ongoing, investigates the extent of skill acquisition for musically cued, musically sonified, or silent gameplay (n=75). We will compare gaming performance while considering musical background, musical perceptual skills, and previous gaming experience, related to subjective gameplay experience, including reward. Study outcomes, to be reported at the time of the conference, will yield a better understanding of the difference and overlap between sonification and synchronization as compared to a silent baseline.

We hypothesize that sonification will result in better learning than synchronization, but both are better than baseline. The outcomes have clinical implications for motor training or rehabilitation, e.g., after stroke, but also elucidate further thinking on the neural processing of these different auditory stimuli during movement learning.

Thus, results will support expansion of motor models to better account for auditory environment and reward.

The role of the motor system in the processing of rhythmic complexity: a critical review

Cossavella, F. & Fernández Slezak, D.
Laboratorio de Inteligencia Artificial Aplicada, Departamento de Computación, Universidad de Buenos Aires, Buenos Aires, Argentina, Instituto de Investigación en Ciencias de la Computación (ICC), CONICET-Universidad de Buenos Aires, Buenos Aires, Argentina. Miguel, M. A. - Department of Psychology, Neuroscience & Behaviour, McMaster University, Hamilton, ON, Canada

Subtheme B - Auditory, Motor and Sensory Integration

The desire to move to music appears to be a human universal. This behavioral response seems to be supported by a tight coupling of auditory and motor networks, even in the absence of overt movement. The prevailing theories explain this phenomenon either in terms of passive brain network entrainment to musical periodicity or motor system involvement in predictive processing. Both explanations recognize the role of rhythmic complexity in modulating motor activity. However, the precise nature of the relationship between rhythmic complexity and motor activity remains unclear.

In this work, we conducted an fMRI literature review to evaluate this relationship. Out of 110 reviewed articles, 24 reported findings ranging from non-existent to linear or inverted-U-shaped relations. Underlying these findings, we encountered significant heterogeneity in the measurement and conceptualization of rhythmic complexity. We provide a summary of the associations found, the approaches to measuring rhythmic complexity and the different types of tasks and stimuli used. We conclude that, in order to move forward, more agreement is needed regarding measures and notions of complexity. Additionally, we note that the entirety of the research reviewed was conducted by teams from the global north, primarily on WEIRD populations, and only a small subset utilized ecologically valid stimuli. To this end, we are in the process of developing an ecological and perceptually validated natural music dataset. Our aim is to utilize this dataset not only for assessing the processing of rhythmic complexity across cultures and crafting a rhythmic complexity metric suitable for audio formats.

Culture-driven Plasticity in Neural and Behavioural Entrainment to the Beat

Emmanuel Coulon 1, Ségolène M. R. Guérin 1, Tomas Lenc 1, Rainer Polak 2, Peter Keller 3, Sylvie Nozaradan 1
1 Institute of Neuroscience (IoNS), Université Catholique de Louvain (UCLouvain), Brussels, Belgium; 2 RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, Oslo, Norway; 3 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/ Aalborg, Aarhus, Denmark;

Subtheme B - Auditory, Motor and Sensory Integration

Music compels humans to move to the musical rhythm, and this behavior often entails the perception of a periodic beat. Although the perception of musical beat is widespread around the globe, a growing body of behavioral and modeling work suggests that it is also shaped by culture. For example, different beat interpretations can be mapped onto the same rhythmic input, depending on the musical traditions that individuals have experienced. However, clear behavioural and neuroscientific evidence supporting this long-term shaping of rhythm processing is still lacking. As part of a larger programmatic registered report project, this study aims to capture the brain processes underlying this plasticity, by comparing electroencephalography (EEG) and hand clapping to an auditory rhythm derived from West/Central African music repertoires, across adult individuals with a specific cultural background from West/ Central Africa and a Western convenience sample of individuals. Measurements will be collected both before and after a short session (~ 15min) of body movement to the rhythm, with half of the participants in each group being instructed to move along a four-beat interpretation, and the other half to a three-beat interpretation. Based on ethnomusicological work and preliminary data, we expect to find differences in beat mapping between the two cultural groups in the pre-movement session, with West/ Central African- and Western-enculturated participants showing a tendency to map onto the rhythm a four-beat or three-beat interpretation, respectively. Moreover, we predict post-movement enhancement in neural and behavioural entrainment, selective to the beat interpretation conveyed by prior movement, and magnified for the beat interpretation predominant in the participant's musical tradition. This cross-cultural study is expected to shed new light on the plasticity of brain processes allowing prior experience of culture and movement to imprint onto rhythm processing in humans.

A double-blind randomized controlled study concerning the role of dopamine in the pleasurable urge to move to music, rhythm perception and production

Pelle De Deckere1, Tomas Matthews1, Victor Pando-Naude1, Rodrigo Labouriau2, Erik Lisbjerg Johnsen3, Peter Vuust1.
1 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Denmark; 2 Applied Statistics Laboratory, Department of Mathematics, Aarhus University, Denmark; 3 Department of Neurology, Aarhus Universitetshospital, Denmark

Subtheme B - Auditory, Motor and Sensory Integration

Humans experience a pleasurable urge to move to musical rhythms (termed PLUMM) which convey a regular pulse, depending on the amount of complexity in these rhythms. Rhythms with moderate complexity evoke a more pronounced PLUMM than low or high-complex rhythms resulting in an inverted U-shaped relationship between the syncopation of these rhythms and how much we want to move to these rhythms. This suggests that timing and predictive processes in the brain play a major role in the PLUMM. Previous studies, furthermore indicate that both pleasure and movement may be related to the release of the neurotransmitter dopamine. Neuroimaging studies have shown that PLUMM engages motor and limbic basal ganglia (BG) networks which overlap with cortico-striatal and mesolimbic dopaminergic pathways. Furthermore, Parkinson's disease, a neurodegenerative disorder in the BG alters PLUMM, flattening the inverted U curve and shifting preferences towards simpler rhythms, which may be related to a malfunction of the dopaminergic systems. However, a direct link between dopamine and PLUMM remains unestablished. In an ongoing double-blind randomized, placebo-controlled study, we aim to establish a causal relationship between dopaminergic functioning and PLUMM. Participants will conduct a series of tasks after receiving either dopamine precursor, dopamine antagonist, or placebo, in three different sessions. The first task assesses PLUMM through rhythmic pattern ratings. The second task tests for harmony likability, and the third task beat -based, interval-based timing perception and production tasks. The aim is to test whether dopamine influences the inverted U-shaped PLUMM curve through beat-based timing, pleasure, or both. This study will help us disentangle dopamine's role in the motor and affective responses to music.

Does the training format matter? Differences between blocked and interleaved music training on auditory evoked responses

Ozgen Demirkaplan (1)
Benjamin Rich Zendel (1)
1: Faculty of Medicine, Memorial University of Newfoundland, NL, Canada

Subtheme B - Auditory, Motor and Sensory Integration

Short-term musical training, over the course of a few weeks or months, has been shown to enhance auditory processing abilities. These findings have led to growing interest in using music training as a foundation for auditory rehabilitation. Standard music education programs are designed and optimized for making musicians, not for improving hearing. Accordingly, optimizing the training for rehabilitative purposes is critical if music training is to be used as a form of rehabilitation. Here, we compared the impact of two types of music training on their capacity to improve auditory processing abilities in the musical domain. Twenty-eight nonmusicians were randomly assigned to one of two groups: Blocked or Interleaved. Both groups learned to play 5 novel pieces on a digital piano throughout 8 training sessions. During each training session, the Blocked Group practiced each piece 9 times before moving on. The Interleaved Group practiced the same pieces the same number of times in each session, but the order was randomized.

Before and after training, EEG was recorded while each participant was presented with a series of melodies that were not part of the training set. These melodies sometimes contained an Out-of-Key (OoK) note. The OoK note evoked an Early Right Anterior Negativity (ERAN) in all participants. The ERAN is related to the automatic registration of the OoK note in the auditory system. After training, the ERAN was enhanced in the Interleaved group compared to the Blocked group. Results from this study highlight that interleaving practice sessions lead to more robust plasticity in the auditory system, likely due to the increased cognitive demands of task switching between the melodies during interleaved training. Critically, it highlights that music training can be optimized to promote neural plasticity and potentially to develop more effective auditory rehabilitation.

Rhythmic Auditory Stimulation Effects On Gait Cadence Are Increased With Anodal Transcranial Direct Current Stimulation

Marina Emerick (1,2,3) and Jessica A. Grahn (1,2,3,4)
1 Neuroscience Program, Schulich School of Medicine & Dentistry, Western University, London, Canada, 2 Brain and Mind Institute, Western University, London, Canada; 3 Western Institute for Neuroscience, Western University, London, Canada; 4 Department of Psychology, Social Science, Western University, London, Canada

Subtheme B - Auditory, Motor and Sensory Integration

Gait patterns, or how one walks, can influence physical health, mental health, and social well-being. Age and disease conditions can negatively affect gait, but external cueing, such as rhythmic auditory stimulation (RAS), may improve gait deficits. The neural mechanisms of RAS remain unclear, however. One candidate neural area for mediating auditory influences on motor activity is the supplementary motor area (SMA). Thus, we investigated the neural mechanisms of RAS on gait using transcranial direct current stimulation (tDCS) of the supplementary motor area (SMA), a region associated with both gait initiation and auditory rhythm perception. We assessed whether excitatory tDCS stimulation would enhance the effects of RAS on gait parameters. Young, healthy participants walked on a pressure-sensitive walkway during a silent, no-stimulation baseline, then again while receiving tDCS and synchronizing their steps to music (set to 10% faster than the baseline cadence). Further silent post-stimulation walking was completed immediately afterward and after a 15-minute delay. The procedure was completed twice: once with sham tDCS and music, and once with anodal (excitatory) tDCS and music. Preliminary results show that, in comparison to the baseline walk, anodal stimulation increased participants' cadence, or steps per minute, more than sham stimulation. These effects were restricted to online stimulation only, as no difference was observed either immediately after stimulation or 15 minutes post-stimulation. Future studies will examine whether this effect is observed in older adults and patient populations, as well as compare the effects of tDCS with and without RAS to determine whether the SMA mediates auditory influences on gait. This work offers potential for interventions like brain stimulation-music rehabilitation programs for gait-disordered populations.

Does rhythmic movement improve speech in noise processing?

Laure Deyna1,Noémie te Rietmolen1,2,3, Benjamin Morillon1,4;
1 Aix Marseille Université, INSERM, Institut de Neurosciences des Systèmes (INS), Marseille, France; 2 Aix-Marseille Université & CNRS, Laboratoire Parole et Langage (LPL), Aix-en-Provence, France; 3 Aix-Marseille Université, Institute for Language, Communication, and the Brain (ILCB), Marseille, France; 4 Senior authorship

Subtheme B - Auditory, Motor and Sensory Integration

Listening to speech activates cortical regions of the sensorimotor system, yet their functional role in speech processing remains a subject of intense debate. The auditory active sensing theory proposes that the motor system engages in predictive timing, aligning attention fluctuations with rhythmic cues in the auditory stream. Behaviorally, it has been demonstrated that processing of musical streams improves when participants execute overt rhythmic movements compared to remaining still. This study aims to explore whether the activation of the motor system through motor movements can also enhance speech comprehension in a noisy environment, providing temporal cues to guide attention and target key temporal features of speech. Our objective is to behaviorally identify which (1) motor effector (hand/mouth), (2) tempo (1.5/4.5 Hz), and (3) induction mode (movement as a prime or in synchrony with speech) can maximize speech comprehension. An initial experiment indicated that participants do not enhance their comprehension by finger-tapping at their spontaneous rhythm while simultaneously listening to the stimulus. This result suggests that processing speech does not necessarily require a behavioral manifestation of motor cortex activation. In a subsequent experiment, we will investigate whether the activation of the motor cortex before listening to speech enhances comprehension. In this experiment, tapping will serve as a prime and will be compared with another type of motor rhythmic production: articulation. We hypothesize that 1) when used as a temporal cue, the prime can shape attention to the subsequent stimulus and improve comprehension, and 2) the quality of speech processing may vary depending on the type of motor effector used. As we tend to spontaneously finger-tap at 1.7 Hz, while we produce syllables at around 4.5 Hz, these different rates could shape attention toward distinct temporal features in speech, influencing comprehension differently.

My feet are further from my eart: Insights from a CHEPs study in Musicians

Johanna Doll-Lee 1, Fabian Sternkopf 2, André Lee 2, 3
1 Department of Neurology, Hannover Medical School, Germany; 2 Institute for Musicphysiology and Musicians' Medicine, Hannover University for Music, Drama and Media, Germany; 3 Department of Neurology, Klinikum rechts der Isar, Technical University Munich, Germany

Subtheme B - Auditory, Motor and Sensory Integration

The prevalence of pain syndromes, such as playing-related musculoskeletal pain and overuse syndromes, is notably high among professional classical musicians. Moreover, the extensive deliberate and intentional training in extremely fine motor movements over many years has been demonstrated to induce functional and structural neuroplastic changes. This characteristic makes musicians an intriguing population for investigating the impact of neuroplasticity on pain perception and transmission. We here exposed a cohort of 15 healthy musicians and 15 healthy non-musician controls to contact heat stimuli at two distinct baseline temperatures: 42°C and 35°C. A total of 15 stimuli were administered at each hand and foot for each baseline temperature in randomized order. The participants provided their subjective response to the stimuli using the numeric rating scale (NRS), while we assessed their objective neuronal response through contact heat-evoked potentials (CHEPs) recorded via electroencephalography (EEG). There was a significant difference between hands and feet latency with the feet exhibiting a 59.88 ms longer N2 latency ($p < 2 \cdot 10^{-16}$) and a 104 ms longer P2 latency ($p < 2 \cdot 10^{-16}$) compared to the hands. Furthermore, a significant difference of the latency in the feet between the groups was identified with musicians exhibiting a significantly longer N2 latency at their feet by 20.86 ms ($p = 0.0045$) compared to non-musicians. Speculatively, the observed elongation of N2 latency at the feet in musicians suggests a potentially less pronounced myelination of nociceptive nerve fibers in the spine of musicians. If the peripheral nerves were involved, the prolonged latency would also have been evident in the hands. We hypothesize that the delayed nociceptive response in musicians' feet may indicate an unconsciously trained inhibition of nociception, possibly attributed to the substantial discrepancy in attention given to hands versus feet during their extensive musical training.

Processing of Naturalistic Music During Listening and Dancing

Deniz Duman 1, John Rehner Iversen 2, Petri Toiviainen 1
1 University of Jyväskylä, Department of Music, Art and Culture Studies, Centre of Excellence in Music Mind Body and Brain, Jyväskylä, Finland; 2 McMaster University, Department of Psychology, Neuroscience & Behaviour, Hamilton, Canada;

Subtheme B - Auditory, Motor and Sensory Integration

The concept of groove and bodily movements are central aspects of music enjoyment, yet the neural mechanisms by which sound impels movement are only partially understood. Previous literature on beat perception and production has showed evidence on contribution of motor areas in auditory processing (Patel & Iversen, 2014; Morillon et al., 2015). Yet, there is a gap in the literature pertaining the role of bodily movements to naturalistic music. Targeting this gap, a multi-methodological study was designed in which participants were given a passive ("listen to the audio clips and do not move") or an active ("follow the audio clips with your body movements") tasks while their EEG and full-body motion capture data were simultaneously recorded. Prior to this main task, a series of localizer tasks were given to participants by which we aim at finding participants' individual auditory and motor areas (similar to the study by Ross et al., 2022). The set of stimuli consisted of 9 commercial musical excerpts (Senn et al., 2019) and their respective drum and bass reconstructions, which were selected based on a number of criteria: excerpts must (1)be representative of either pop, funk, or rock genres, (2)have a tempo around 120bpm, and (3)have previously been rated with different levels of groove(high, medium, low). While the data collection is undergoing, we plan to use a combination of pre-processing (Artifact Subspace Reconstruction) and analysis (Independent Component Analysis) methods plus the localizer tasks to separate brain activity from auditory and motor regions from other sources. Then we will perform a double dissociation analysis to investigate changes in frequency domain (such as mu oscillations) in auditory and motor regions for high versus low groove stimuli. Overall, this project will not only increase our knowledge about the neural underpinnings of music induced movements, but also lead to methodological advancement.

Characterizing the Genetic Architecture of Functional Connectivity Networks Supporting Human Singing

Tanguy R. du Mérac 1,3, Yasmina N. Mekki 1, 2, Reyna L. Gordon 1,2,3,4,5,
1. Vanderbilt Genetics Institute, Vanderbilt University, Nashville, TN, USA; 2. Vanderbilt Brain Institute, Vanderbilt University, Nashville, TN, USA; 3. Department of Otolaryngology – Head and Neck Surgery, Vanderbilt University Medical Center, Nashville, TN, USA; 4. Department of Psychology, Vanderbilt University, Nashville, TN, USA; 5. Vanderbilt Kennedy Center, Vanderbilt University Medical Center, Nashville, TN, USA

Subtheme B - Auditory, Motor and Sensory Integration

Singing is a universal and multifaceted skill, presumably supported by an intricate neural connectivity network. In recent years, singing ability and engagement have both been defined as complex and heritable traits (e.g., Yeom et al., 2022). To unravel the genetic architecture of singing, we performed a systematic review and activation likelihood estimation (ALE) meta-analyses on PubMed records following the PRISMA guidelines (Page et al., 2021). Here, 9 singing production vs. rest neuroimaging contrasts (216 foci, N=143) were included in a first meta-analysis. To increase granularity, 13 contrasts were included in a second meta-analysis (212 foci, N=201), covering multiple facets of

singing production and perception, as contrasted with auditory/visual sensory processing. Results of the singing production vs. rest meta -analysis showed 50 activations ($p < 0.05$, family-wise error rate - FWER - corrected) bilaterally distributed across perisylvian, limbic areas and the cerebellum. The more refined approach (singing production/perception vs. sensory processes) revealed 37 peak activations ($p < 0.05$, FWER corrected) similarly covering bilateral perisylvian and limbic areas, but no cerebellar activation was captured. Overlapping activations between our two singing meta-analyses encompassed the left precentral, postcentral and middle temporal gyri, bilateral Rolandic operculum, bilateral superior temporal gyrus, bilateral temporal pole, right insula, and right Heschl's gyrus. Our findings overcome some of the limitations associated to the only existing meta-analysis on syllable-singing (Brown et al. 2009) and confirm the previously established role of the right cortical hemisphere in singing (Riecker et al., 2000). In line with recent work by Kleber et al. (2017) and Zamorano et al. (2023), our meta-analyses highlight the involvement of the bilateral insula, which was not reflected in Brown et al.'s (2009) results. Future steps include combining large-scale multivariate genome-wide association study methods to characterize how interindividual genetic variation supports the functional connectivity of the singing network.

Enhanced groove sensation using a closed-loop brain-machine interface

Shinya Fujii* (1, 2), Takahide Etani** (2, 3, 4, 5), Sotaro Kondoh (3), Yuna Sakakibara (2, 3), Keigo Yoshida (1), Yasushi Naruse (2), Yasuhiko Imamura (2), Takuya Ibaraki* (2),
(1) Faculty of Environment and Information Studies, Keio University, Kanagawa, Japan; (2) VIE, Inc., Kanagawa, Japan, (3) Graduate School of Media and Governance, Keio University, Kanagawa, Japan; (4) School of Medicine, College of Medical, Pharmaceutical, and Health, Kanazawa University, Ishikawa, Japan; (5) Advanced Research Center for Human Sciences, Waseda University, Saitama, Japan.
*correspondence author, **co-first author

Subtheme B - Auditory, Motor and Sensory Integration

The desire to move one's body in response to music, known as "groove," is widely shared among people. However, individuals also derive groove sensation from different musical pieces. Here we developed a closed-loop brain-machine interface that enhances individual groove sensation by utilizing an in-ear electroencephalogram (EEG). Ten healthy subjects (mean age = 26.6 3 7.8 years old) participated in this study. They listened to three high-groove and three low-groove music selected from Janata et al. (2012). They rated each excerpt's "desire to move" on a visual analog scale (VAS), while we recorded their in-ear EEG signal . The acoustic features of high-groove pieces were analyzed by VGGish, a pre-trained neural network, to make a linear lasso model estimating groove sensation from acoustic features (Model 1). Additionally, we developed a general linear lasso model classifying the individual EEG pattern into the state of listening to high-groove or low-groove music (Model 2). Utilizing Model 1, the acoustic features of 7000+ candidate excerpts were ranked based on the estimated groove sensation. While listening to the playlists, Model 2 estimated the groove sensation from EEG in real-time, which re-trained Model 1 and updated the ranking. We thus created four playlists for each participant: two using only Model 1 (groove-increasing-playlist [GIP] and groove-reducing-playlist [GRP]) and two using both models (GIP-EEG and GRP-EEG). Participants listened to these playlists and evaluated their "desire to move" using a VAS. We employed a one-way analysis of variance (ANOVA) to compare the "desire to move" ratings across the playlists. The results showed a significant main effect of the playlist type ($F(3,9)=7.65$, $p=0.007$), with post-hoc analyses showing that GIP-EEG enhanced the "desire to move" compared to GRP-EEG ($p=0.02$) and GRP ($p=0.02$). Our findings indicate the potential of EEG-informed systems to create personalized music playlists increasing the groove sensation for each listener.

Beatmatching in DJing: An analysis of temporal coordination using electroencephalogram (EEG), motion capture, and audio analysis

Daniel Galvis 1, Patti Nijhuis 2, Diar Karim 3, Rob Sturman 4, Maria Witek 5
1 Centre for Systems Modelling and Quantitative Biomedicine, University of Birmingham, Birmingham, UK; 2 Centre of Excellence in Music, Mind, Body and Brain, University of Jyväskylä, Finland; 3 Department of Psychology, University of Birmingham, Birmingham, UK; 4 School of Mathematics, University of Leeds, Leeds, UK; 5 Department of Music, University of Birmingham, Birmingham, UK.

Subtheme B - Auditory, Motor and Sensory Integration

DJing is a sophisticated musical skill involving complex temporal perception and active manipulation of multiple, often polyrhythmic patterns simultaneously. In the process of beatmatching, DJs synchronise two different records that are out of phase or playing at different tempo. This is an embodied, dynamic activity relying on a coordinated system of processes in the body, the brain, the turntables and the sonic patterns in the music. The aim of this work is to explore the interactions occurring between these dynamic processes and to compare them over a set of behaviours commonly exhibited during beatmatching. We collected

audio, EEG, and motion capture data from 28 DJs. The task was to beatmatch two tracks initially playing at different phases (shifted one sixth of a bar) or tempi (130 vs 135 bpm) using digital turntables with the automatic sync function turned off. We then extracted a phase representation for each dataset to study synchronisation between the two tracks and body movement. In initial analysis of the audio, we extracted the dynamic changes to the tracks over time, identifying windows of distinct behaviour. In the movement data, we identified associated windows of rhythmic movement locked to the beat. Together, these analyses provide a clear picture of the behavioural modes. Using these results, we then compared functional neural connectivity across different behavioural modes including slip cueing, nudging the platter, adjusting the pitch control, and monitoring the resulting mix. In this poster, we will present preliminary EEG analyses relating the combined audio and motor modes to features of the functional networks. This research has potential to improve understanding of the role of movement, brain states, and their interactions in coordinating the beatmatching process. More broadly, this work supports an embodied approach to studying how humans coordinate complex rhythmic behaviours to complex rhythmic stimuli in their environments.

Oscillatory coding of natural speech and music via spectrotemporal modulations in the human auditory cortex

Jérémie Ginzburg(1,2), Émilie Cloutier Debaque(2), Laurence Martineau(3), Paule Lessard Bonaventure(3), Robert J Zatorre(1), Philippe Albouy(2)
1: Montreal Neurological Institute, McGill University, Montreal, Canada; 2: CERVO research center, Laval University, Québec, Canada; 3: Centre Hospitalier Universitaire, Laval University, Québec, Canada

Subtheme B - Auditory, Motor and Sensory Integration

Speech and music represent the most intricate ways through which humans use sound to convey information. Recent studies increasingly indicate that the human brain is finely tuned to encode the temporal and spectral features of sound that are crucial for processing speech and music, respectively. Despite considerable progress in unraveling the mechanisms underlying the processing of these spectrotemporal features, much of our current knowledge originates from studies using artificial, lab-created stimuli, raising concerns about the generalizability of findings to real-world scenarios. To address this limitation, we conducted stereo-electroencephalography (sEEG) recordings on ten patients with implanted electrodes while they listened to a natural stimulus: the first seven minutes of the soundtrack from Harry Potter and the Philosopher's Stone.

We calculated the variation in spectrotemporal modulations during the time course of the soundtrack. Then, we decomposed the sEEG signal into various frequency bands to examine power fluctuations that were related to the stimulus features. We conducted preliminary multivariate analyses using ridge regressions to predict spectrotemporal modulations throughout the duration of the soundtrack, using the power of six frequency bands as features. Examination of feature weights revealed that the alpha and theta bands were predominantly used by the classifier to predict spectral modulations in the soundtrack and that gamma and beta bands were used by the classifier to predict temporal modulations. The results indicate that the auditory cortex employs distinct oscillatory rates, with alpha and theta bands dedicated to encoding spectral modulations crucial for understanding musical content, and gamma and beta bands dedicated to encoding temporal information essential for understanding speech. Next steps involve investigating the possible lateralization of the preference for these frequency bands in encoding spectrotemporal information within the auditory cortex.

Inhibitory control in piano duet: an EEG hyperscanning study

Giovannelli F.1, Gavazzi G.1, Noferini C.2, Bravi R.3, Ballerini L.4, Dalpasso M.G.5, Minciacchi D.3, Cincotta M.6, Viggiano M.P.1,
1 Department of Neuroscience, Psychology, Drug Research and Child’s Health (NEUROFARBA), University of Florence, Florence, Italy; 2 European Laboratory for Non-Linear Spectroscopy (LENS), Sesto Fiorentino, Italy; 3 Department of Experimental and Clinical Medicine (DMSC), University of Florence, Florence, Italy; 4 Conservatorio Antonio Scontrino, Trapani, Italy; 5 Conservatorio Luigi Cherubini, Florence, Italy; 6 Unit of Neurology of Florence, Central Tuscany Local Health Authority, Florence, Italy

Subtheme B - Auditory, Motor and Sensory Integration

Playing music together implies inhibitory control processes in order to perform appropriate actions at the right timing and rapid adjustments allowing interactive coordination among musicians. The aim of the present study was to investigate the role of brain-to-brain coupling and inhibitory control processes in modulating the mutual adaptation during a dyadic musical performance. Fourteen pianists (seven pairs) performed a Go/NoGo-like musical task. The participants (pianist A and B) were required to play in a duet on 8-bars scores, playing alternately one measure each. In half of the trials ('NoGo' trials), pianist A randomly introduced a variation, breaking the alternation with a longer phrase between measures 5 and 7, and pianist B had to withhold the response (at measure 6) and resume playing in time for the last measure. For each pair, the experiment was repeated by reversing the roles in order to evaluate inhibitory control in both participants. EEG was simultaneously recorded from both pianists using a dual recording system with two 32-channels caps. For each pair, circular correlation (CCorr) coefficients were calculated in three 2-seconds time windows (before, during, and after the measure 6 of the score) to estimate brain-to-brain coupling between the two participants. At behavioural level, the mean accuracy in 'NoGo' trials was 84%. For correctly inhibited 'NoGo' trials, significant CCorrs were observed for parietal electrodes in the alpha and beta frequency bands before and after the sixth measure of the score. In the time window that includes the sixth measure of the score significant CCorrs emerged for frontal electrodes. These preliminary data suggest a posterior-to-anterior shift of the brain-to-brain coupling when an unexpected variation is introduced during a piano duet. It is conceivable that this effect reflects inhibitory control processes.

Contribution of the auditory and insular cortex to tactile frequencydiscrimination assessed with iEEG

Anne Sophie Grenier (1,2) , Paule Lessard-Bonaventure (3), Laurence Martineau (3), Andréanne Sharp (1,2), Philippe Albouy (1,2).
1. Laval University, Québec, Canada; 2. CERVO Brain Research Center, Québec, Canada; 3. CHU de Québec – Laval University, Québec, Canada

Subtheme B - Auditory, Motor and Sensory Integration

Background: Recent studies have shown that auditory-tactile stimulation can modulate perception. However, how these sensory modalities interact with each other remains understudied. Using iEEG recordings in humans, we investigate the contribution of the auditory and insular systems to the passive and active discrimination of sounds (pitch) delivered via the tactile modality only, the auditory modality only and the auditory-tactile modalities combined. Methods: Intracranial recordings were obtained from six neurosurgical patients with intractable epilepsy. In the first experiment, we presented a passive oddball paradigm through two vibrotactile stimulation gloves (Sharp et al., 2019). The task consisted of a random presentation of five deviant stimuli (225, 250, 500, 800 and 1000Hz) during a variable sequence of standard sounds (200Hz). To control for auditory perception,

participants listened to a continuous white noise while wearing earplugs. In the second experiment, we use five stimuli (200, 250, 500, 800 and 1000Hz). The active task consists of 80 sequences of five stimuli each in which participants must determine if the fifth sound is similar or different than the first four. Participants completed the task under three conditions: auditory only (headphones), tactile only (vibrotactile speakers) and auditory-tactile (headphones and vibrotactile speakers). Results: iEEG data of the first experiment revealed an activation of the primary auditory cortex and the insula (gamma increase relative to baseline) during tactile perception, and their activity is modulated with deviance detection. The preliminary results of the active task show similar results pattern. Analyses are still ongoing for the other conditions. We expect to observe an enhanced activity in these regions during multisensory stimulation. Conclusion: These findings suggest that pitch discrimination without auditory perception is supported by an interplay between somatosensory, insular and auditory systems. These results provide a better understanding of the interactions between auditory and tactile systems in the human brain.

EMDR+ Musical and auditory personalization of the EMDR technique for the treatment of psychic trauma-related disorders

Joy Grifoni1,4,5, Alfredo Brancucci 2, L'Abbate Teresa1,4, Massimo Bertoli1,3,4, Giada Perichilli1, Luca Paulon1 Luca Cerniglia 4, Marco Pagani1,4,5, Franca Tecchio1,4,
1 ISTC, CNR, Rome, Italy; 2 Foro Italico University, Rome; 3 D'Annunzio University, Chieti, Italy; 4 International University Uninettuno, Rome, Italy; 5 Emdr International society

Subtheme B - Auditory, Motor and Sensory Integration

According to the WHO (World Health Organization), Eye Movement Desensitization and Reprocessing (EMDR) is an elective therapy to treat people with post-traumatic stress disorders (PTSD). In line with the personalization of therapeutic strategies, through this pilot study, we assessed in people suffering from the effects of trauma the feasibility, safety, acceptance, and efficacy of EMDR enriched with sound stimulation (by administering neutral sounds synchronized with the guided bilateral alternating stimulation of the gaze) and musical reward (musical listening based on the patients' predisposition and personal tastes). Feasibility, quantified by the number of patients who completed the treatment, was excellent as this was the case in 12 out of the 12 enrolled people with psychological trauma. Safety and acceptance, assessed by

self-compiled questionnaires, were excellent, with an absence of side effects and high satisfaction. Efficacy, quantified by the number of EMDR treatment sessions required to reach the optimal scores on the Subjective Units of Disturbance (SUD) and Validity of Cognition (VOC) scales typical of EMDR protocols, revealed an average duration of 8.5 (SD 1.2) sessions, which is well below the 12 sessions considered a standard EMDR treatment duration. EMDR+ appears to be a relevant personalization of EMDR, particularly in music-sensitive people, consolidating the therapeutic alliance through a multisensory communicative bond for trauma treatment.
Keywords: multisensory sensorimotor stimulation, bilateral alternating stimulation (BAS), psychic trauma (PT), post-traumatic stress disorder (PTSD), audio-visual stimulation, music, personalized therapy, musical reward, musical trigger.

Imprints of Periodic Body Movement onto Subsequent Processing of Auditory Rhythm

Ségolène M. R. Guérin1; Emmanuel Coulon1; Tomas Lenc1; Rainer Polak2; Peter Keller3; Sylvie Nozaradan1
1 Institute of Neuroscience, Université Catholique de Louvain, Brussels, Belgium; 2 RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, Norway; 3 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Aarhus, Denmark

Subtheme B - Auditory, Motor and Sensory Integration

Moving the body on music can help individuals to internalise the temporal structure of music, making it easier to understand and appreciate the rhythmic complexities of a musical piece as it unfolds over time. Although this phenomenon is deemed an established principle in music transmission around the globe, clear behavioural and neuroscientific evidence is still lacking. This registered report aims at capturing the brain processes underlying the rhythmic, movement-related shaping of auditory information. Electroencephalography (EEG) and hand clapping were recorded in separate sessions while participants listened to a repeated rhythmic pattern derived from West/Central African music repertoire. Ecological plausibility was ensured by matching the cultural validity of the rhythmic input and cultural background of the participants. Neural and behavioural recordings were conducted both before and after a body movement session where participants engaged in stepping and clapping to the rhythm following a specific metre (three- vs. four-beat metre). A frequency-tagging approach was used to measure the relative prominence of the periodicity corresponding to the perceived metre in the various signals of interest (i.e., acoustic input, EEG response, clapping movement). Data collection is still ongoing, but we predict post-movement enhancement in neural and behavioural entrainment, selective to the periodicity corresponding to the metrical interpretation conveyed by prior body movements. These findings aim to demonstrate how body movements flexibly imprint onto human sensory processing. It is worth noting that this study is part of a larger, programmatic registered report, in which the effect of body movement is compared across participants of different cultural background (West/ Central African vs. Western), to provide direct behavioural and neuroscientific evidence on how short-term prior experience of rhythmic body movements, together with long-term cultural background, shapes the subsequent internal representation of rhythm.

Investigating Perceptual Processing Links between Sound and Touch via Auditory Evoked Tingling Somatosensation

Ilana Harris1, Sarah Liu1, Kennedy Walsh1, Madison Chinich1, Marcus Pearce2,3, and Sophie Scott1.
1 Institute of Cognitive Neuroscience, University College London, London, UK. 2 School of Electronic Engineering and Computer Science, Queen Mary University of London, London, UK. 3 Department of Clinical Medicine, Aarhus University, Aarhus, Denmark

Subtheme B - Auditory, Motor and Sensory Integration

Some sounds—including music and nails on a chalkboard—evoke feelings of touch. Prior research suggests that a) spatial properties conveyed in recorded media may help drive certain sound-evoked touch sensations and b) positive vs. negative perceived valence of sounds may lead to differentiated tactile experiences. In this study, we aim to identify the degree to which pleasure and the amount of spatial information contribute to auditory-evoked tingling tactile sensations. We performed two online behavioral experiments (N=150 and N=100), where we presented participants with 40 and 80 sounds, respectively, that were previously found to elicit tingling touch sensations in the general population, and asked them to rate perceived pleasurableness, touch, and

spatial cues. We included non-melodic sounds that are used in Western experimental music and ASMR media to induce tingling sensations (e.g., scraping and tapping sounds), and systematically varied whether stimuli were stereo recordings (vs. monaural) and pleasurable (vs. unpleasurable). In experiment 1, we recruited adults from an online forum for individuals who commonly experience sound-evoked touch. In experiment 2, we recruited adults from the general university population. In both experiments, we used a multi-level logistic regression to test the degree to which pleasurableness and spatial information predicted sound-evoked tingling sensations. In experiment 1, we found that that stereo stimuli, subjective perception of stereo cues, and pleasurableness significantly predicted probability of perceived touch. In experiment 2, we replicated these findings and additionally found that perceived proximity significantly predicted perceived touch. These behavioral results will inform an imminent fMRI study with a similar listening paradigm, where we will investigate the role of caudal auditory regions in auditory-elicited tingling touch sensations. We hope this work will contribute to understanding the underpinnings of sound-evoked touch across auditory aesthetic phenomena, and to cross-modal links in auditory processing.

Effects of Learning on Neural Representations of Rhythm and Beat

Joshua Hoddinott
University of Western Ontario, London, Canada

Subtheme B - Auditory, Motor and Sensory Integration

Listening to rhythmic sounds elicits activity in the basal ganglia, cerebellum, and motor cortices, including supplementary motor area and premotor cortex. Rhythms with musical structure that give rise to a steady underlying pulse, or 'beat', elicit increased activity in the SMA and basal ganglia, suggesting these areas are involved in beat perception. However, because people hear music regularly, rhythms eliciting a strong beat are necessarily more predictable than amusical, irregularly-timed rhythms that are often used as control stimuli. Thus, neural correlates of beat perception may be confounded by the relative experience-driven predictability of strong-beat rhythms. To address this confound, we equalize the predictability of a subset of rhythms that vary in beat strength, and measure BOLD activity associated with the rhythms before and after predictability is equalized. Across 4 sessions, participants train on 12 unique rhythms (4 strong-beat, 4 weak-beat, and 4 non-beat) in finger-tapping tasks. In pre- and post-training fMRI sessions, BOLD responses are measured while participants listen to the rhythms during a rhythm discrimination task.

Brain regions that are truly sensitive to the beat will maintain activity differences between beat strength conditions in both pre- and post -training scans. However, predictability-sensitive regions will show no difference between beat strength conditions in the post-training scan only, as all rhythms will be equally predictable. In the SMA and basal ganglia, preliminary findings show similar differences between beat strength conditions in pre- and post-training scans, suggesting these beat-sensitive regions are not driven by experience-driven predictability.

Neuroaesthetic Investigation of Opera Perception: A Pilot Study on the Electroencephalographic Evaluation of the Impact of Instructional Prime on Brain Indices of Approach-Withdrawal and Mental Workload

Bianca Maria Serena Inguscio (1;2), Dario Rossi(1;2), Elvira Brattico(3;4), Fabio Babiloni (1;2;5), Giulia Cartocci(1;2).
(1) Department of Molecular Medicine, Sapienza University of Rome, Rome, Italy; (2) BrainSigns Srl, Rome, Italy; (3) Centre for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Aarhus, Denmark; (4) Department of Education, Psychology, Communication, University of Bari Aldo Moro, Italy; (5) Department of Computer Science, Hangzhou Dianzi University, Hangzhou, China

Subtheme B - Auditory, Motor and Sensory Integration

Opera, the centuries-old fruit of human genius, is an art form rich in sociocultural, historical, psychological elements and deep meanings. Unfortunately, it is not always received by young audiences in its beauty unless it is enjoyed by an audience of experts skilled in listening. However, considering the complexity of modern times, to date it is essential to deepen what additional elements can enhance the aesthetic enjoyment of Opera in order to support the dissemination of cultural heritage to younger generations. In this pilot study, we intended to evaluate, with cutting-edge electroencephalographic (EEG) technology, the effect of an instructional prime on the brain processing of opera excerpts. Thirteen participants, young adults not music-expert, divided into two groups (Blind group: 6 pts, mean 24.539 31.296 years old; Instructed group: 7 pts, mean 25.410 32.237 years old) were asked to attend short audiovisual excerpts (60 sec) from 4 key arias from Mozart's Magic Flute Opera while EEG signal was acquired for analysis of neurophysiological indices of Approach-Withdrawal (AW) and Mental Workload (WL). Subjective responses (self-reported data) regarding Pleasantness and Difficulty after each stimulus were also collected during the task. Data analyzed through

nonparametric statistics showed significantly lower WL ($p=0.045$) and, on average, higher AW in the Instructed group than in the Blind group. Furthermore, subjective data showed a lower trend in self-reported Pleasantness for the Blind group, and a correlation between Pleasantness and participants' age (rho=0.650, $p=0.026$). Overall, the present results, discussed in light of recent findings in the field of auditory neuroaesthetics, although preliminary, would suggest the neurocognitive benefit of previous knowledge on the aesthetic enjoyment of musical work. Finally, our study paves a new brain-way to the perceptual evaluation of the cultural heritage in both learning and leisure settings.

Keep up the rhythm : A longitudinal approach to the dynamic interplay between phonological awareness, executive functions, rhythmic abilities and literacy abilities in young children

Nora Jamoulle, Pol Ghesquière
Parenting and Special Education Unit, Faculty of Psychology and Educational Sciences, KU Leuven, Belgium

Subtheme B - Auditory, Motor and Sensory Integration

Developmental Dyslexia (DD) presents challenges rooted in deficits of phonological awareness (PA) and executive functioning (EF). Understanding their interplay and potential mediation in relation to literacy is crucial. Moreover, individuals with DD often exhibit deficits in rhythmic information processing. The inability to keep a steady beat is now considered an early indicator for reading difficulties, and an expanding body of literature has been exploring the link between rhythmical abilities (RhA) and literacy development. Musical training and music-based interventions, through near and far transfer effects, have shown promise in enhancing performance in cognitive skills and literacy outcomes. Recent research has hypothesize PA and subcomponents of EF to play a mediation role between rhythm and literacy, however gaps persist in understanding the relationship between RhA and the cognitive network of reading. We conducted a pilot study in 2022 with thirty 5-year-old Dutch-speaking children ($n=27$) evaluating rhythmic timing, cognitive inhibition, and PA. Findings revealed significant correlations between rhythmic tapping, inhibition reaction time, and music exposure. To delve deeper into the dynamic interplay between EF, PA, and RhA, we elaborated a broader longitudinal study involving 89 typically-developing children from third year kindergarten and first year primary school ($M = 73.81$ months). This ongoing longitudinal study involves two testing time-points where participants are tested on rhythmic perception and production abilities, EF, PA, reading skills, vocabulary, and intelligence. The poster will present preliminary findings from both time-points.

Rhythmic Resonance: Investigating Music's Role in Social Bonding through Behavioral, Physiological, and Neural Measures

Lisha Li1,2, Han Wang1, Yifan Xu1, Xiaoqin, Wang,3, and Juan Huang3*,
1 Tsinghua Laboratory of Brain and Intelligence (THBI), Tsinghua University, Beijing, P.R. China; 2 Department of Music Artificial Intelligence and Music Information Technology, Central Conservatory of Music, Beijing, China; 3 Department of Biomedical Engineering, The Johns Hopkins University, Baltimore, Maryland, USA

Subtheme B - Auditory, Motor and Sensory Integration

Music rhythm significantly enhances social connection by promoting interpersonal motor synchronization, aligning cardiorespiratory rhythms, and triggering endorphin release. To explore the neural mechanisms behind this effect, listeners were exposed to four types of music with varying rhythmic patterns (March, Waltz, Samba, and irregular) in both a soundproof chamber and a small concert hall. During these sessions, tapping behavior, various biological markers, and EEG data were collected concurrently. The analysis focused on group synchronization and individual variations across these diverse measures, revealing that music rhythm notably affects the consistency of beat tapping, heart rate variability, and EEG response patterns. These findings underscore music's role in fostering social cohesion and offer a nuanced understanding of the social implications of different rhythmic patterns in music.

Neural tracking of speech at preschool age is modulated by familial musical background: Insights from neural and behavioural measures

Dimitra-Maria Kandia (1,2), Katharina Menn (3), Simone Dalla Bella (4,5,6), Claudia Männel (1,3),
1 Department of Audiology and Phoniatrics, Charité–University Medicine Berlin, Germany, 2 Department of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, 3 Department of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, 4 International Laboratory for Brain, Music, and Sound Research (BRAMS), Montreal, Canada, 5 Department of Psychology, University of Montreal, Montreal, Canada, 6 Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada

Subtheme B - Auditory, Motor and Sensory Integration

During auditory processing, brain activity synchronizes with rhythmic input, such as speech or music. The developing auditory system becomes increasingly adept at extracting rhythmic information crucial for music and language processing. Individual differences in the

neural tracking of speech have been linked to children's precision of behavioural (audio-motor) beat synchronization as well as early linguistic processing. Moreover, familial musical background has been associated with infant neural rhythm tracking as well as early language outcomes. Despite the significance of these findings, investigations into the preschool years that lay the foundation of complex auditory processing mechanisms remain limited. In our study, we combined neural and behavioural measures to investigate individual differences in 2- to 4-year-old preschoolers' (n=42) neural tracking of speech-syllable rates and children's behavioral ability to synchronize with metronome beats. Neural tracking of speech was assessed via speech-brain coherence, which reflects the synchronization between the speech envelope and the electrophysiological signal. Behavioral synchronization was measured via a tapping task to metronome beat sequences (100 and 120 bpm). We also assessed children's musical exposure at home and parental musical sophistication via parental questionnaires. We examined whether individual and familial variables could significantly predict children's neural tracking of speech with multiple regression analysis. Results indicate that speech-brain coherence was positively correlated with age (corr. $p < 0.05$), parental initiation of musical behaviour (corr. $p < 0.05$), and parental singing ability (corr. $p < 0.05$). However, no significant effects were found for children's behavioural rhythmic measures on their neural speech encoding; which might reflect the challenging measurement of early behavioural synchronization abilities rather than a lack of brain-behaviour relation in children's processing and production of auditory rhythm per se. In sum, our findings underscore the relevance of enriched parental musical input for auditory processing mechanisms during language development in early childhood.

Neurologic Music Therapy (NMT®) and Non-Invasive Brain Stimulation for Upper Limb Performance in Patients with Corticobasal Syndrome (CBS)

Kyurim Kang, Shriya Bakhshi, Chris Bedell, Alexander Pantelyat;
Center for Music and Medicine, Department of Neurology, Johns Hopkins University School of Medicine, Baltimore, MD, USA

Subtheme B - Auditory, Motor and Sensory Integration

Musical patterns with spatial, temporal, and dynamic cues (Patterned Sensory Enhancement, PSE®) and musical instrument playing targeting individualized optimized movement (Therapeutic Instrumental Musical Performance, TIMP®) can improve upper limb function in individuals with movement disorders. PSE® and TIMP® are Neurologic Music Therapy (NMT®) techniques designed to target sensorimotor challenges. Corticobasal syndrome (CBS) is a rare neurological disorder marked by progressive movement difficulties, cognitive decline, and other neurological symptoms due to focal neurodegeneration. This can cause significant difficulty in using upper extremities for skilled movements. Transcranial direct current stimulation (tDCS) is a noninvasive brain stimulation technique that uses low levels of direct electrical current to modulate the activity of specific cortical areas. Previous research found potential benefits in CBS. However, to our knowledge, NMT® with tDCS in CBS has not been investigated to date. Nine Participants (female=4, age =67.4434.16, years since diagnosis =1.7830.83) underwent six 30-minute sessions of either sham or active tDCS (random assignment with masking of outcome assessor) twice a week for 3 weeks. Using a 32-electrode EEG/tDCS system, motor and somatosensory cortices contralateral to the more affected arm were targeted. Assessments included Purdue Pegboard test (PPT) and Box and Block Test (BBT), State-Trait-Anxiety-Inventory, and Cortical-Basal ganglia Functional Scale (CBFS) at baseline, post-6th session, and one-month-follow-up. PPT and BBT scores (fine/gross upper limb movement) improved from baseline (PPT: 8.7735.40 to 11.1137.39; BBT: 7.5637.32 to 11.3339.23) and slightly worsened at follow-up (PPT: 10.4436.00; BBT: 10.2239.01). Anxiety levels decreased from baseline (37.00315.69) to post-intervention (32.67314.87) but increased at follow-up (36.33314.84). CBFS scores improved from baseline (29.78315.90) to post-intervention (29.11313.72) and further improved at follow-up (27.11316.78). Our initial findings suggest that NMT®, with/without tDCS, can improve arm/hand performance, reduce anxiety, and enhance functional performance in CBS. Notably, some improvements may persist for a month post-intervention. Analyses factoring in tDCS effects are forthcoming.

Sensory effects of sequential actions are pre-planned in a parallel fashion similar to their coupled actions

Alexandros Karagiorgis1; Anwesha Das1; Katja Kornysheva2; Elena Azañón3; Max-Philipp Stenner3
1 Department of Neurology, Otto-von-Guericke-University Magdeburg, Germany, 2 Centre for Human Brain Health, School of Psychology, University of Birmingham, UK, 3 Department of Behavioral Neurology, Leibniz Institute for Neurobiology, Magdeburg, Germany

Subtheme B - Auditory, Motor and Sensory Integration

Ideomotor theory posits that actions and their sensory outcomes, also termed action effects, become coupled through repeated exposure to fixed response-effect mappings, enabling bidirectional activations. Behaviorally, evidence suggests that anticipating action effects can facilitate the planning of actions. Previous findings on sequential action planning revealed that representations of all upcoming sequence elements follow a parallel organization before movement onset. We hypothesized that anticipated action effects would also be governed by the same principle. Here, participants (N=23) learned to produce from memory two 5-element sequences on a tone-producing keyboard (notes C-G), resulting in a coupling of motor actions to auditory action effects. We recorded magnetoencephalography (MEG) data in a separate session with three blocked conditions: 1) motor sequence production as experienced during learning, 2) motor sequence production but muted, and 3) passive listening to the melodies of the learned motor sequences. In all conditions, each trial started with a visual cue, indicating which motor sequence subjects would have to produce, or which tone sequence they would hear, followed by a preparation time window. With a multivariate pattern analysis approach, we trained a classifier to discriminate individual elements of the sequence (either individual finger presses during sequence production, or individual tones during passive listening) and tested for a parallel representation of those elements during the preparation time window. Preliminary results of this ongoing study reveal a parallel organization during preparation in all conditions, confirming our hypothesis that action effects can be preplanned similarly to their coupled motor action. We are currently investigating (a) the source localization of the preplanning activity in each condition, (b) relationships between behavioral measures of performance and neural preplanning activity, and (c) whether preplanning of either the action or the action effects involves a cross-modal preplanning of the coupled counterpart, following a cross-decoding approach across conditions.

Paradoxical responses in auditory pitch control – tracking online motor learning with MEG

Johannes Kasper & Christian A. Kell
Department of Neurology and Brain Imaging Center, Goethe University Frankfurt, Germany

Subtheme B - Auditory, Motor and Sensory Integration

We collected MEG and behavioral data from 19 subjects performing an auditory pitch control task, in which slow continuous and fast intermittent pitch alterations had to be compensated with a valve-like button. We identified compensating as well as paradoxical “following” responses to fast pitch alterations, in which the finger appears to follow the externally induced pitch motion. Through statistical and computational modeling we demonstrate that following responses can be explained by context-dependent high surprisal about the apparent sensorimotor contingency and that they could be a signature of active confirmatory sampling for (re) learning or stabilizing the audiomotor law. Here, we assess whether MEG signals track the predicted contingency surprisals and whether intrinsic neural processes at the time of disturbances hold additional predictive value about the type of reaction (following vs. compensating). Due to a low numbers of following responses we seek to partially pool information across participants. The traditional approach for partial pooling, mixed linear models, is not readily applicable to MEG data due to poor inter-subject alignment of the neurophysiological correlates in the spatial (i.e. sensor) and temporal domains. While projecting individual sensor data to a standard source space or to virtual common sensors improves spatial inter-subject alignment, it assumes a common anatomical-functional mapping and suffers from the underspecification of inverse mapping. Multiset Canonical Correlation Analysis (M-CCA) performs favorably but relies on the temporal alignment of neural processes between subjects and is agnostic of the spatial structure. We therefore explore the applicability of generalized additive mixed models, a class of semi-parametric non-linear regularized regression models, with per-subject Markov Random Field smooths of sensor location to account for inter-subject variability while retaining the gross spatial structure. By explicitly modeling time (and frequency) as smooth factors, we further increase statistical sensitivity compared to mass univariate methods. We compare this approach to M-CCA.

Music Therapy and Predictive Ability in Children with Autism

Asena U. Kocan1; Alexander Groessing1; Marianna Ruiz2; Alexandrina Guran3; Nace Mikus3; Maj-Britt Posserud4; Karsten Specht5; Christian Gold2; Giorgia Silani1
1 Department of Clinical and Health Psychology, Faculty of Psychology, University of Vienna, Vienna, Austria; 2 Department of Health and Social Sciences, NORCE Norwegian Research Centre, Bergen, Norway; 3 Department of Cognition, Emotion, and Methods in Psychology, Faculty of Psychology, University of Vienna, Vienna, Austria; 4 Division of Psychiatry, Haukeland University Hospital, Bergen, Norway, Maayan Salomon-Gimmon- The School of Creative Arts Therapies, Faculty of Social Welfare and Health Sciences, University of Haifa, Haifa, Israel; 5 Department of Biological and Medical Psychology, Faculty of Psychology, University of Bergen, Bergen, Norway;

Subtheme B - Auditory, Motor and Sensory Integration

Background: Interest and ability for music has been reported since the first description of autism spectrum disorder (ASD). Considering that music is regarded as a "social art" and many deficits in ASD are found in the social domain, beneficial effects of music therapy (MT) have long been assumed. However, its efficacy remains variable among individuals, and mechanisms of actions unexplored. Objective: To address these gaps, our study investigates whether children's understanding of musical components, such as predictability, and their preference for it (consonant versus dissonant musical endings), serves as a predictor of MT effectiveness. Methods: Here 53 children with ASD, aged 6-12, completed 12 sessions each of MT and play-based therapy (PT) in a randomized sequence. In pre- and post-therapy assessments, preference for expected musical endings alongside clinical outcomes including social communication, participation, family quality of life (FQoL), and symptom severity, and resting state functional connectivity (rsFC) were evaluated. Results: Initial analyses done with 21 children revealed no significant association between clinical outcomes and preference for consonant music at baseline. Interestingly, a non-significant increase in preference for consonant vs. dissonant music was observed after MT ($M = 7.85$) compared to baseline ($M = 0.85$), $t(38.08) = -1.15$, $p = .26$. Moreover, a trend indicating an association between children's baseline preference for consonant music and improvement in FQoL after MT, was observed ($r = .46$, $p = .06$). It is expected that such association is underpinned by changes in rsFC, especially between auditory-subcortical, auditory-visual and fronto-motor regions. Conclusions: The results are discussed in the context of the predictive processing theory of autism, as the effectiveness of MT may stem from inherent features of music, which evoke pleasure through systematically fulfilling or challenging predictions.

Musical pleasantness shapes our interpersonal synchronization: exploring the role of consonance and dissonance in joint action

Giorgio Lazzari1; Lucia Sacheli2; Charles-Etienne Benoit3; Floris van Vugt4; Carlotta Lega1
1 Department of Brain and Behavioral Sciences, University of Pavia, Pavia, Italy; 2 Psychology Department, University of Milano-Bicocca, Milano, Italy; 3 Inter-University Laboratory of Human Movement Biology, Univ Lyon, University Claude Bernard Lyon -1, Villeurbanne, France; 4 Psychology Department, International Laboratory for Brain, Music, and Sound Research, University of Montreal, Montreal, Canada;

Subtheme B - Auditory, Motor and Sensory Integration

One of the key way in which humans interact with their auditory environment is when they synchronize their movements to regular patterns of sound. While at the individual level, it has been suggested that the quality of the sound (i.e. if it is consonant or not) affects auditory-motor synchronization, no studies have ever investigated whether and how sound consonance influences a joint action synchronization task. Paired participants performed a dyadic synchronization–continuation task (SCT) with auditory feedback: each participant heard the auditory feedback from the self and the other, thus creating a chord, which can be consonant (Perf5 and Maj6) or dissonant (Min2 and Maj2). Results showed an increased synchronization accuracy as a function of consonance, with consonant chords leading to a better interpersonal coordination, compared to dissonant ones. This effect was maximized in couples with higher musical hedonia (measured with eBMRQ questionnaire) and stronger connection feelings (tested with IOS scale). Additionally, greater dyadic scoring in the Gold-MSI, indicating overall higher musical training, was associated with a better interpersonal synchrony. Together these results suggested that the harmonic aspect of musical structure significantly affects interpersonal synchronization, underlying the crucial role of consonance in shaping our ability to temporally coordinate our actions with others.

Measurement of Presence in Auditory Virtual Environments: Development of an Auditory Presence Questionnaire

Clémence Lelaumier1,3,4, Clément Vesque1, Antoine Petroff2, Baptiste Fruleux3, Yann Coello4 ,Hervé Platel1; 1.Inserm, U1077, EPHE, UNICAEN, Normandie Université, PSL Université Paris, CHU de Caen, GIP Cyceron, Neuropsychologie et Imagerie de la Mémoire Humaine (NIMH), 14 000 Caen, France; 2.Cosmos Acoustique, Paris, France; 3. Wivy (wivy.fr), Lille, France; 4. Univ. Lille, CNRS, UMR 9193 – SCALab – Sciences Cognitives et Sciences Affectives, Lille, France

Subtheme B - Auditory, Motor and Sensory Integration

The sense of presence, defined as the feeling of "being there," has been extensively explored in visual virtual environments but largely neglected in auditory virtual environments, despite indications of its existence. This study aims to develop an assessment questionnaire for auditory presence, considering presence as a cognitive construct that should be amodal. Methodology involved two phases: a literature review to propose a presence model and essential factors, followed by expert validation. Three sound experts, three presence experts, and three non-experts reviewed the questionnaire for validity. The second phase included a validation study with healthy participants experiencing natural and musical sound scenes in 2D and 3D formats. Physiological and behavioral parameters were measured, and an auditory presence questionnaire was completed after each session. Sound scenes were created using SPAT Revolution and Max MSP software, played through a BeyerDynamic headset (dt 770), with 3D scenes adapted to head movements using an eye tracker (Tobii 5L). We hypothesize that presence scores will be higher in realistic sound scenes, i.e., those presented in 3D, than in scenes presented in 2D. Indeed, technological advancements now allow us to reproduce more realistic auditory virtual environments than what we can offer in visual virtual environments. Furthermore, we expect physiological and behavioral measures to vary depending on the presentation format (2D or 3D) and to be correlated with measures taken by the questionnaire. Given the importance of presence in clinical therapy generalization, validating measurement tools to increase the use and quality of virtual sound environments.

Low-frequency neural activity critically supports temporal integration and selective enhancement of the beat, as revealed with auditory vs. tactile rhythm

Cédric Lenoir, Tomas Lenc, Sylvie Nozaradan
Rhythm and Brains Lab, Institute of Neuroscience (IoNS) UCLouvain, Brussels, Belgium

Subtheme B - Auditory, Motor and Sensory Integration

The propensity of humans to move with musical rhythm requires multiscale temporal integration, a key process to organize fast rhythmic events into larger, behavior-relevant entities such as the musical beat. However, the neural dynamics underlying this high-level perceptual process, and the extent to which these dynamics are shared across senses, beyond audition, are still unknown. In a series of three experiments, we characterized the EEG of volunteers while exposed to rhythms, and in a separate session, their motor entrainment to the same rhythms using finger tapping. Rhythms were conveyed by acoustic or vibrotactile stimuli, given their similar characteristics and often-concomitant occurrence in musical contexts. Results indicate prominent neural representation of the beat specific to the low-frequency range (<10Hz) in the auditory modality, thus corroborating previous studies. In contrast, vibrotactile rhythms elicited responses over a broader frequency range (<25Hz)

without prominent representation of the beat, in line with poorer tapping performance. Moreover, the prominent neural representation of the beat in the auditory modality was enhanced by longer shape of sounds, as was the stability of motor entrainment to the rhythm, in contrast with the tactile modality which was invariant to the shape of stimulus events. Finally, tactile rhythm delivered on different body parts (ribcage vs. fingers), eliciting more ecologically valid sensations, confirmed low-level tracking of the stimulus, but did not improve neural representation of the beat or motor performance. In sum, the somatosensory system seems to faithfully track individual sensory events composing a rhythm, even when the input features are adjusted to match the sensory modality's preferred response window. In contrast, the spontaneous ability of the auditory system to generate activity in the low-frequency range in response to acoustic rhythm may support multiscale temporal integration necessary to behavior-relevant representations of rhythm.

Perceiving Musical Vibrations: Exploring The Limits of Tactile Sensations

Jeremy Marozeau1,3; Mario Prsa2; Alice Taylor3; Aleksandra Novozhilova3; Daniel Huber3
1 Technical University of Denmark, Switzerland; 2University of Fribourg, Switzerland; 3 University of Geneva, Switzerland

Subtheme B - Auditory, Motor and Sensory Integration

Music is primarily perceived through vibrotactile stimuli by many individuals with hearing impairments. Although the hearing and tactile modalities share many common mechanisms related to vibration perception, they significantly differ in other aspects. As a result, music perceived through tactile sensations cannot replicate the exact sensations experienced when heard. Twenty participants were stimulated with tactile vibrations composed of perceived-intensity-matched pure tones at frequencies ranging from 40 to 750 Hz and presented mechanically to the whole hand. They were asked to rate those stimuli on their own scale of pitch, roughness, and pleasantness. Initially, our participants had difficulty translating the concept of musical pitch into tactile sensation. Consequently, we asked them to rate the "perceived frequency" instead, defined as the speed of oscillation. With this revised instruction, the results revealed a significant monotonic increase in ratings across all frequencies.

By utilizing a model of mechanoreceptors on the hand, we accurately predicted the average growth function of "perceived frequency" based on the firing rates of two somatosensory afferent nerve fibers (PC and RA). Furthermore, the analysis showed that when participants were asked to evaluate the roughness of the stimuli, there was no significant effect of frequency on their perceptions. However, a significant effect was observed when they assessed the pleasantness, identifying a maximal peak at approximately 80 Hz. Overall, these results suggest that people can relate vibration frequency to a perceptual continuum that cannot always be directly translated into musical dimensions. Above 750 Hz, no tactile sensation could be reliably induced, indicating that adapting complex music information across its wide frequency range requires tailoring it to the limited scope of the tactile modality. So far, only pure tones have been tested; further experiments using complex signals would provide additional dimensions useful for conveying musical signals.

Auditory, motor and sensory integration: the intervention with family in NICU

Simona Matricardi; Lorenzo Masini
Gemelli-Isola Hospital, Rome, Italy;

Subtheme B - Auditory, Motor and Sensory Integration

The Sensory Intervention on the premature newborn aims to promote adequate sensory information (tactile, proprioceptive, vestibular, motor, and auditory) during hospitalization in neonatal intensive care, based on the evaluation of the child's anamnestic clinical conditions. The intervention also involves the parents and is conducted by an Infant Neurodevelopmental Therapist with a Music Therapist. The intervention is sometimes filmed. Sensory information is modulated based on the infant's level of neuro-sensory maturation and age of development. The aim is to favor a gradual neuro-sensory maturation through a monomodal, bimodal or multimodal intervention, from 30-31 weeks (post-menstrual age) until discharge (around 36 weeks post-menstrual age). We will present the data collected to date for each child, at time 0 (before the operation) and at times T1, T2, T3, T4 (at the end, after 5, 10, 15 minutes) of the parameters of Heart Rate, Saturation, Behavior, Postural-Motor Organization.

Slower spontaneous rates are linked to better performance in pitch discrimination tasks

Cecilie Møller[1]*, Anna Zamm[2], Ben H. Engler[1,3],
[1] Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Denmark; [2] Department of Linguistics, Cognitive Science and Semiotics, Aarhus University, Aarhus, Denmark; [3] Department of Psychology, Centre for Cognitive Neuroscience, Paris-Lodron-University of Salzburg, Austria

Subtheme B - Auditory, Motor and Sensory Integration

Many everyday events and actions display stable rhythmic patterns, such as walking, talking, and making music, and individuals' spontaneous rates in performing such tasks vary considerably. Endogenous rhythms thought to underlie these spontaneous rates influence our brains' sensitivity to sensory information structured in time. Thus, the question arises: do individuals' spontaneous rates influence perceptual sensitivity beyond the timing domain, specifically pitch discrimination ability? Sixty participants completed two pitch discrimination tests and eight tasks assessing spontaneous rates in different ways (clapping, walking, tapping to produce melodies, tapping with and without sound production, tapping online outside and in the lab). Participants' spontaneous motor tempo (SMT) was measured in an initial tapping task and the subsequent pitch discrimination threshold (PDT) test featured three stimulus presentation rate conditions: at SMT, 15% faster, and 15% slower. This was also the case for the oddball task at rates between 350 ms and 750 ms (n=39). For participants beyond these limits (n=20), a presentation rate of 550 ms substituted the rate presented in the SMT condition. Preliminary results show no support for the main hypothesis that anchoring stimulus presentation rate at participants' individual SMT increases sensitivity to pitch changes, compared to 15% faster or slower. Interestingly, though, participants with slower spontaneous rates performed better in the PDT test. Within the group of tappers exposed to identical presentation rates in the oddball task (n=20), better pitch sensitivity and faster response times were also linked to slower spontaneous rates across several tasks. While more musicians had slower SMTs the association was particularly strong in musicians. Together, our results indicate that the effect is not caused by differences in stimulus presentation rate or by slower SMT in musicians but linked to individual differences in SMT. Whether the association is driven by better test-taking abilities or increased sensory processing remains open.

Spared neural and behavioral adaptation following changes in rhythm in patients with cerebellar impairments

Eleonora Baliviera1, Mattia Rosso2, Bart Moens2, Marc Leman2, Peter Feys1, Lousin Moumdjian1,2
1 Faculty of Rehabilitation Sciences, REVAL, Hasselt University, Belgium. 2 Faculty of Arts and Philosophy, IPEM, Gent University, Belgium.

Subtheme B - Auditory, Motor and Sensory Integration

Cerebellum plays a key role in precise temporal encoding required for auditory-motor synchronization. However, it's role in precise tracking of unpredictable rhythmic changes as a function of neural entrainment has not been studied yet. We thus aim to investigate this phenomenon in persons with cerebellar impairments (pwCI) compared to healthy controls (HC). 14 PwCI (SARA 4,8336,31) and 14 HC were included. The experiment consisted of a listening (60'), and two tapping tasks to a metronome set at 1.67Hz in two conditions. Each tapping condition lasted 465', of which the first 60' were perturbation free, followed by the stimuli containing 40 perturbations in total within 5' time windows. The two conditions were differentiated by the type of perturbation: Tempo changes (3 10%) and Phase shifts (3 90°). EEG was recorded during the task, and participants were instructed to tap to metronomes while maintaining synchronization. As an outcome, Event-Related Frequency Adjustment (ERFA) was computed on both behavioral and neural EEG responses for the listening (perceptual component PC) and tapping (sensorimotor component SMC) tasks. ERFA is a measure quantifying the dynamics of instantaneous frequency of the signal as a response to tracking changes. For tempo perturbations, similar behavioral adaptation were found in both groups, differentiated by perturbation's directions. Neural ERFA tracked perturbation's directions over time, with a significant difference for PwCI in response to slower tempi. Furthermore, SMC followed changes for faster and slower tempi. For phase perturbations, behavioral ERFA was attuned to the perturbation's directions in both groups; while the neural ERFA showed the tracking of the SCM (compared to perceptual) to the positive perturbation directions. In conclusion, PwCI showed spared neural and behavioral adaptation and neural tracking to unpredictable tempo and phase perturbations. The difference found for slower tempi for PwCI may be due to impairments of inhibition in the population.

Changes in cortical thickness and volume related to auditory -motor sequence training

Mohammed A. Mudarris[1,2,3], Elise S. Besemer[1], Neil Roberts [4], Katie Overy [5,6], Rebecca S. Schaefer[1,2,7],
1. Leiden University, Faculty of Social and Behvaioural Sciences, Insitute of Psychology, Health Medical and Neuropsychology, Leiden, NL; 2. Leiden Institute for Brain and Cognition, Leiden, NL; 3. University of Jeddah, Jeddah, Saudi Arabia; 4. The Queens Medical Research Institute (QMRI), School of Clinical Sciences, University of Edinburgh, Edinburgh, UK; 5. Reid School of Music, Edinburgh College of Art, University of Edinburgh; 6. Edinburgh Neuroscience, University of Edinburgh; 7. Leiden University, Academy of Creative and Performing Arts, Faculty of Humanities, Leiden, The Netherlands.

Subtheme B - Auditory, Motor and Sensory Integration

This study used MRI to investigate changes in the cortical thickness and grey matter volume related to a visuomotor hand training with or without musical cues. Regions of interest (ROIs) were bilateral motor and auditory regions, namely precentral gyrus (PCG), superior temporal gyrus (STG), and transverse temporal gyrus (TTG), expecting increases with training that were more pronounced when musical cues were added, and exploring correlations between motor performance increases and brain change. Twenty-seven participants were allocated to a Music or Control Group (MG/CG), where the former trained with musical cues and the latter did not. Both groups completed left-hand training for four weeks with three weekly 20-minute sessions, and underwent pre- and post-training scans and motor assessment on trained and novel finger sequences. ROIs were extracted using the Freesurfer atlas. Contrary to expectations, an ANOVA on the change over time (post-pre) yielded no significant differences in grey matter volume or cortical thickness between groups or hemispheres for all ROIs. However, significant interactions were observed between hemisphere and group for thickness in auditory regions (STG: ($F(1,25) = 5.06$, $p=.03$; TTG: ($F(1,25) = 4.37$, $p<.05$)) indicating greater increase in the contralateral hemisphere for CG. For MG, correlations were found between improved timing stability on trained sequences and decreased contralateral STG volume ($r=-.64$, $p=.019$), and between higher sequence accuracy in novel sequences and increased ipsilateral PCG thickness ($r=.58$, $p=.038$). For CG, reduced tapping timing stability was related to decreased ipsilateral STG thickness ($r=.57$, $p=.03$). These early findings suggest a complex interaction between hemisphere and group for auditory brain regions, with the main hypotheses left unsupported. Correlations found between motor

outcomes and auditory areas may aid interpretations of these findings, but limitations in sample size need to be considered. Further exploratory analyses that are currently underway may facilitate a better understanding of these results.

Beating in Sync: An Explorative Study of 9-10 Year-Old Children's Rhythmic Abilities Using the Beat Alignment Test

Sándor Imre Nagy1; Csaba Kertész2; Ferenc Honbolygó2
1 HUN-REN Research Centre for Natural Sciences, Budapest, Hungary University of Pécs, Faculty of Music and Visual Arts, Institute of Music, Pécs. 2 Institute of Psychology, ELTE Eötvös Loránd University, Budapest, Hungary.

Subtheme B - Auditory, Motor and Sensory Integration

In the past two decades, an increasing number of studies have posited a significant connection between beat-based processing, speech, and reading abilities (Ozernov-Palchik & Patel, 2018). In an effort to expand upon this understanding, the current cross-sectional study aims to investigate the relationship among beat perception, reading skills, and rhythmic tapping performance in Hungarian 3rd and 4th grade children (N=42, Mage = 9.91, SD=0.72). Beat perception was assessed using the Complex Beat Alignment Test (C-BAT; Trainor & Einarson, 2016), while beat maintenance was measured through a tapping test (TT; Kertész & Honbolygó, 2023). Reading skills were evaluated using subtests from the 3DM-H test (Tóth et al., 2014), including reading fluency, spelling, phonological awareness, and rapid automatized naming. Although this study is part of a larger ongoing longitudinal study, preliminary results revealed a low positive correlation (ρ=0.3) between TT synchronicity and C-BAT performance. Additionally, we observed low negative correlations (ρ=-0.32) between phonological awareness and TT inconsistency, as well as between spelling and inconsistency (ρ=-0.38). However, no further significant correlations were found between C-BAT and other reading or rhythmic tapping skills. Despite the limited sample size hindering extensive conclusions, these findings suggest a potential specific association between beat alignment abilities and synchronicity in young children, underscoring the need for further investigation into developmental aspects and potential implications for educational interventions.

References Kertész, C., & Honbolygó, F. (2023). First school year tapping predicts children's third-grade literacy skills. Scientific Reports, 13(1), 2298. Ozernov-Palchik, O., & Patel, A. D. (2018). Musical rhythm and reading development: does beat processing matter? Annals of the New York Academy of Sciences, 1423(1), 166-175. Tóth D., Csépe V., Vaessen A., Blomert L. (2014). 3DM-H: A diszlexia differenciáldiagnózisa. Az olvasás és helyesírás kognitív elemzése. Technikai kézikönyv. Nyíregyháza, Hungary: Kogentum.

Adaptive Dance Music Matching Its Tempo to the Integer Ratio of Heart Rate Reduces Runner's Perceived Exertion

Tomoya Nakamura (1), Ryo Yumoto (2), Kenta Ueda (1), Tomohiro Samma (1), Kenta Tanaka (2), Sotaro Kondoh (1), Yuki Uno (3), Yuya Kikukawa (3), Shinya Fujii (4),
(1) Graduate School of Media and Governance, Keio, University,Kanagawa, Japan; (2) Keio Research Institute at SFC,Kanagawa, Japan; (3) ORPHE Inc.,Tokyo, Japan; (4) Faculty of Environment and Information Studies, Keio University, Kanagawa, Japan

Subtheme B - Auditory, Motor and Sensory Integration

An adaptive metronome tempo, matching the integer ratio of heart rate, facilitates runner's cardio-locomotor synchronization and performance. However, it remains unclear how the subjective rating of perceived exertion (RPE) changes when the adaptive tempo is provided with dance music. This study aimed to investigate whether a runner's RPE during adaptive music feedback would be reduced compared to adaptive metronome and random music feedback. Fourteen students (21.43 3 2.53 [Mean 3 SD] years old) participated in this study. They wore a wearable heart rate sensor (H-10, Polar) to measure their electrocardiogram (ECG) and accelerations. The data were transmitted to a computer and a custom-written program adjusted the tempo to match the simple integer ratio of the heart rate. The program also adjusted the tempo randomly. The participants ran on a treadmill for 20 minutes under adaptive dance music, adaptive metronome, and random music feedback conditions, and verbally reported their RPE at time points at 6,13, and 20 minutes for each condition. A two-way analysis of variance (ANOVA) with factors of 3 conditions and 3 time points was used to compare the RPE among the conditions. The ANOVA revealed no significant interaction between the two factors ($F(4, 52) = 2.20$, $p = 0.082$, $\eta^2 = 0.14$). There were significant main effects of time point ($F(2, 26) = 136.75$, $p < 0.001$, $\eta^2 = 0.91$) and conditions ($F(2, 26) = 4.71$, $p = 0.018$, $\eta^2 = 0.27$). The post-hoc tests revealed that the RPE in the adaptive music condition is significantly lower than in the adaptive metronome condition ($p = 0.016$). Our results suggest that dance music, when its tempo is matched to the integer ratio of heart rate, reduces the perceived exertion of a runner.

Neural Mechanisms of Joint Action in Musical Ensembles: Disentangling Self and Other Integration

Patti Nijhuis1; Joshua S. Bamford1,2
1 Centre of Excellence in Music, Mind, Brain and Body, Department of Music, Art and Culture studies, University of Jyväskylä, Finland; 2 Institute of Human Sciences, School of Anthropology and Museum Ethnography, University of Oxford

Subtheme B - Auditory, Motor and Sensory Integration

Musical ensembles continuously anticipate and adapt to each other's movements for optimal joint performance. Players must divide their attentional resources between their own actions and those of the ensemble. In improvisational contexts, this dynamic interplay becomes even more critical. However, neural mechanisms for joint action remain challenging to study due to the entanglement of movement perception and production in brain activity. Here we disentangle neural responses related to self versus other, and assess their integration by combining dual-EEG recordings with frequency-tagging techniques. Participants wore LEDs flickering at 5.7 and 7.7 Hz on their index finger while producing novel patterns of coordinated horizontal forearm movements by varying the speed and amplitude. We aim to reproduce and extend the findings from Varlet et al. (2020) who demonstrated that: 1) leadership roles influence individual's monitoring of self- and other-generated movements and the degree to which they are integrated, 2) neural activity of self-other integration is strongest during cooperative joint action without an assigned leader, and 3) that coordination strength is related to the amplitude of neural activity at self-other integration frequencies. We will extend their findings, obtained during synchronised (in-phase) movement improvisation, to anti-phase (180-degree relative phase difference) coordination. Anti-phase coordination is expected to require more effort to maintain, being the less stable pattern. As a result, stronger neural self-other integration responses are hypothesised to occur during anti-phase coordination compared to in-phase coordination. The same relationship between coordination strength and self-other integration strength is expected in anti-phase coordination, unless the integration strength in the original study was confounded by the physical proximity of the frequency tagged LEDs. The implications of this study have wide-reaching applications beyond musical contexts, as we coordinate with people in our environment across a wide range of tasks, both for social purposes and to extend our action capabilities.

Complex rhythmic auditory stimulation for gait in Parkinson's disease

Victor Pando-Naude1; Viktor Hartmann Kuang2; Tomas E. Matthews1; Karen Lambæk Christensen1; Ole A. Heggli1; Jan Stupacher1; Erik Johnsen2; Peter Keller1; Peter Vuust1
1 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University and The Royal Academy of Music, Aarhus/Aalborg, Aarhus, Denmark; 2 Department of Neurology, Aarhus University Hospital, Aarhus, Denmark

Subtheme B - Auditory, Motor and Sensory Integration

Parkinson's disease (PD) is a neurodegenerative disorder characterised by loss of dopaminergic neurons in the basal ganglia (BG), resulting in motor and cognitive deficits. Current treatments provide only symptomatic relief, necessitating the investigation of alternative therapies such as rhythmic auditory stimulation (RAS) to address gait deficits. This study aims to investigate the relationship between the pleasurable urge to move to music (PLUMM) during walking, rhythmic complexity, and gait kinematics, while exploring potential links to music reward processing and timing abilities. Our translational approach connects basic research (rhythm in the brain) and applied research (rhythm as therapy) with PD serving as an optimal model to understand the neural underpinnings of rhythm and timing processing in the BG, when compared to healthy controls (C). Participants answered behavioural and music-related questionnaires, conducted tapping tasks to assess auditory, sensorimotor, and timing abilities, and rated PLUMM of different rhythmic complexities, while gait kinematics were measured during RAS. Our results revealed that PD participants exhibited a significant preference for rhythms of low complexity, whereas C preferred medium complexity, consistent with previous studies. No significant differences were observed in harmonic complexity preferences. Correlations were found between PLUMM ratings and cognitive function, depression symptoms, and music reward processing. In terms of timing abilities, results showed no significant differences between groups, but revealed correlations between synchronisation and pleasure ratings in PD. Gait kinematics analysis highlighted interactions between rhythmic and harmonic complexity, affecting mean pace, cadence, and step length differently in PD and C groups. These findings suggest a complex relationship between auditory perception, motor function, and gait in PD, with implications for understanding and managing motor symptoms in this popula-tion. We propose that dopamine dysregulation in PD disrupts beat- and rhythm-based predictive processes, and that complex RAS promotes temporal processing in the brain to guide the sequencing of movements.

Multilayer network analysis of cortical connectivity induced by computerized music training reveals different patterns plasticity within and across frequencies showcasing the advantage of multisensory learning

Evangelos Paraskevopoulos1; Alexandra Anagnostopoulou2; Nikolas Chalas3; Maria Karagianni2; Panagiotis Bamidis2
1 Department of Psychology, University of Cyprus, Nicosia, Cyprus; 2 School of Medicine, Faculty of Health Sciences, Aristotle University of Thessaloniki, Thessaloniki, Greece; 3 Institute for Biomagnetism and Biosignalanalysis, University of Münster, Germany.

Subtheme B - Auditory, Motor and Sensory Integration

This study aimed to determine, at the macro level of the human cortex, how multisensory training differs from uni-sensory. Following a multilayer network approach in analyzing pre- and post-training EEG recordings, we modelled cross-frequency coupling within and between the different bands of activity at the whole cortex. A multisensory mismatch paradigm evaluated the neuroplastic effects of (a) a computerized music reading training that exploited multisensory learning, and (b) a uni-sensory training composed by the same training elements but not employing multisensory integration. Results modelled the neuronal processing of multisensory irregularities prior to any training, indicating that this process was supported by extensive cross-frequency coupling from a distributed cortical network, including the intraparietal lobule, the left inferior middle temporal and pre-frontal regions. The trainings' neuroplastic effects revealed that multisensory training modified oscillatory coupling mainly within the β band and at a relatively focused cortical network that employed typical multisensory regions, such as the inferior parietal lobule. In contrast, the uni-sensory one induced cross-frequency changes primarily across θ and β as well as α and γ frequencies in distributed regions of the cortex. Statistical evaluation of the neuroplastic effects showcased that the effects differed significantly, illuminating the differential neuroplastic pattern. The behavioral and cognitive evaluation showed that general cognitive processes benefited from both trainings, but only the multisensory one improved multisensory processing.

Sex differences in vocal learning ability in songbirds are linked with differences in flexible rhythm pattern perception

Andrew A. Rouse (1), Aniruddh D. Patel (1), Samantha Wainapel (2), Mimi H. Kao (2)
Dept. of (1) Psychology and (2) Biology, Tufts University, Medford, MA, USA

Subtheme B - Auditory, Motor and Sensory Integration

Humans readily recognize a familiar rhythmic pattern, such that of a favorite song, across a wide range of rates. This reflects a facility with perceiving rhythmic structure based on the relative timing of events, not just based on absolute interval durations. Several lines of evidence suggest this ability is supported by precise temporal predictions arising from forebrain auditory-premotor interactions. We have shown previously that male zebra finches, Taeniopygia guttata, which possess specialized auditory-premotor networks and communicate with rhythmically patterned sequences, share our ability to flexibly recognize a fundamental rhythmic pattern (isochrony) across rates. To test the hypothesis that flexible rhythm pattern perception is linked to vocal learning, we ask whether female zebra finches, which do not learn to sing, can also recognize global temporal patterns across tempi. We find that females can flexibly recognize isochrony across a wide range of rates but perform slightly worse than males on average. These findings are consistent with recent work showing that while females have reduced forebrain song regions, the overall network connectivity of vocal premotor regions is similar to males and may support predictions of upcoming events. Comparative studies of male and female songbirds thus offer an opportunity to study how individual differences in auditory-motor connectivity influence perception of relative timing, a hallmark of human music perception. In ongoing work, we are investigating the contribution of a motor planning region that is reciprocally connected with auditory regions to flexible rhythmic pattern perception.

Predicting the effects of the statistical properties of auditory rhythms on the perception of time

Lena Esther Ptasczynski1; Jessie Rademacher2; Philipp Sterzer 3; María Herrojo Ruiz4; Gabriel Curio5, Gunnar Waterstraat6
1 Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin and Humboldt-Universität zu Berlin, Department of Psychiatry and Psychotherapy, Department of Neurology with Experimental Neurology, Berlin, Germany; Berlin School of Mind and Brain, Humboldt-Universität zu Berlin, Berlin, Germany; 2 Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin and Humboldt -Universität zu Berlin, Department of Psychiatry and

Psychotherapy, Berlin, Germany; 3 Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin and Humboldt -Universität zu Berlin, Department of Psychiatry and Psychotherapy, Berlin, Germany; Berlin School of Mind and Brain, Humboldt-Universität zu Berlin, Berlin, Germany; Universitäre Psychiatrische Kliniken Basel, University of Basel, Basel, Switzerland; 4 Goldsmiths, University of London, Department of Psychology, London, United Kingdom; 5 Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin and Humboldt -Universität zu Berlin, Department of Neurology with Experimental Neurology, Berlin, Germany; Berlin School of Mind and Brain, Humboldt-Universität zu Berlin, Berlin, Germany; 6 Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin and Humboldt-Universität zu Berlin, Department of Neurology with Experimental Neurology, Berlin, Germany; Berlin School of Mind and Brain, Humboldt-Universität zu Berlin, Berlin, Germany

Subtheme B - Auditory, Motor and Sensory Integration

Introduction:Perception of time is a dynamic process, considerably influenced by both exogenous (sensory input) and endogenous (esp. dopaminergic) factors. While distorted time perception may be a sign of dopamine-associated pathologies, e.g., in Parkinson‘s disease and schizophrenia, neurophysiological evidence in the sub-second range suggests that subjective time also emerges from dynamics in sensory-specific neural networks. Specifically, the Neural Magnitude approach of perceived duration claims that perceived time correlates with the level of congruency between temporally structured sensory input and neural activity. Methods: Using electroencephalography (EEG), we investigated both isochronous and an-isochronous auditory rhythms since these might be processed by distinct neural pathways (i.e., relative vs. absolute timing). Isochronous/an-isochronous sequences were manipulated by changing the underlying tone probability distribution, and the degree of these manipulations was quantified using a computational model of auditory expectancy. In the experiment, two rhythmic sequences (manipulated and isochronous baseline) were presented sequentially, and participants were asked to judge the extent to which the second rhythm was longer/ shorter than the first one on a 7 -step scale (-3 to +3). Results and discussion: Spatio-spectral decomposition was applied to estimate dominant sources of EEG activity in the delta, theta, alpha, beta, and gamma frequency bands. Subsequently, a mixed-effects location-scale model was fitted to test the effect of physiological and behavioural markers on perceived time and on the variance of the judgments. Blink rates and schizotypal personality questionnaire were included as a proxy of dopaminergic tone. Preliminary results suggest that during absolute timing, temporal underestimation is driven by musical expertise, higher occipital alpha, lower left frontolateral beta, and lower centroparietal theta. During relative timing, temporal overestimation seems to be driven by markers of dopaminergic activity (internal clock model). Altogether, we suggest that future models of time perception shall also consider the distinct processing of relative and absolute time structure.

Decrypting the relation between groove, pleasure and movement types

Marie-Andrée Richard, Will Azzi, Juliette Fortier, Nicholas E.V. Foster, Nathalie Gosselin, Simone Dalla Bella,
1 International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal, Canada,
2 Department of Psychology, University of Montreal, Montreal, Canada,
3 Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada

Subtheme B - Auditory, Motor and Sensory Integration

Music can evoke pleasure and a feeling of wanting to move (WTM, or “groove”). Pleasure and WTM are highly linked, and are predicted by factors such as arousal, familiarity and acoustic parameters. WTM is typically assessed without making reference to a specific movement. This makes the concept quite disembodied, and raises the question as to whether the pleasure-WTM relation varies with movement types. To address this question, we tested whether the pleasure -WTM relation changes as a function of movement type by taking into account common rhythmic movement types. In an online study, 480 participants rated 264 songs in terms of pleasure, arousal (relaxing-stimulating) and familiarity. They also rated the stimuli on WTM (low-high) and imagined pleasure while moving (iPWM, low-high) for moving in general, tapping/head nodding, walking, running and dancing. We extracted stimuli’s acoustical parameters (pulse clarity and roughness). We used network models to identify the relation between these variables and WTM. We found that WTM, iPWM and the pleasure-WTM relation were higher for local movements (tapping/nodding) than for full-body movements (dancing and locomotion). Arousal, pleasure and pulse clarity directly influenced general WTM (without specifying the movement type), whereas familiarity and roughness had an indirect effect. Similar results were found when WTM was specific for tapping/nodding. However, these relations changed importantly for full-body movements, as in those cases, no variable had an effect (direct or indirect) on WTM ratings. These findings strongly suggest that WTM ratings may depend on the nature of the movement, whether this is local movement (e.g., tapping/nodding) or full-body (e.g., walking or dancing). The relations of WTM with arousal and familiarity, typically observed in the groove literature, do not seem to hold when considering specific movement types, with the exception of tapping/nodding. These differences should be taken into account in searching for the determinants of groove.

The Urge to Move in Musical Anhedonia

Isaac Romkey1; Tomas Matthews2; Nicholas Foster3; Simone Dalla Bella3; Virginia Penhune1
1 Department of Psychology, Concordia University, Montréal, Canada; 2 Department of Clinical Medicine, Aarhus University Hospital, Aarhus, Denmark. 3 Department of Psychology, Université de Montréal, Montréal, Canada.

Subtheme B - Auditory, Motor and Sensory Integration

In cognitive science, the sensation of “groove” has been defined as the pleasurable urge to move to music. When listeners rate rhythmic stimuli on derived pleasure and urge to move, ratings on these dimensions are highly correlated. However, recent behavioural and brain imaging work has shown that these two components may be separable. To examine the separability of these two components, our study investigates the sensation of groove in people with specific musical anhedonia. Individuals with musical anhedonia have a blunted ability to derive pleasure from music but can still derive pleasure from other domains (e.g., sex and food). People with musical anhedonia were identified as those with scores in the lower 10% of scores on the Barcelona Musical Reward Questionnaire but had no deficits in music perception, no symptoms of depression, average levels of physical and social anhedonia, and normal sensitivity to punishment and reward. We predicted that if the two components of groove are separable, individuals with musical anhedonia would experience lower levels of derived pleasure but have comparable ratings of urge to move to controls. Groove responses were measured in a large online study for a set of musical stimuli. In the full control sample, our results replicated previous findings such that rhythm shared a quadratic relationship with groove responses. Surprisingly, we found no significant differences in groove response between individuals with musical anhedonia and a matched control group. Mediation analyses for the anhedonia sample found that wanting to move ratings fully mediated the effect of rhythmic and harmonic complexity on pleasure ratings. Taken together, these results indicate that the urge to move may compensate for the blunted pleasure response in those with musical anhedonia. More generally, these results suggest that the urge to move is a primary source of pleasure in the groove response.

Neurobehavioral Outcomes of Music Therapy for Autistic Children

Marianna Ruiz1; Maayan Salomon-Gimmon2; Alexander Gröessing3; Asena U. Kocan3; Maj-Britt Posserud4; Karsten Specht5; Giorgia Silani3; Christian Gold1
1 Department of Health and Social Sciences, NORCE Norwegian Research Centre, Bergen, Norway; 2 The School of Creative Arts Therapies, Faculty of Social Welfare and Health Sciences, University of Haifa, Haifa, Israel; 3 Department of Clinical and Health Psychology, Faculty of Psychology, University of Vienna, Vienna, Austria; 4 Division of Psychiatry, Haukeland University Hospital, Bergen, Norway; 5 Department of Biological and Medical Psychology, Faculty of Psychology, University of Bergen, Bergen, Norway,

Subtheme B - Auditory, Motor and Sensory Integration

Background: Recent research has begun to explore the neurological benefits of music therapy for autistic children and points to the importance of sensorimotor network modulation as a possible mechanism for subtending such changes (Sharda et al., 2018). Building on this initial evidence, the current Music for Autism (M4A) study, a bi-national project conducted in Norway and Austria, aims to replicate these findings with an improved randomized-controlled-trial (RCT) design and bigger sample. Objectives: The main goal of M4A is to assess the efficacy of MT in improving pragmatic communication, participation, and frontotemporal brain connectivity compared to a structurally matched play-based (PT) intervention. Methods: In this assessor-blinded, crossover, RCT approximately 80 autistic children (6-12 years) are randomized to a sequence of interventions (MT-PT or PT-MT), consisting of weekly therapy session over 3 months. All assessments are taken before and after each intervention period, which are separated by a 3-month washout period. Behavioral outcomes are assessed using the Children's Communication Checklist 2nd Edition (CCC-2), and the Children and Adolescents Scale of Participation (CASP). Resting -state functional brain connectivity (rsFC) of six seeds in frontotemporal brain networks is the primary neuroscientific outcome. Statistical analysis of outcomes uses an ANCOVA model to compare change from before to after each intervention within each participant. Results: Preliminary findings (n=53) up to January 2024, focusing on changes in communication, participation, and rsFC, will be presented. Expected outcomes include improved communication and participation post-MT, increased rs-FC in auditory-subcortical and fronto-motor regions,

decreased auditory-visual rs-FC, and an association between enhanced connectivity and communication gains. Conclusions: The M4A trial will shed light on the behavioral and neurophysiological effects of MT in autistic children, providing robust evidence on the potential mechanisms which may drive communication skills, participation, and overall quality of life improvements.

Auditory-Motor Paired Stimulation in Musicians: A Preliminary Study

Shizuka Sata1; Naotsugu Kaneko2; Inhyeok Jeong2; Kimitaka Nakazawa2; Shinya Fujii3
1 Graduate School of Media and Governance, Keio University, Kanagawa, Japan), 2 Graduate School of Arts and Sciences, Department of Life Sciences, The University of Tokyo, Tokyo, Japan, 3 Department of Environment and Information Studies, Keio University, Kanagawa, Japan

Subtheme B - Auditory, Motor and Sensory Integration

Auditory-motor plasticity is essential for musicians to play instruments. A previous study demonstrated that auditory-motor plasticity was induced in non-musicians by repeating paired stimuli of an auditory stimulus (speech sound) and transcranial magnetic stimulation (TMS), showing enhanced corticospinal excitability (Sowman et al., 2014). This plasticity is based on the phenomenon that preceding auditory stimuli facilitate excitability, and the facilitation is more pronounced at an inter-stimulus interval (ISI) of 100 msec within ISIs ranging from 50 to 300 msec in 50-msec increments (Sowman et al., 2014). It is unclear whether these findings apply to musicians for whom long-term music training may have already induced auditory-motor plasticity. This study aimed to determine if corticospinal excitability in musicians is most significantly enhanced when auditory-motor paired stimulation is administered at an ISI of 100 msec among various ISIs.Eleven musicians (29.6 3 6.7 years old [mean 3 SD]), who started musical training at 6.73 3 4.18 years of age and had 13.91 3 11.23 years of experience, participated in this study. TMS intensity was set to 120% of the resting motor threshold for the first dorsal interosseous muscle. Baseline motor evoked potentials (MEPs), reflecting corticospinal excitability, were assessed without any sound. Subsequently, the speech sound "Da" was used as an auditory stimulus, and MEPs were measured under auditory-motor stimulation conditions at intervals of 50, 75, 100, 125, 150, 175, and 200 msec between sound onset and TMS. The MEP amplitude relative to the baseline was calculated for each ISI condition (%). A one-way repeated measures ANOVA showed no significant main effect of ISI condition on MEP amplitude ($F(6,60) = 2.39$, $p = 0.962$), indicating that corticospinal excitability was not most enhanced at an ISI of 100 msec in musicians. Future research is needed to explore further the effects of auditory-motor stimulation in musicians and non-musicians.

Sounds for Silence: Auditory Neural Entrainment of Consciousness

Joana Sayal1; Alexandre Celma-Miralles2; Boris Kleber2; Óscar Gonçalves1
1 Center for Research in Neuropsychology and Cognitive and Behavioral Intervention (CINEICC), Faculty of Psychology and Educational Sciences, University of Coimbra, Portugal. 2 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & R.A.M.A., Denmark.

Subtheme B - Auditory, Motor and Sensory Integration

Consciousness involves a flow of neuronal information strongly linked to oscillatory synchronization in the brain. The alignment between environmental rhythms and brain oscillations is known as neural entrainment, and it might play a role in states of consciousness. When it occurs in response to auditory stimuli, it is termed auditory neural entrainment - brain waves syncing with sound waves. Building on previous research about the effects of music on people with disorders of consciousness, our study uses electroencephalography and auditory stimulation (binaural beats) to characterize and modulate states of consciousness (focused attention and mind wandering) through matching and mismatching of auditory neural entrainment. Furthermore, we will investigate the influence of musical training on such entrainment. Understanding neural entrainment with auditory stimulation in diverse states of consciousness holds potential for future research focused on improving the rehabilitation of disorders of consciousness, as well as deepening our knowledge about the effects of sound on the brain.

Feel the beat and improve the groove: multimodal rhythm perception in cochlear implant users

Alberte B. Seeberg 1, Andreas Højlund 2,3, Ana Teresa Queiroga 1, Alexandre Celma-Miralles 1, Mark Fletcher 4,5, Samuel Perry 4,5, Kathleen F. Faulkner 6, Peter Vuust 1, Bjørn Petersen 1
1 Center for Music in the Brain, dpt. of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/ Aalborg, Aarhus, Denmark; 2 Department of Linguistics, Cognitive Science, and Semiotics, Aarhus University, Aarhus, Denmark; 3 Center of Functionally Integrative Neuroscience, dpt. of Clinical Medicine, Aarhus University, Aarhus, Denmark; 4 University of Southampton Auditory Implant Service, Southampton, UK; 5 Institute of Sound and Vibration Research, University of Southampton, Southampton,

UK; 6 Oticon A/S, Smørum, Denmark

Subtheme B - Auditory, Motor and Sensory Integration

Background: Despite the success of cochlear implants (CIs) in regaining speech perception, they remain poor in conveying music. The ability to perceive more complex real-world musical rhythms is important for the experience of groove (the pleasurable urge to move to music), which remains unexplored in CI research. Findings suggest that electro-haptic stimulation (EHS) can enhance the perception of various sound properties in CI users, and thus potentially the ability to distinguish and integrate sounds of simultaneously occurring rhythmic instruments. Thereby, feeling the beat through rhythm -specific EHS could improve CI users' experience of groove. Aim: This project investigates rhythm and groove perception in CI users and the potential effect of rhythm-specific EHS. Methods: We tested 10 CI users both behaviorally and using electroencephalography, as well as 20 NH controls for reference. Stimuli consisted of drumbeats varying in rhythmic complexity (low, medium, high) and number of instruments (one, two, three). These were presented in three conditions: audio only, EHS only, and audio and EHS together. We measured how the different conditions influence: 1) participants' ratings of "wanting to move" and "experienced pleasure", 2) participants' neural synchronization to the rhythms and the strength of their beat encoding, assessed through frequency tagging. Results: Preliminary findings revealed 1) no difference in ratings between audio only and audio and EHS together for both NH and CI users and 2) beat-related peaks in both groups for audio only and audio and EHS together, though not for EHS only. Further investigations of the differences between listening conditions and groups are in preparation. Implications: The experience of rhythm is a central part of contemporary music and the basis of how we dance to and socialize through music. Thus, enhancement of rhythm perception could impact CI users' quality of life.

The use of auditory and visual cues to influence gait in virtual reality

Riya K. Sidhu, Jessica A. Grahn
Brain and Mind, Department of Psychology, Western University, London, Canada

Subtheme B - Auditory, Motor and Sensory Integration

In previous walking studies, auditory cues influence gait more effectively than visual cues (Sejdic et al., 2014). Visual cues are harder to synchronize with, often attributed to the visual domain being better for coding spatial information, whereas the auditory domain is better for encoding temporal information (Repp & Penel, 2004). However, a potential reason for visual superiority is that the visual cues used are simple and unnatural compared to real-world cues. An alternative to simple visual cues is cues with biological motion, as it can influence temporal judgements, even more so than auditory cues (Wang et al., 2021). The goal of the current study was to assess if biological motion, as conveyed by a walking virtual reality avatar, effectively influences temporal aspects of gait. Participants completed several walking trials while wearing a virtual reality headset. Auditory only trials consisted of the sound of footsteps with no avatar, visual only trials had an avatar silently walking in front of the participant, and auditory-visual trials had the avatar with footstep sounds present. Participants completed one set of walking trials with no specific instructions about synchronization, then completed additional behavioural/survey measures, and finally completed an identical set of walking trials but with instructions to synchronize to the cues. In preliminary analyses, cue type did not significantly affect gait, suggesting that participants were influenced similarly by the auditory, visual, and audiovisual cues, both when given no instructions and also when given instructions to synchronize. These results suggest that auditory and visual cues can influence temporal measures of gait in a similar manner when using a richer visual cue.

Musical Groove Listening Does Not Enhance Primary Motor Cortex Activation

Samantha O'Connell1, Daniel Berkowitz2, Grace Wilson2, Erin Hannon2, Joel Snyder2
1 Caruso Department of Otolaryngology, Auditory Research Center, Keck School of Medicine, University of Southern California, Los Angeles, California, USA; 2 Department of Psychology, University of Nevada, Las Vegas, Las Vegas, Nevada, USA

Subtheme B - Auditory, Motor and Sensory Integration

Groove is the pleasurable urge to move to the beat of music, a universally experienced human phenomenon. Because listeners are often inspired to move to music with groove, we asked whether high-groove music would promote greater motor system activity than low-groove music, noise, or silence, as shown by faster latency and/or higher amplitude of the lateralized readiness potential (LRP), an event-related potential measure of neural response preparation and execution in the primary motor cortex. In Experiment 1, 21 participants were presented with one of two symbols (@ and #) on a computer monitor and pressed a button with their left or right hand, depending on which symbol was presented, while listening to high-groove music, low-groove music, noise, or silence. Throughout the duration of the experiment, electroencephalography was recorded at the scalp and we calculated stimulus-locked and response-locked activity by averaging across correctly responded, non-artifact trials. The LRP was calculated for each participant as the difference between electrodes C3 and C4. In Experiment 2, 32 participants were tested with the same stimuli, procedure, and analysis, with the following exception: instead of responding to visual stimuli, participants pressed a button with their left or right hand, depending on whether they heard an occasional increase or decrease in volume in the music or noise. None of the analyses in either experiment showed differences in LRP latency or amplitude due to differences between the high-groove or low -groove conditions. Several of the analyses yielded Bayes Factor values greater than 3 in favor of the null hypothesis. Thus, we found no convincing evidence that high-groove music enhances activity in the primary motor cortex. Future studies should use other brain activity measurement and manipulation techniques to conceptually replicate our findings, including techniques that can separately measure different motor and auditory cortical areas.

Expecting the Timing of the Next Beat: Distinguishing the Roles of Predictability and Periodicity

Sandra Solli1, Anne Danielsen1, Sabine Leske1, Alejandro Blenkmann1, Keith B. Doelling2, Anne-Kristin Solbakk1, Tor Endestad1
1 RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, Department of Psychology, University of Oslo, Norway; 2 Institut de l'Audition, Institut Pasteur, Paris, France.

Subtheme B - Auditory, Motor and Sensory Integration

Background. When we dance to music, our ability to anticipate the next beat allows us to align our body movements accordingly. Rhythm-based temporal expectations guide not only movements but also attention and perceptual processing. However, the mechanisms underlying this process remain unclear. Previous research offered mixed findings, and most findings are limited to isochronous rhythms. This leaves a gap in our knowledge of how rhythms beyond periodic structure influence perception. This study aimed to differentiate the distinct roles of predictability and periodicity in rhythm-based expectations and their impact on auditory perception. Methods. Thirty-eight participants performed a pitch-identification task while their brain activity (EEG) was recorded. Target tones followed different rhythm types: periodic predictable (isochronous),

aperiodic predictable (accelerating), and aperiodic unpredictable (jittered). By manipulating the timing of the target (in or out of phase with the preceding rhythm), we observed how auditory sensitivity was modulated by the target position in each rhythm condition. Results. Predictable rhythms, regardless of their periodicity, yielded a clear behavioral benefit in perceptual sensitivity to the target tone. Interestingly, periodicity exerted an additional effect. While both periodic and aperiodic predictable rhythms enhanced overall sensitivity, only the periodic rhythm induced an entrained sensitivity pattern, peaking in synchrony with the expected rhythm continuation. Modulations of the target-evoked P3b, possibly reflecting attention allocation, paralleled the patterns observed in perceptual sensitivity. This supports the hypothesis that rhythm-guided temporal attention modulates perceptual processing. Predictability may involve a ramping neural activity pattern akin to the CNV, indicating target preparation. On the other hand, periodicity might rely on neural entrainment or solely more precise temporal expectations. Conclusion. Our findings suggest that predictability and periodicity influence perception via distinct mechanisms. By shedding light on how rhythms facilitate auditory processing, this study highlights the interplay of different mechanisms underlying this process.

It'll be fine. Stronger subjective habituation in musicians

Fabian Sternkopf1; Rebecca Divarco2; Prof. Dr. med. André Lee1
1 Institute for Music Physiology and Musicians' Medicine Hannover, Germany; 2 Georg-August University, Göttingen, Germany;

Subtheme B - Auditory, Motor and Sensory Integration

Due to their high prevalence of pain syndromes and due to the neuroplastic changes induced by many years of intense training of extreme fine motor movements, musicians are a relevant model to investigate the influence of neuroplasticity on pain perception and transmission in general. In this preliminary study we stimulated both hands and feet of 15 healthy musicians and 15 healthy non-musicians with 15 painful contact heat stimuli with two different baseline temperatures. We recorded both, the subjective pain rating on the numeric rating scale (NRS) and the neuronal response via electroencephalogram at the CZ position. We used linear mixed effect models to investigate the subjective habituation in the pain rating, as well as the objective habituation in the amplitude of the contact heat evoked potentials (CHEPs). Musicians report a significantly higher pain rating, but show no significant difference regarding the CHEPs amplitude compared to non-musicians. For the pain rating as well as the CHEPs amplitude, both groups show significant habitation. But only for the pain ratings do musicians habituate significantly faster than non-musicians. This indicates, that musicians habituate faster only subjectively, which has not been shown yet. Additional investigation of the CHEPs data is needed to further quantify the differences between the groups and research the influence of neuroplasticity on pain transmission.

Musicianship Influences the Processing of Short and Long Auditory Time Intervals: An EEG Study

Nicola Thibault[1,2]; Stéphanie D'amours[1]; Philippe Albouy[1,2†]; Simon Grondin[1†].;
[1]École de Psychologie, Université Laval, Québec, Canada; [2] CERVO Brain Research Centre, Québec, Canada
† These authors contributed equally to this work

Subtheme B - Auditory, Motor and Sensory Integration

Musical expertise has been proven to be beneficial for time perception abilities, with musicians outperforming non-musicians in several explicit timing tasks. However, it is unclear how musical expertise impacts implicit time perception. Twenty non-musicians and fifteen expert musicians participated in an EEG recording during a passive auditory oddball paradigm with .8- and 1.6-s standard time intervals and deviant intervals that were either played earlier or delayed relative to the standard interval. We first confirmed that different neurofunctional processes in the musician brain, as for non-musicians, support the perception of short (below 1.2 s) and long (above 1.2 s) time intervals. While deviance detection for long intervals elicited a N1 component, a P2 was associated with deviance detection for short time intervals. Interestingly, musicians did not elicit a CNV for longer intervals and show additional components of deviance detection such as i) attention-related N1 component, even for deviants occurring during short intervals, ii) a N2 for above and below 1.2-s deviance detection, and iii) a P2 for above 1.2-s deviance detection. We propose that the N2 component is a marker of explicit deviance detection, and acts as an inhibitory/conflict monitoring of the deviance. This hypothesis was supported by a positive correlation between CNV amplitude and N2 observed in non-musicians: the CNV reflects the temporal accumulator and can predict explicit detection of the deviance. In expert musicians a N2 is observable without CNV suggesting that deviance detection is optimized and does not require the temporal accumulator.

Exploring complex audiovisual crossmodal associations on pupillary behavior

Daniel Quintela Bertuzzi; Patricia Vanzella
Center for Mathematics, Computing, and Cognition, Universidade Federal do ABC, São Bernardo do Campo, Brazil

Subtheme B - Auditory, Motor and Sensory Integration

This research explores the influence of crossmodal associations between visual and auditory complex stimuli on pupillary behavior. Motivated by prior findings suggesting that subjective interpretation of visual stimuli influences pupillary responses, this study employs figurative paintings and musical excerpts associated with the sun and the moon to explore the influence of these associations on pupil responses. The research aims to provide insights into the relationships between sensory modalities, cognition, and affective responses, thereby advancing our comprehension of how multisensory experiences influence perceptual and cognitive processes. A total of 39 participants (25 women, 14 men) took part in the study, which focused on monitoring pupil changes during the presentation of paintings depicting sun and moon themes with matched luminance, paired with sun and moon-associated musical excerpts or silence conditions. Participants completed sociodemographic surveys, fatigue assessments, and aesthetic evaluations. Data preprocessing, such as baseline correction and trial exclusion, was conducted. Statistical analysis utilized linear mixed effects models to explore the impact of painting and music categories on mean pupil size. Pupillary responses revealed that sun-themed paintings elicited greater constriction compared to moon-themed or neutral paintings. The moon-associated musical excerpt led to less constriction than the sun-associated one. Additionally, music valence and arousal influenced pupil size. The most significant pupillary constriction occurred when congruent sun-associated music was paired with sun-themed paintings, while the combination of moon-associated music and moon-themed paintings resulted in a less pronounced constriction, suggesting a crossmodal association effect. Understanding how audiovisual stimuli influence pupillary responses provides insights into the integration of visual and auditory information, enriching our understanding of multisensory perception. These insights can be utilized to improve educational and art therapy practices and user experiences in multimedia environments such as immersive art exhibitions.

Neural response to rhythmic input among children with dyslexia and children on the autism spectrum

Samantha Tze Sum Wong1; Sarah Lippé2; Eve-Marie Quintin1
1 Department of Educational and Counselling Psychology, McGill University, QC, Canada; 2 Psychology Department, University of Montreal, Montreal, Montreal, QC, Canada,

Subtheme B - Auditory, Motor and Sensory Integration

Despite the popularity of rhythm-based educational programs for children with neurodevelopmental disorders (NDDs), there is emergent research documenting rhythm vulnerabilities across NDDs. There is abundant research on rhythm processing difficulties underlying phonological development among children with dyslexia (DYS) at behavioural, and neurophysiological levels, and this research is emergent among children on the autism spectrum (AS). There is also evidence showing that motor areas are consistently activated when perceiving rhythm and speech. The proposed research aims to compare 1) neural responses to rhythmic input; and 2) their relationship to language and motor functioning, between children with DYS and on the AS. 78 8-13 -year-old children (26 in each group: AS, DYS and typical development [TD]) will be presented with 1) 6Hz and 40 Hz click-trains (auditory steady-state response [ASSR] paradigm); and 2) beat and pitch perception oddball paradigms. The neural responses to these paradigms will be measured by EEG passively. Beat perception, phonological awareness, motor coordination and reading skills will be measured while auditory working memory, nonverbal IQ, sensory sensitivity, and music experience will be controlled. Power spectral, inter-trial coherence and phase-amplitude coupling analyses will be completed for responses to the ASSR paradigm and standard trials in the EEG oddball paradigm and compared amongst groups. These neural measures will then be evaluated as predictors of neural response to deviants, and performance on beat perception, language and motor tasks performance within each group. Findings will elucidate the underlying neural mechanism of children on the AS and with DYS in response to rhythmic input, and its relationship to motor and language skills. Additionally, this line of research will inform the potential clinical implication of using rhythm-based screening tools and music interventions to promote motor and language development for two or more NDDs.

Relationships between 40-Hz Auditory Steady-State Response and Musical Training

Keigo Yoshida1, Sotaro Kondoh2, Shunsuke Tamura3,4, Shinichiro Nakajima5, Yoji Hirano3,4, Shinya Fujii1.

1 Faculty of Environment and Information Studies, Keio University, Fujisawa, Japan; 2 Graduate School of Media and Governance, Keio University, Fujisawa, Japan; 3 Department of Psychiatry, Division of Clinical Neuroscience, Faculty of Medicine, University of Miyazaki, Miyazaki, Japan; 4 Department of Neuropsychiatry, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan; 5 Department of Neuropsychiatry, Keio University School of Medicine, Tokyo, Japan

Subtheme B - Auditory, Motor and Sensory Integration

Auditory steady-state response (ASSR) is an electroencephalographic response elicited by auditory stimuli with amplitude modulation at a steady frequency. The ASSR is characterized by evoked power or inter-trial coherence (ITC) that measures neural synchronization with the modulation frequency of auditory stimuli. Notably, 40-Hz or 80-Hz ASSR has been measured to examine the role of gamma-band neural oscillation on various cognitive functions. A previous study reported that higher degree of gamma-band synchronization over the brain was observed while listening to music in musicians than non-musicians. However, it still remains unclear what type of musical experience is connected with gamma-band oscillatory function. To address the issue, we enrolled 25 participants (17 females (68.0%), 37.0 3 12.5 years old) and measured their ASSR elicited by the 40-Hz chirp-train sounds. We also investigated their musical experience with the Goldsmiths Musical Sophistication Index (GMSI). We calculated the spearman's rank correlation coefficient between the ASSR and each factor of the GMSI. As a result, we observed a trend-toward correlation between the 40-Hz ASSR's ITC and the GMSI's musical training factor ($r = 0.39$, $p = 0.053$). On the other hand, there was no significant correlation between ASSR and the other factors of the GMSI. These results suggest that musical training might induce enhanced gamma-band neural processing of auditory information.

The Ramp protocol: A new method for uncovering individual differences in walking to an auditory beat

Agnès Zagala 1,2,3,5, Nicholas E.V. Foster 1,3, Floris T. van Vugt 1,2,3,5, Fabien Dal Maso 1,4,5, Simone Dalla Bella 1,2,3,5. 1 International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal, Canada. 2 Department of Psychology, University of Montreal, Montreal, Canada. 3 Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada. 4 School of kinesiology and physical activity sciences, University of Montreal, Montreal, Canada. 5 Centre for Interdisciplinary Research on Brain and Learning (CIRCA), Montreal, Canada

Subtheme B - Auditory, Motor and Sensory Integration

Walking to the beat of an auditory stimulus seems effortless for most humans. However, recent studies suggest significant individual differences in the spontaneous tendency to synchronize to the beat. Some individuals tend to adapt their walking pace to the beat while others show little or no adjustment. Unfortunately, to date, there is no protocol sensitive to individual differences in adapting to rhythmic stimuli while walking that can experimentally validate nor explain this phenomenon. To fill this gap, we introduce the Ramp protocol assessing spontaneous adaptation to a change in a rhythmic stimulus in a gait task. First, participants start walking at their preferred cadence without stimulation. After several steps, a metronome is presented, timed to match the timing of the participant's heel strike. Then, the metronome tempo progressively departs from the participant's cadence by either accelerating or decelerating. The implementation of the Ramp protocol required real-time detection of heel strikes and auditory stimuli aligned with participants' preferred cadence. To this aim, we developed a solution (TeensyStep device), which we validated compared to a gold standard for step detection. We also demonstrated the sensitivity of the Ramp protocol to individual differences in the spontaneous response to a rhythmic stimulus by introducing a new measure: the Response Score. This new method reliably quantifies the spontaneous gait response to a changing auditory stimulation, thus revealing individual differences in rhythmic abilities in young adults. The method holds promise for identifying the response to an auditory stimulus with the purpose of rhythmic interventions in a clinical context.

Effects of musical training and prolonged pain on corticomotor excitability and primary motor representation

Anna M. Zamorano 1,2, Boris Kleber 1, Enrico De Martino 2, Ainhoa Insausti-Delgado 3, Peter Vuust 1, Herta Flor 2,4 & Thomas Graven-Nielsen 2,
1. Center for Music in the Brain, Dept. of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/ Aalborg, Aarhus, Denmark,
2. Center for Neuroplasticity and Pain (CNAP), Department of Health Science and Technology, Aalborg University, Gistrup, Denmark,
3. TECNALIA, Basque Research and Technology Alliance (BRTA), Donostia-San Sebastián, Spain,
4. Institute of Cognitive and Clinical Neuroscience, Medical Faculty Mannheim, Central Institute of Mental Health, University of Heidelberg, Mannheim, Germany

Subtheme B - Auditory, Motor and Sensory Integration

Prolonged and repeated musical training is a multifaceted activity that significantly influences the corticomotor pathways and the representation of the primary motor (M1) cortices. Despite such adaptive effects, extensive musical training is also linked to developing musculoskeletal pain, a common problem affecting up to 80% of musicians. Chronic musculoskeletal pain is a complex and widespread health issue associated with maladaptive function and organization of M1. It is unknown if the altered plasticity linked with chronic pain may affect the acquired use-dependent plasticity in the M1 of trained musicians. This project aimed to investigate musicians' corticomotor excitability and M1 representation during both (i) persistent experimental pain, and (ii) actual chronic pain conditions. Two separate experiments were performed. Using transcranial magnetic stimulation (TMS), corticospinal excitability was assessed by measuring the amplitude of the motor-evoked potentials, area of the motor map, volume, and center of gravity of the first dorsal interosseous muscle in healthy musicians and non-musicians after induction of experimental muscle pain (Experiment-1) and in chronic pain musicians, healthy musicians, and non-musicians (Experiment-2). In Experiment-1, Nerve Growth Factor, a well-known experimental pain model that induces muscle pain lasting up to 21 days, was injected into the right hand of musicians and non-musicians. The results shed light on two critical aspects. First, compared to non-musicians, both experiments confirmed that long-term musical training can lead to focalized and specialized functional organization of the M1. Second, results showed that this adaptive functional reorganization was not significantly compromised by the maladaptive plasticity associated with persistent experimental pain (Experiment-1) and chronic pain (Experiment

-2), highlighting the potential of long-term sensorimotor training to counteract the effects of persistent pain in the motor system. These findings have profound implications in motor learning and pain management, providing invaluable insights to comprehend adaptive neural plasticity and its resilience during pain syndromes.

The 12-year AMseL-Study: Influence of neuroanatomical disposition, natural development and musical training-induced plasticity on the human auditory system from childhood to adulthood

Annemarie Seither-Preisler 1, Bettina Zeidler1, Markus Christiner1, Jan Benner1, Peter Schneider1.
1 Music Psychology and Brain Research Section, Institute of psychology, University of Graz, Graz, Austria

Subtheme B - Auditory, Motor and Sensory Integration

Auditory perception is of fundamental importance for human development, communication and physical and mental health. Here we summarize the results of the AMseL study ("Audio and Neuroplasticity of Musical Learning"), the first longitudinal study on the development of human hearing from childhood to adulthood (Schneider et al., 2023). This 12-year project combined neurological and behavioral methods, including magnetic resonance imaging, magnetoencephalography and auditory tests to assess individual sound perception profiles. A cohort of 219 participants, including 112 typically developing children and 107 children with the developmental learning disorders ADHD (n=36), ADD (n=35) and dyslexia (n=36), were examined at five consecutive measurement time points. They were categorized as "musicians" (n=118) and "non-musicians" (n=101). Overall, an extremely stable morphology of the auditory cortex was observed. However, there were significant differences between musicians and non-musicians that were already present at the beginning of formal music education and may be interpreted as macroscopically visible biomarkers of musical aptitude. Maturation-induced plasticity led to a continuous increase in white matter myelination and to systematic changes in the auditory evoked P1-N1-P2 complex. Regardless of musical expertise, latencies of the evoked responses decreased and synchronized between the hemispheres. The musicians showed stronger training-related changes at the neurofunctional level, in particular more synchronized P1 responses and bilaterally enlarged P2 amplitudes. In addition, musical training had a positive influence on elementary auditory perception (frequency, tone duration, onset ramp) and pattern recognition (rhythm, subjective pitch). The participants with ADHD, ADD and dyslexia consistently showed characteristic differences in their neuro-auditory profiles. The observed interplay of "nature" (stable biological dispositions and natural maturation) and "nurture" (learning-induced plasticity) is integrated into a novel neurodevelopmental model of the human auditory system. Overall, these results have far-reaching implications for neuromusic research as well as for therapeutic approaches (Schneider et al. 2022).

Mapping Tonal Hierarchy in the Brain Using an Active Task

Danica Robichaud (1), Sarah A. Sauvé (2), Heath Matheson (1), Benjamin Rich Zendel (1,3),

1. Department of Psychology, Memorial University of Newfoundland, St. John's, Canada; 2. School of Psychology, University of Lincoln, Lincoln, United Kingdom; 3. Faculty of Medicine, Memorial University of Newfoundland, St. John's, Canada.

B - Auditory, Motor and Sensory Integration

Research has shown that Western enculturated listeners perceive a tonal hierarchy: They perceptually rate the goodness of fit of tones from the chromatic scales consistently when primed with a musical sequence that provides a strong sense of tonal centre. Typically, chord tones (C, E, G, in the key of C) are rated highest, diatonic tones (A, B, D, F) are rated lower, and the rest of the notes of the chromatic scale are rated lowest. One question that remains poorly understood is how brain responses map onto the tonal hierarchy. To explore this mapping, we used a probe-tone method while recording EEG. Participants listened to a chord progression (e.g., Cmaj, Fmaj, Gmaj, Cmaj) followed by one of 12 notes of the chromatic scale, and rated the goodness-of-fit for each tone. Ratings were consistent with previous research. ERPs were generated by averaging EEG data to the 12 probe tones (i.e., 1 ERP for each scale degree). Probe tones evoked an N1-P2 response, and when compared to the dominant scale degree probe tone (i.e., G) an ERAN and P600 were evoked. These results revealed a significant difference in the amplitude of the P600 between probe tones of differing scale degrees. Interestingly, goodness-of-fit ratings were correlated with ERAN; higher ratings were associated with a longer latency and a lower amplitude. Overall, this pattern of results suggests that goodness-of-fit ratings map to the timing of the ERAN, and that our judgements of fit are based on brain responses that happen early and automatically.

Selective Auditory Attention Decoding of Instrumental Duets for Bilateral Cochlear Implant Users

Jonas Althoff 1,2. Waldo Nogueira 1,2.
1) Department of Otolaryngology, Hannover Medical School 2) Cluster of Excellence Hearing4all, Hanover, Germany

Subtheme C - Perception and Performance

Previous studies showed the possibility of decoding an attended music source from electroencephalography (EEG) data via reconstruction of the sound envelope in normal hearing (NH) listeners. This work investigates if selective auditory attention decoding (SAAD) is also possible for cochlear implant (CI) users in music, especially for two instruments arising from the same piece. In the current study, NH listeners and bilateral CI users attended one of two instruments, cello and clarinet, in a dichotically presented duet. Brain activity was recorded with a 64-channel EEG. Linear decoders were trained on the EEG signals to reconstruct audio features extracted from the musical sources. Decoding accuracy was measured comparing the correlation coefficients between the attended and the unattended music sources. Results showed that for both groups, NH listeners and CI users, there was a significant difference between the correlation coefficients for the attended and the unattended music in the alpha band. These preliminary results are first steps to possible future brain computer interfaces that enhance music components based on SAAD to improve music enjoyment and accessibility.

The Cortical Organization of Musical Timbre Processing

Oliver Tab Bellmann (1), Rie Asano (2, 3);
(1) Acoustics Research Institute, Austrian Academy of Sciences, Vienna, Austria;
(2) Institute for Musicology, University of Cologne, Germany;
(3) Max-Planck-Institute for Empirical Aesthetics, Frankfurt, Germany

Subtheme C - Perception and Performance

Timbre, one of the design features of music, plays a crucial role in enabling listeners to recognize musical sounds, convey emotion, and structurally organize music (McAdams, 2013). While the ventral auditory stream is known to be involved in sound identification and emotion conveyance by musical timbre, the involvement of a dorsal auditory stream, typically associated with structural processing in other musical domains, remains unclear (Alluri & Kadiri, 2019). To elucidate if musical timbre processing engages both ventral and dorsal pathways, we conducted an activation likelihood estimation (ALE) meta-analysis of neuroimaging studies. The analysis revealed consistent activations in the bilateral transverse temporal gyri, posterior superior temporal gyri, and planum temporale, as well as in the bilateral inferior parietal lobe, and in the right anterior insula and superior temporal gyrus. Most of these regions are associated with both ventral and dorsal auditory processing streams. Moreover, previous research consistently showed involvement of regions in the inferior frontal gyrus in processing musical timbre (Alluri & Kadiri, 2019). Thus, we propose a dual-stream model for musical timbre processing: an anteroventral stream along the superior temporal gyrus, anterior insula and parts of the inferior frontal gyrus for processing stimulus identity and categorical information, and a dorsal stream comprising the posterior superior temporal gyrus, regions in the inferior parietal lobe and parts of the inferior frontal gyrus for the timbre-based sensorimotor and sequence processing. Furthermore, as the activated regions exhibit similarities to those involved in processing various design features of music like pitch and rhythm, we deliberate shared neural bases between musical timbre and other musical domains.

Inter-brain connectivity during naturalistic music performance: a proof-of-concept fNIRS hyperscanning study with violin duet performances

Thenille Braun Janzen1; Joana B. Balardin2; João R. Sato1; Patricia Vanzella1;
1 Center for Mathematics, Computing, and Cognition, Universidade Federal do ABC, São Bernardo do Campo, Brazil.
2 Instituto do Cérebro, Instituto Israelita de Ensino e Pesquisa Albert Einstein, Hospital Albert Einstein, São Paulo, Brazil.

Subtheme C - Perception and Performance

Recent advancements in neuroimaging, including portable tools such as functional near-infrared spectroscopy (fNIRS), have enabled simultaneous monitoring of neural activity in multiple individuals during joint tasks. Despite increased interest in studying brain states during dynamic and uninterrupted real-world experiences, gaps remain in understanding the neural correlates of ensemble music performance in naturalistic paradigms. This proof-of-concept study investigated inter-brain connectivity during a continuous violin duet performance. Seven violin duos performed the Duo n. 37 (Prelude and Canon) by Béla Bartók while hemodynamic response correlates were recorded with hyperscanning fNIRS. The Euclidean distance between the spatial distribution of hemodynamic responses of both violinists was calculated for each moment of the

performance and averaged across participants, providing a numerical measure of the dissimilarity between the neural activation of the duos across the entire performance. This analysis identified variations in brain connectivity patterns during the musical performance, particularly notable at the beginning of the music piece and in sections with significant changes in music tempo, dynamics, and rhythm complexity. To assess whether these patterns reflected social interaction, musicians were randomly paired for a permutation-based test. Results indicated a similar hemodynamic response between real and surrogate pairs, suggesting that connectivity patterns may be linked to movement similarities. Further analysis of violinists' head motions with motion analysis of the video recordings showed that movement artifacts alone could not sufficiently explain the observed brain activity pattern. Therefore, the results suggest that cognitive, expressive, or structural elements may influence brain connectivity in continuous tasks. The study emphasizes that monitoring brain activity in dynamic real-world experiences, such as music performance, offers valuable insights into interbrain connectivity during uninterrupted collaborative joint tasks.

Musical Practice-Related Pain and its strong link to student musicians' Mental Health

Anne-Violette Bruyneel (1), Clara E. James (1,2,3), Florian Stern (4)
(1) Geneva School of Health Sciences, HES-SO University of Applied Sciences and Arts Western Switzerland; (2) Faculty of Psychology and Educational Sciences, University of Geneva, Switzerland; (3) Geneva Musical Minds Lab, Geneva, Switzerland; (4) University Teacher Training Institute (IUFE), University of Geneva, Switzerland

Subtheme C - Perception and Performance

Introduction: Professional musicians face significant risks of pain that are directly related to their musical practice. The transition to higher education presents a particularly high risk due to increased musical workload and performance demands. Pain can hinder students' learning and professional growth. This study focused on identifying physical and mental risk factors for playing-related musculoskeletal disorders (PRMDs) in student musicians. Methods: This cross-sectional study was carried out with bachelor and master level music students. PRMDs was assessed using the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM). Free questions on demographic characteristics and work habits were used. Validated questionnaires assessed physical activity, self-rated

health, stress, performance anxiety, perfectionism, physical and mental fatigue, and personality traits. We applied a psychological network analysis to explore the overall correlational structure of the dataset. Results: Two hundred thirty-five students across three bachelor and two master years filled out the questionnaires. All instruments were represented, with a prevalence of violin and piano. On average, students practiced their main instrument weekly for around 9 hours (39) at the conservatory, and 20 hours (310) outside the conservatory. 86 of the 235 students had suffered from PRMDs in the previous 12 months. Network analysis revealed a strong association between PRMDs and mental risk factors (general stress and performance anxiety). In addition, fatigue, perfectionism, physical activity, and self-rated health were associated with pain intensity. Discussion: To effectively comprehend PRMDs, it is essential to integrate physical and mental risk factors. Integrating stress management in future student training may reduce these risks and lower the incidence of PRMDs.

Optimizing microtonality listening skills in expert musicians

Mathilde Callac, Sorbonne University, Paris, France

Subtheme C - Perception and Performance

Expert musicians lack the time to tackle repertoire they are called upon to perform. Especially in spectral repertoire which pushes many performers to their technical and psychological limits. This is what emerges from a semi-structured qualitative interviews conducted with expert musicians. To optimize this learning, we have designed a digital application focuses on three points. The first one uses psychoacoustics by playing on the exposure to beats to accustom the musician to the roughness of microtonality. The second works uses discrimination tasks under a progressive exposure of white noise and visual indicators. Finally, listening to dissonance is optimized by listening diotically. Indeed, research indicates that the brainstem, is more able to process dissonance when it is listen diotically. The pilot study consisted of a pre-test of 16 musicians then 8 of them completed the course over 5 days for 10 minutes a day. The other 8 listened to a piece from the spectral repertoire for 10 minutes a day dung 5 days. Both groups were also asked to keep a logbook to ensure that the protocol was well followed and complete the protocol with a post test. Results indicate that

participants with a relative ear perform better between pre-test and post-test than musicians with an absolute ear. It seems that musicians with a so-called relative ear are more used to pitch discrimination strategies. Similarly, the musicians who applied the 5-day intervention protocol with the digital application rated their difficulty as lower on the post-test compared with the control group. Next, we want to analyse the impact of diotic listening on auditory discrimination tasks, as well as the impact of melodic contour in the same type of task, in order to understand better the expert musician's ability to discriminate in the context of microtonality.

Infants' engagement during an immersive contemporary music experience: a research-creation project inspired by neuroscience

Anne Chabot-Bucchi1, Aimée Gaudette-Leblanc 2, Jean-Michaël Lavoie1
1 Université de Montréal, Montreal, Canada. Observatoire Interdisciplinaire de Création et de Recherche en Musique (OICRM). 2 Université du Québec à Trois-Rivières, Trois-Rivière, Canada .Observatoire Interdisciplinaire de Création et de Recherche en Musique (OICRM).

Subtheme C - Perception and Performance

In the last decade, a growing number of concerts have been designed for young children (Dyonissiou & Fytika, 2017; Ben Moshe & Gluchankof, 2022), offering them the opportunity to discover and explore music and engage in non-formal music learning (Creech et al., 2020). Infants, considered as "music connoisseurs" from birth due to their excellent musical memory and early listening skills (Trebub & Degé, 2015), seem keenly interested in these musical performances (Barbosa et al., 2021; Kragness et al., 2021a; Kragness et al., 2023b). Recent studies documenting infant engagement when attending a musical performance with their parents have shown that these little ones are able to stay engaged over a long period (Barbosa et al., 2021). Babies are more engaged when listening to play songs than lullabies (Kragness et al., 2023a) and when attending a live performance than a recording of the same performance (Kragness et al., 2023b). While these exciting results indicate that babies may appreciate their participation in musical performances where musicians interpret tonal classical or children's music, we still need a clear understanding of how this engagement may vary as a function of the musical style of the musical performance. To move forward in this area, we are currently conducting a research-creation project, aiming to (1) create an immersive musical experience in contemporary music, (2) document the child's engagement while participating in this musical experience, and (3) identify factors that may influence the child's engagement while participating in this musical experience. In this poster, we propose to present the process behind the creation of this experiment (phase 1) and discuss how the previous literature in neuroscience has influenced this process.

The dyslexic brain: out of time but in tune? Behavioural signatures of musical impairments in developmental dyslexia

Manon Couvignou, Usha Goswami;
Centre for Neuroscience in Education, Department of Psychology, University of Cambridge, Cambridge, UK

Subtheme C - Perception and Performance

This study seeks empirical evidence on the contribution of rhythm and pitch skills to the development of phonological and reading skills, aiming to help to inform remediation strategies. In recent years, it has been argued that early sensory difficulties with acoustic rhythm patterns may underlie the difficulties in acquiring written language experienced by children with developmental dyslexia (DD). This ‘Temporal Sampling’ theory predicts that training in the temporal dimension of music (such as rhythm and meter) may support the development of phonological and reading skills. In contrast, the pitch dimension of music (such as scale, contour, and interval processing) has received much less attention. Its potential interplay with the phonological and temporal difficulties in DD remains underexplored. The present study aims to fill this gap by concurrently investigating relations between musical pitch and temporal subsystems for phonological processing. We are evaluating 40 non-musician adults, 20 with history of DD, with a range of phonological (verbal short-term memory, phoneme awareness, rapid automatized naming, and syllable stress perception), psychoacoustic (frequency, duration, intensity, and rise time discrimination), and musical (music perception and memory, singing, and tapping) tests. If pitch and temporal processing each play a specific role in phonological processing, (1) their respective predictive powers on phonology should differ qualitatively and/or quantitatively, and (2) the profile of musical difficulties of participants with DD should be more pronounced in either dimension. Results will be discussed in light of the modular framework contrasting pitch vs temporal processing of Peretz and Coltheart (2003) and the Temporal Sampling Framework of Goswami (2011).

Heschl's Gyrus morphology: A function of musical experience?

Anja-Xiaoxing Cui1; Alisha Davis2; Alessandra Rampinini3; Negin Motamed Yeganeh4; Narly Golestani5; Nancy Hermiston4; Janet F. Werker5; Lara A. Boyd6;
1 Department of Musicology, Faculty of Philological and Cultural Studies, University of Vienna, Vienna, Austria / Department of Psychology, University of British Columbia, Vancouver, BC, Canada. 2 Department of Psychology, University of British Columbia, Kelowna, BC, Canada. 3 Department of Psychology, Faculty of Psychology and Educational Sciences, University of Geneva, Geneva, Switzerland. 4 School of Music, University of British Columbia, Vancouver, BC, Canada. 5 Department of Psychology, Faculty of Psychology and Educational Sciences, University of Geneva, Geneva, Switzerland / Brain and Language Lab, Cognitive Science Hub, University of Vienna, Vienna, Austria / Department of Behavioral and Cognitive Biology, Faculty of Life Sciences, University of Vienna, Vienna, Austria. 5 Department of Psychology, University of British Columbia, Vancouver, BC, Canada. 6 Brain Behaviour Lab, Department of Physical Therapy, University of British Columbia, Vancouver, BC, Canada

Subtheme C - Perception and Performance

Previous research suggests a higher prevalence of Heschl's gyrus (HG) structural morphology complexities in professional musicians, such that 90% exhibit morphotypes other than a single HG in each hemisphere (i.e., common-stem duplications or complete multiplications). These morphological complexities are thought to contribute to better auditory processing (Benner et al., 2017). In a conceptual replication of this previous research, we utilized the Toolbox for the Automated Segmentation of Heschl's gyrus (TASH) to identify HG morphology complexities in high-resolution T1 scans of N = 34 young adults receiving musical training at university level (instrumental or opera), and N = 50 young adults receiving other kinds of university level training (language, drama, or athletics). Two independent and group-blind coders evaluated the TASH outputs to determine HG morphotypes (single gyrus, common-stem duplication or complete multiplications). The chi-square-test comparing the prevalence of single gyri to other morphotypes between the two groups of participants was not significant, contrary to our expectations (right hemisphere: chi-square = 0.051, p = 0.822; left hemisphere: chi-square = 0.011, p = 0.915). This may indicate HG morphology differences between trainee and professional musicians, or an equally increased prevalence of other morphotypes as a result of the other kinds of training. Additional analyses are planned to investigate whether participants receiving musical

training exhibit larger hemisphere-combined HG surface area and thickness as well as greater bilateral concavity in the primary HG, as expected based on other research (Dalboni da Rocha et al., 2020; 2023).

Neural Networks of Rhythm Learning Enhancement through Visual Representation

Deosdad Díez, Marc 1,2. Fàbrega Camps, Gemma 1,2. Nicolaou, Stella 1,2. Marco-Pallarés, Josep 1,2.
1. Department of Cognition, Development and Educational Psychology, Institute of Neurosciences, University of Barcelona, Barcelona, Spain.
2. Cognition and Brain Plasticity Unit, Bellvitge Biomedical Research Institute (IDIBELL), L'Hospitalet de Llobregat, Barcelona, Spain.

Subtheme C - Perception and Performance

Rhythm learning is a complex skill that requires perception of temporal information and motor control to execute the required actions. Precision in production requires the correct encoding of the temporal structure of the rhythm via interaction of motor and auditory areas. In addition, the dorsal pathway and the motor cortico-basal ganglia thalamo-cortical (mCBGT) circuit are involved in beat-based timing, critical in decoding the temporal structure of rhythms, and are also active during the encoding and execution of rhythms. This overlap suggests that the generation of temporal templates during production is sensitive to the encoding of temporal information. Therefore, reducing the uncertainty of the temporal structure of rhythms may be a potential factor in generating more precise responses during rhythm learning.

A sample of 62 non-musicians learned to synchronize and reproduce four rhythms while undergoing fMRI. Each rhythm was repeated 6 times in a sequence of listening to, synchronize with and reproduce without sound the rhythms. Along the learning process, participants were assigned to one of the two conditions. In one condition (graphical), rhythm production was facilitated using images that represented time between notes as distance between lines. In the other condition (categorical), the different time intervals were presented as different shapes. Accuracy in rhythm performance increased through repetition as indexed by a reduction in the asynchrony (difference between the time of the note and the given response). Additionally, participants in the graphical condition performed better than the participants in the categorical one.

Overall, synchronizing and reproducing rhythms activated areas of the dorsal pathway and the mCBGT circuit. Moreover, the graphical group showed an increase in the activation of basal ganglia. These results suggest that visual information representing the temporal structure might improve rhythm learning via enhancing mCBGT activation during rhythm production.

The complex dynamics of spontaneous rates in musicians and non-musicians: Intra-individual stability and inter-individual differences

Ben H. Engler1, 2*, Anna Zamm3, Cecilie Møller2,
1 Department of Psychology, Centre for Cognitive Neuroscience, Paris-Lodron-University of Salzburg, Salzburg, Austria; 2 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/ Aalborg, Aarhus, Denmark; 3 Department of Linguistics, Cognitive Science and Semiotics, Aarhus University, Denmark

Subtheme C - Perception and Performance

Humans regularly perform different kinds of repetitive movements in a spontaneous un-cued manner (walking, clapping, etc.). Theoretical and empirical evidence suggests that these spontaneous rates are determined by certain biomechanical constraints, such as limb length. However, research is additionally pointing to inter-individually varying cognitive factors exerting their own power over rate and variability of respective movements. One such factor is musical ability, which has been proposed to not only influence movements in a music- but also a general context (e.g., Scheurich et al., 2018). Musicians are assumed to possess a superior ability to track auditory-motor events over longer time scales, thus producing slower spontaneous movements than non-musicians (Drake et al., 2000; Scheurich et al., 2018). In this study, we asked participants (n = 60) to execute different spontaneous movements (different modes of finger tapping, melody production, walking, clapping) at a pace most comfortable to them. We found that different spontaneous rates were robustly correlated within subjects across different domains of behavior. Averaged across all types of behavior, participants who categorized themselves as musicians exhibited significantly slower rates than non-musicians. Musical training and self-reported perceptual ability measured on continuous scales, however, did not predict spontaneous rates or movement variability. These findings add a layer of complexity to the theoretical explanation for slower spontaneous rates in musicians than in non-musicians. In the light of more recent studies proposing that internal time keeping mechanisms be more complex than merely having one preferred rate (Kaya & Henry, 2022), it arises the necessity for more complex and dynamic explanations for inter-individual differences in spontaneous rates.

Delineating the auditory and reward-related structures involved in listening to pleasant music: a 7T fMRI functional localizer

Gemma Fàbrega-Camps1; Alberto Ara2; Josep Marco-Pallarés1; Robert Zatorre2
1 Department of Cognition, Development and Educational Psychology, Institute of Neurosciences, University of Barcelona, Spain; Cognition and Brain Plasticity Unit, Bellvitge Biomedical Research Institute (IDIBELL), Spain; 2 Montreal Neurological Institute, McGill University, Montreal, Canada

Subtheme C - Perception and Performance

Prior neuroimaging studies have shown that listening to pleasant music engages auditory and reward system structures. However, despite the reproducibility of these neural findings, there are still some inter-individual variability and task-dependent activations that complicate a reliable identification of these specific areas within individuals. To address this issue, we developed a functional localizer protocol that aims to identify the cortical and subcortical perceptual and reward regions that are sensitive to pleasurable music listening at an individual level. Given the methodological difficulties of non-invasive functional localisation of auditory and reward subcortical areas, spatial resolution was enhanced by using ultra-high field 7T functional magnetic resonance in 19 healthy participants. Echo-planar images sensitive to BOLD contrast (repetition time (TR) = 1500ms, voxel size = 1.5mm3 isotropic) were acquired in a horizontal orientation to cover all the regions of interest. The functional localiser consisted of two runs, in each of which participants listened to 6 melodies of 60 seconds preceded each by 30 seconds of rest. To ensure that stimuli elicited pleasure responses and inducing activity in reward system structures, participants provided their favourite fragments from their 12 most preferred songs. Out-of-scan hedonic ratings confirmed that self-selected excerpts were rated as highly rewarding. fMRI results showed that this protocol can reliably identify auditory pathway structures including the cochlear nucleus, inferior colliculus, the medial geniculate body and the auditory cortices; and also reward structures including the ventromedial prefrontal cortex and the ventral tegmental area within individuals, as well as the striatum, albeit less consistently. Individual thresholded T-maps were then normalised, smoothed with a 2-mm kernel, and binarized to compute a probabilistic functional atlas that provides probability maps of activation patterns. Overall, results suggest that this protocol can be a useful tool for individual mapping of auditory and reward-related structures involved in listening to pleasant music.

On the role of ancillary body movements in interpersonal synchronization during joint music making

Sara F. Abalde (1, 2), Félix Bigand (1), Trinh Nguyen (1), Roberta Bianco (1), Peter E. Keller (3, 4), Giacomo Novembre (1);

1 Neuroscience of Perception and Action Lab, Italian Institute of Technology, Rome, Italy; 2 The Open University Affiliated Research Center, United Kingdom; 3 Center for Music in the Brain, Aarhus University, Denmark; 4 The MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Australia;

Subtheme C - Perception and Performance

Joint music making is a universal human behavior. However, research in this domain typically involves musicians. We conducted a study in which dyads of participants played songs through e-music boxes: digital instruments that allow non-musically trained participants to control the tempo of songs through cyclic hand (instrumental) movements. Participants were asked to synchronize the outputted music with that of their partners. We tested if ancillary body movements (i.e. movements that are not necessary to output music) facilitate interpersonal synchronization, and whether that occurs irrespective of musical training. Participants performed different songs while either seeing or not seeing the partner (but always without seeing instrumental movements). The participants' performance was encoded as continuous oscillatory data, which facilitates the computation of synchrony measures between the e-music boxes. Further, we recorded eye-tracking, full-body kinematics, and electroencephalography from both participants simultaneously. Preliminary results demonstrate that seeing the partner facilitates interpersonal synchronization, suggesting that information retrieved from partners 'ancillary movements promotes coordination. Consistently with this, preliminary eye-tracking results indicated that the more partners' movements fell within the visual field of a participant, the stronger the facilitatory effect of vision on synchronization. The analysis of full-body kinematics and electroencephalography is expected to shed light on the sensorimotor mechanisms mediating the beneficial effect of seeing ancillary movements on interpersonal synchronization. Further, comparing dyads composed of musicians with those composed of non-musicians will establish whether these mechanisms are experience-dependent or not.

Effects of Ambient Music on Cognitive Performance, Cognitive Effort and Task Pleasantness

Gigliotti, Maria Francesca*; Lauret, David; Delevoye-Turrell, Yvonne-Nathalie° (Pr)
* Filboost, Strasbourg, France, ° SCALab UMR CNRS 9193, Cognitive and Affective Sciences Laboratory, University of Lille, France

Subtheme C - Perception and Performance

Listening to music while engaging in mental tasks (e.g., writing, reading) is a popular habit. Despite the number of playlists made available for this purpose, the effect of music, and more specifically ambient music, on cognitive tasks has attracted scant scientific interest. The aim of the present study was to understand which type of ambient music is best suited to the demands of a cognitive task. Participants performed an Attention Network Test (Fan et al., 2002) assessing alerting, orienting and conflict-resolution attentional mechanisms. They also performed a phonemic Verbal Fluency Task (Moscovitch, 1994) assessing mental flexibility and language access abilities. Participants executed the tasks either in silence or while listening to a high- or low-arousing music excerpt. The music excerpts were composed purposefully in order control for a range of salient acoustic parameters. Reaction time, accuracy and the words produced were chosen as performance indicators. In addition, task execution pleasantness and difficulty along with cognitive effort were assessed through post-task questions and physiological measures (haemodynamic and respiratory activity, blinking frequency and pupil dilation). Results show beneficial effects of ambient music on the attentional task–conflict resolution domain and on word-evocation fluidity across time. In addition, the perceived cognitive effort during task execution depended on the ambient music as well as the task. Performing both tasks was perceived to be more pleasant when listening to both high and low-arousing excerpts compared to silence. Finally, physiological measures showed a slight increase in the activation level in both music conditions with respect to silence. In a context of heterogeneity of stimuli and paradigms, the present findings open new research avenues on the importance of acoustic features and the effect of ambient music on cognitive performances.

Musical scene analysis: What factors explain individual differences in listening abilities?

Robin Hake (1), Daniel Müllensiefen (2,3), Kai Siedenburg (1,4)
(1) Dept. of Medical Physics and Acoustics, Carl von Ossietzky University Oldenburg, Oldenburg, Germany,, (2) Dept. of Psychology, Goldsmiths, University of London, London, United Kingdom (3) Hanover Music Lab, Hochschule für Musik, Theater und Medien, Hannover, Germany (4) Signal Processing and Speech Communication Laboratory, Graz University of Technology, Graz, Austria

Subtheme C - Perception and Performance

Background. Auditory Scene Analysis (ASA) is the process in which listeners make sense of complex acoustic environments by organizing sound mixtures into meaningful events and streams. Listeners are known to vary in their ASA abilities, but only little is known about the factors that contribute to individual differences in ASA abilities. The objective of this study is to identify factors that contribute to individual differences in ASA abilities in the context of music and to assess their relative importance. Methods. Thirty-one older normal-hearing (oNH; M = 62.2), 34 older hearing-impaired (oHI; M = 67.8), 26 younger normal-hearing (yNH; M = 25.3), and one younger hearing-impaired (yHI; age 26) participant were recruited for a laboratory experiment. The adaptive Musical Scene Analysis test (MSA), a backwards digit span test (BDS), pure-tone audiometry (PTA), as well as the Goldsmiths-Musical Sophistication Index (GMSI) were administered. Results. As hypothesized, yNH participants performed best on the MSA task, followed by oNH, the one yHI, while oHI performed the worst ($p < .001, \eta^2 = .22$). Moderate correlations were observed between the MSA and PTA (r = -.49), age (-.41), GMSI (.44), and BDS (.35). However, the factors are intercorrelated and thus group dependent. To quantify the relative importance of each predictor that accounts for the prevalent complex nonlinear relationships, including interaction effects, a gradient boosting decision tree model was utilized. This model revealed that PTA emerged as the most influential predictor for MSA scores (‘Gain’ = .34), followed by GMSI (.30) and age (.22). BDS exhibited the least relative importance (.14). Overall, the model explains about 32% of the variance, with an RMSE of .33. Discussion. This study reveals factors crucial for analyzing complex musical scenes, offering insights that might help to improve music enjoyment among the hearing-impaired, potentially through auditory training or refined hearing aid technology.

Brain Specialization for Music and Word Reading: a High-Resolution Precision Imaging Study

Suzanne Hébrard1; Emily Coffey2; Robert Zatorre3; Laurent Cohen1,4
Sorbonne Université, Inserm U 1127, CNRS 7225, Institut du Cerveau, ICM, Paris, France; 2 Department of Psychology, Concordia University, Montreal, QC, Canada; 3 Montreal Neurological Institute, McGill University, Montreal, QC, Canada;4-HP, Hôpital de La Pitié Salpêtrière, Fédération de Neurologie, Paris France

Subtheme C - Perception and Performance

Over the past millennia, humans created graphic symbolic systems allowing them to preserve and share cognitive constructs in a durable visual form. Words and music can both be written down using basic signs and their recursive combinations. This invention rests on plasticity, the brain's ability to change under the effect of experience, and cortical specialization, the principle that specific functions depend on dedicated brain regions. With literacy, a specialized region in the left ventral occipitotemporal cortex (VOT), the Visual Word Form Area, becomes specialized for identifying letters and words. There are indications that a distinct specialization may also exist for music: selective deficits for music reading have been reported following VOT lesions and VOT activation is generated by music scores. Although largely overlapping with word-related regions, music-induced activations peak at a distinct location. Our goal here is to understand the nature and origin of specialization for musical and verbal symbols, in the visual and the auditory cortices, using precision imaging with 7 Tesla high-resolution fMRI, in expert musicians. Musicians will participate in a series of experiments. First, visual and auditory passive "localizer" experiments will allow us to identify individual cortical patches specialized for musical or verbal stimuli, for use as regions of interest in the other experiments. Second, a reading experiment will directly contrast musical and alphabetic visual stimuli and low-level controls. In music scores, we will study the sensitivity of activation to rhythmic structure, melodic structure, and clefs and key signature. Third, musicians will be presented with bimodal stimuli (sung speech with matching or mismatching lyrics or music score), allowing us to study the crossmodal links between specialized regions in visual and auditory cortices, and their dependence on task structure. We expect distinct patterns of connectivity between auditory and visual specialized regions for word and musical symbols.

Towards a Rigorous Mathematical Model for Music Perception

Benjamin Himpel, Tim Mangliers
Department of Informatics, Reutlingen University, Germany

Subtheme C - Perception and Performance

Music plays an important role for humanity, yet it remains a great mystery why we enjoy music. An array of scientific disciplines—from psychology to physiology to music theory—engage with various facets of musical perception, while musicians craft immersive listening experiences through their artistic intuition. Despite music's tangible existence as a waveform, our understanding of how humans perceive it remains incomplete. Thus, the overarching inquiry remains: What is music? Our approach is human-centric, aiming to construct mathematical models that elucidate the fundamental mechanisms of music perception, validated through targeted psychoacoustic experiments. The multidimensional nature of music perception necessitates a synthesis of insights from diverse disciplines, melding them into a cohesive, mathematically robust, and psychologically informed framework. While existing models address certain aspects—such as context-dependent perception or music's inherent geometric structure—our goal is to integrate these facets into a unified whole. This endeavour requires an appropriate mathematical foundation, built upon axioms derived from literature across disciplines and empirical data, culminating in the construction of a comprehensive model providing a mechanistic understanding of music perception at various hierarchical levels within the brain. For instance, prior studies have successfully established a rigorous mathematical metric for voice leading, illuminating its utility. However, certain perceptual quantities remain elusive despite ongoing research efforts. This approach has the potential of bridging different disciplines via a rigorous mathematical foundation and tool set. We anticipate that it will yield not only familiar principles of music theory but also novel compositions featuring unconventional scales and instrumentations. The practical applications span from optimising music streaming services to empowering musicians with creative tools and extending findings to realms such as language acquisition and neuroscience.

The FOAM Project – results from three studies investigating the effects of focus of attention in music

Jesper Hohagen, Claudia Spahn, Anna Immerz
Freiburg Institute for Musicians' Medicine, University of Music Freiburg, Medical Center– University of Freiburg, Germany,

Subtheme C - Perception and Performance

Background and aims. The FOAM (focus of attention in music) research project is designed to investigating the effects of attentional focus on musical performance and musical learning with both exploratively and experimentally consecutive studies. The individual studies are divided into 3 sub-projects (SP) with following research questions: How does a focus of attention manifest itself in music? (finding focus; SP1); What are the effects of FOA in music? (focus effects; SP2); To what extent can the effects of FOA be seen over a longer period of practice? (focus learning; SP3). Methods. In SP1, we did 3 studies. Study1: Systematic review and discussion on focus instructions in FOA music studies. Study2: Online-survey with music university students (N=100) about their FOA in 3 different practice phases in preparation of an exam. Study3: Semi-structured video-stimulated-recall (VSR) interviews with 10 music university students to get comments about reconstructed FOA during practice and on-stage performances. Results and discussion. Study1: One of the main results show that external FOA instructions used in studies refer to many different dimensions of musical goals. Study2: Preliminary results (N=30) show high-individual routines in directing FOA in different practice stages referring to various FOA categories, e.g. expressive focus, image focus, sound focus. Study3: Results from pilot tests show that there is a strong link between musical demands of the piece and FOA directions, e.g. technical focus vs. visual imagery focus. Data acquisition and analysis of studies 2 and 3 is ongoing, final results will be presented at the conference. We expect to gain insights into the routines of FOA use of music students. By applying an inductive categorization of qualitative data on FOA directions, we may find FOA patterns that form the basis for a music specific FOA model that could be tested in future research.

Music structure affects the accuracy of sound source location change detection

Zofia Hołubowska1; Marc Schönwiesner2
1 Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany; Faculty of Life Sciences, University of Leipzig, Leipzig, Germany; 2 Faculty of Life Sciences, University of Leipzig, Leipzig, Germany; Department of Psychology, University of Montreal, Montreal, Quebec, Canada

Subtheme C - Perception and Performance

Features of varying complexity are extracted from music along the auditory pathway. Traditionally, sound perception has been described in a sequential model, in which low-level features such as pitch, loudness or sound location precede grouping and structure -building mechanisms (Koelsch, 2011). It has been shown than higher-level structures modify the perception of individual tones, e.g. when the identification of mistuned tones is facilitated in the tonal context (Brattico et al., 2001). In this study, we aim to go further and ask how the grouping of music into phrases affects the perception of a seemingly unrelated feature - the spatial location of sound. The musical material consisted of 12 multi-phrase melodies based on compositions by J.S. Bach. As the music was presented to the participants, the location of the sound changed, either at a phrase boundary or within a phrase. Participants attended two sessions of the experiment, during which neural and behavioural data were collected. The electrophysiological (EEG) data were recorded while participants listened passively to music. In the behavioural part, participants were asked to press a button to indicate the detection of a change in the sound source location. The first results of the experiment indicate that the musical structure has an effect on the ability to detect changes in the location of the sound source. Behavioural results from pilot data (N=8) show significantly higher change detection accuracy (d′, $t(7)=3.077$, $p= .018$) when the location change occurred at the phrase boundary, while EEG data analysis reveals differences in the MMN amplitude in response to location changes depending on the musical structure. The results of this study allow us to conclude that the perception of sound’s spatial location can be modulated by arbitrary musical formations - phrases. Thus, the processing of abstract-level structures in music alters the performance in lower-level acoustic tasks.

Association of Acoustic Features with Rankings in Classical Vocal Music Competitions

Haruka Kondo (1), Shigeto Kawahara (2), Shinya Fujii (3).
(1) Graduate School of Media and Governance, Keio University, Kanagawa, Japan;
(2) Institute of Cultural and Linguistic Studies, Keio University, Kanagawa, Japan;
(3) Faculty of Environment and Information Studies, Keio University, Tokyo, Japan

Subtheme C - Perception and Performance

The musical competition is used extensively to identify talent and to determine musicians' careers. Competition results are generally determined by the judges' subjective scoring. To objectively rate vocal music, the acoustic parameter "Singing Power Ratio (SPR)", which quantifies the resonance of the singing voice, has been proposed (Omori et al., 1996). In addition, spectral centroid, intensity, jitter, shimmer, and harmonics-to-noise ratio (HNR), which indicate timbral brightness, loudness, stability, and noise, are also important parameters for quantifying the singing voices (Larrouy-Maestri et al., 2014). This study aimed to explore the relationship between these acoustic parameters and subjective performance ratings. To achieve this aim, a simulated classical vocal competition was held in a concert hall. Twenty-two singers (12 females, mean age = 27.41 3 10.40 years) and five judges who are professional singers (4 females, mean age = 49.60 3 10.59 years) participated in this study. Singers sang "Caro mio ben", and their voices were recorded. Judges rated their overall impression on a 100-point scale in the hall. The recorded voices were analyzed using Praat and MATLAB. We fit an ordinal logistic regression model (normalized performance rating score ~ SPR + spectral centroid + intensity + jitter +shimmer + HNR) using R. As a result, the intensity proved to be the best predictor of subjective performance ratings. Analysis of the overall impression score revealed the significant effects of intensity (Estimate = 0.93, SE = 0.22 z = 4.17, $p < 0.001$, R2 = 0.056), jitter (Estimate = -0.71, SE = 0.30, z = -2.37, $p < 0.05$, R2 = 0.00090) and shimmer (Estimate = 0.87, SE = 0.37, z = 2.36, $p < 0.05$, R2 = 0.024), but not SPR, spectral centroid and HNR. We found that louder and more varied voices were rated higher and less stable voices were rated lower.

Vocal mimicry through a cochlear implant provides insight into pitch and timbre.

David M. Landsberger1,2; Natalia Stupak1; Gabriel McDerment1,3; Rahul Sinha1,4; Aaron M. Johnson1; John J. Galvin III5
1 New York University Grossman School of Medicine, New York, NY USA; 2 House Institute Foundation, Los Angeles, CA USA; 3 NYU Gallatin School of Individualized Study, New York, NY USA; 4 Philadelphia College of Osteopathic Medicine, Philadelphia, PA USA; 5House Institute Foundation, Los Angeles, CA USA
Subtheme C - Perception and Performance

Subtheme C - Perception and Performance

Although cochlear implants (CIs) do not faithfully represent music, they provide a unique opportunity to understand the attributes of signals that represent pitch, timbre, and sound quality. Through a CI, the physics of sound can be bypassed, allowing independent control over spectral and temporal information to an extent that cannot be obtained through acoustic hearing. We have developed a novel vocal mimicry task for testing with unilaterally deaf CI users. In the task, a sound stimulus is presented directly to the CI of a single-sided deaf CI (SSD-CI) user. The participant mimics the sound heard through their CI while hearing their vocalizations only through their acoustic-hearing ear. As a within-subject control, mimicry is repeated for stimuli presented to the acoustic-hearing ear. The vocalizations are recorded and analyzed. The vocal mimicry task has provided insights into two critical questions: Question 1: What is the contribution of temporal (rate of stimulation) and place (electrode) information to pitch and timbre? Vocal mimicry was conducted for a series of three single-electrode pulse trains. Pulse trains differed in temporal cues (changes in modulation rates for a fixed electrode), cochlear location (changes in electrode), or in combination. Both temporal-only and place-only changes affected the mimicked F0. However, when cues were combined, the F0 of vocal mimicry corresponded to the temporal cues. Question 2: What is the perceived pitch and sound quality of single notes from musical instruments through a CI? Vocal mimicry was performed with single notes. Mimicked F0s were highly correlated with stimulus F0s below approximately 300 Hz. However, F0 changes for notes above 300 Hz produced little-to-no changes in the mimicked F0, suggesting CI listeners were not sensitive to pitch changes above 300 Hz. These results, combined with knowledge of CI signal processing, suggest that pitch with the CI is dominated by temporal cues.

Exploring the interplay between rhythm complexity, musical pleasure and musical hedonia in shaping rhythm perceptual abilities

Carlotta Lega, Giorgio Lazzari, Eleonora Fullone, Laura Ferreri. Department of Brain and Behavioral Sciences, University of Pavia, Pavia, Italy

Subtheme C - Perception and Performance

Consistent evidence has highlighted the pivotal role of rhythm complexity in eliciting pleasurable responses to music, with medium complexity rhythms eliciting the highest levels of pleasure and wanting to move. However, to date, no studies have delved into whether rhythm complexity also predicts rhythmic musical skills and its association with musical pleasure and musical hedonia. To address this gap, in Experiment 1, we first quantified the pulse entropy of realistic musical excerpts as a measure of rhythmic complexity, while participants (N=102) rated the pleasure and the wanting to move of these excerpts. Additionally, we employed the Barcelona Music Reward Questionnaire (BMRQ) to measure participants' sensitivity to musical reward (i.e., musical hedonia). Consistent with prior research, results revealed an inverted U-shaped relationship between pleasure and wanting to move ratings and pulse entropy. Intriguingly, this relationship was more pronounced in participants with higher levels of musical hedonia.

In Experiment 2 participants (N=210, independent sample re-analysis) were asked to perform a Beat Alignment Test (BAT) and detect misalignments between a superimposed metronome and realistic musical extracts (the same ones used in Experiment 1). Concurrently, participants completed the BMRQ questionnaire. Results showed for the first time that rhythmic complexity predicts rhythmic perceptual abilities: Participants perceived musical tracks with medium pulse entropy (i.e., medium complexity) as more rhythmically aligned compared to tracks with low or high pulse entropy. Furthermore, higher scores on the BMRQ were associated with better rhythm perception performance, thus pinpointing a relationship between musical hedonia and rhythmic abilities. In summary, our findings highlight the complex relationship among intrinsic properties of stimuli, such as pulse entropy, variations in reward sensitivity among individuals, and subjective musical pleasure, all influencing rhythmic perception abilities.

Exploring the Emergence of Beat Induction Using a ‘Swarm of Onsets’ Generative Model

Nolan Lem, Jens Ahrens
Chalmers Institute of Technology, Gothenburg, Sweden

Subtheme C - Perception and Performance

This study investigates the emergence of the beat percept in auditory textures that are built up from homogenous sources. Sensorimotor synchronization (SMS) models of beat perception have examined how humans synchronize to musically relevant signals however there have been few systematic inquiries into SMS in more soundscape-oriented phenomena where a listener is confronted by multiples of concurrent, interactive sources. In this experiment, participants were asked to synchronize to stimuli via finger tapping using a 'swarm of onsets' generative model where forty metronome sounds were clustered around periodic, temporal centers using a gaussian probability distribution function parameterized with seven levels of variance. We hypothesized that the spatial presentation of the sounds might produce significant differences in tap responses when the stimuli are rendered spatially in binaural format with head tracking versus mono (dichotic) format. As evidenced by inter-beat interval analysis and circular statistics, participants were able to synchronize to six of the seven onset variance conditions despite tap variability increasing with onset spread. Similarly, while we found a slight interaction between spatial format and onset variance, no significant differences were found between the overall tap responses to binaural versus dichotic stimuli. This study is a first look into how the beat percept arises to soundscapes that contain different levels of embedded synchrony.

Measuring self-similarity in real -world signals to understand musical beat perception

Tomas Lenc (1); Cédric Lenoir (1); Peter E. Keller (2, 4); Rainer Polak (5); Dounia Mulders (1, 6, 7, 8); Sylvie Nozaradan (1, 2, 3);
(1) Institute of Neuroscience (IONS), UCLouvain, Brussels, Belgium; (2) MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Sydney, Australia; (3) International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal, Canada; (4) Center for Music in the Brain & Department of Clinical Medicine, Aarhus University, Aarhus, Denmark; (5) RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, Oslo, Norway; (6) Computational and Biological Learning Unit, Department of Engineering, University of Cambridge, Cambridge, UK; (7) Institute for Information and Communication Technologies, Electronics and Applied Mathematics, UCLouvain,

Louvain-la-Neuve, Belgium;
(8) Department of Brain and Cognitive Sciences and McGovern Institute, Massachusetts Institute of Technology (MIT), MA, USA

Subtheme C - Perception and Performance

Experiencing music often entails the perception of a periodic beat. Despite being a widespread phenomenon across cultures, the nature and neural underpinnings of beat perception remain largely unknown. In the last decade, there has been a growing interest in developing methods to probe these processes, particularly to measure the extent to which beat-related information is contained in behavioral and neural responses. In this conceptual work, we propose a theoretical framework and practical implementation of an analytic approach to capture beat-related periodicity in real-world signals using frequency-tagging. We highlight its sensitivity in measuring the extent to which the periodicity of a perceived beat is represented in a range of continuous time-varying signals with minimal assumptions. We also discuss a limitation of this approach with respect to its specificity when restricted to measuring beat-related periodicity only from the magnitude spectrum of a signal, and introduce a novel extension of the approach based on autocorrelation to overcome this issue. We test the new autocorrelation-based method using simulated signals and by re-analysing previously published data, and show how it can be used to process measurements of brain activity as captured with surface EEG in adults and infants in response to rhythmic inputs. Taken together, the theoretical framework and related methodological advances confirm and elaborate the frequency-tagging approach as a promising window into the processes underlying beat perception and, more generally, temporally coordinated behaviors.

Predicting the Beat Bin: Beta Oscillations Predict the Envelope Sharpness in a Rhythmic Sequence

Sabine Leske 1,2,3, Tor Endestad 1,3,4, Vegard Volehaugen 1,4, Maja D. Foldal 1,4, Alejandro O. Blenkmann 1,4, Anne-Kristin Solbakk 1,3,4,5, Anne Danielsen 1,2;
1 RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, Oslo, Norway; 2 Department of Musicology, University of Oslo, Oslo, Norway; 3 Department of Neuropsychology, Helgeland Hospital, Mosjøen, Norway;
4 Department of Psychology, University of Oslo, Oslo, Norway; 5 Department of Neurosurgery, Oslo University Hospital, Rikshospitalet, Oslo, Norway

Subtheme C - Perception and Performance

Periodic sensory inputs entrain

oscillatory brain activity, reflecting a neural mechanism that might be fundamental to temporal prediction and perception. Most environmental rhythms, such as music or speech, however, are rather quasi-periodic. Research has shown that neural tracking of speech is driven by modulations of the amplitude envelope, especially via sharp acoustic edges, which serve as prominent temporal landmarks. In the same vein, research on rhythm processing in music supports the notion that perceptual timing precision varies systematically with the sharpness of acoustic onset edges, conceptualized in the beat bin hypothesis. Increased envelope sharpness induces increased precision in localizing a sound in time. Despite this tight relationship between envelope shape and temporal processing, it is currently unknown how the brain uses predictive information about envelope features to optimize temporal perception. With the current study, we show that the predicted sharpness of the amplitude envelope is encoded by pre-target neural activity in the beta band (15–25 Hz), and has an impact on the temporal perception of sounds. Using probabilistic sound cues in an EEG experiment, we informed participants about the sharpness of the amplitude envelope of an upcoming target sound embedded in a quasi-isochronous beat. The predictive information about the envelope shape modulated the performance in the timing judgment task and pre-target beta power. Interestingly, these conditional beta-power modulations correlated positively with behavioral performance in the timing-judgment task and with perceptual temporal precision in a click-alignment task. This study provides new insight into the neural processes underlying prediction of the sharpness of the amplitude envelope during beat perception, which modulate the temporal perception of sounds. This finding could reflect a process that is involved in temporal prediction, exerting top-down control on neural entrainment via the prediction of acoustic edges in the auditory stream.

EEG Investigation of Content and Timing Predictions in Music and Speech

Luiza Lucuţa(1), Anne Kösem(2), Peter Keller(1,3), Anna Fiveash (1),
(1) The MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Sydney, Australia. 2) Lyon Neuroscience Research Center (CRNL), Computation, Cognition and Neurophysiology team (Cophy), Inserm U1028, Université Claude Bernard Lyon1, CNRS UMR 5292, Lyon, France, (3) Center for Music in the Brain, Aarhus University, Aarhus, Denmark/The Royal Academy of Music Aarhus/ Aalborg, Denmark.

Subtheme C - Perception and Performance

Prediction is a fundamental aspect of cognition that allows for anticipation of the content ("what" will occur) and timing ("when" will it occur) of upcoming events. However, it is unclear how the brain generates and integrates these predictions, and whether these processes operate similarly across domains. The current EEG experiment aims to investigate the interaction between content and timing predictions across music and speech domains by manipulating each type of prediction independently. Content in melodies/sentences was altered such that the ending note or word was either predictable or unpredictable based on the preceding context. Timing was manipulated to be predictable or unpredictable on a global level. The presentation rate of notes/words was modified through the compression or lengthening of the acoustic signal in the unpredictable condition and remained unaltered in the predictable condition. Simultaneously manipulating both dimensions (content, timing) will provide insights into the effect of timing predictions on content predictions in music and speech. Data collection will commence shortly, with preliminary data to be presented at the conference. Behaviourally, participants will be asked to rate how well the final note/word completed the melody/sentence. Musicians and non-musicians will be recruited to investigate effects of training-related neuroplasticity on music prediction, as well as potential transfer effects to speech prediction. It is expected that manipulations of content (incongruent final note/word) will elicit prediction error-related ERPs (ERAN for melodies, N400 for sentences), which will be reduced when timing is unpredictable, reflecting an interaction between content and timing predictions. It is of particular interest to investigate whether this interaction operates differently within music and speech, and how it might be influenced by musical training and working memory capacity. Results will shed light on the complex interaction of content and timing predictions across music and speech domains, with implications for music training and rehabilitation.

Measuring the brain response to music and speech using EEG: A pilot study.

Victoria Norris - The University of Sydney; Professor Alistair McEwan - Cerebral Palsy Chair of Technology and Engineering | Engineering and Computer Science, Biomedical Engineering, Cerebral Palsy Alliance; Dr Petra Karlsson - Senior Research Fellow, Cerebral Palsy Alliance, The University of Sydney; Professor Leanne Togher PhD FSPA FASSBI - Professor of Allied Health, The University of Sydney and Western Sydney Local Health District

Subtheme C - Perception and Performance

Background. Engagement with music has been shown to have a beneficial effect on mental well-being and overall quality of life. Understanding more about how the brain responds to music and speech may inform treatments involving music therapy for patients. Electroencephalography (EEG) is a measure of electrical brain activity over time which typically involves extensive preparation of electrodes and wires. The development of wireless EEG headsets has made EEG experiments more accessible. Further investigation is necessary to define the capability of wireless EEG for measuring responses to auditory stimuli. Method. We conducted a pilot study to investigate whether accurate responses to music and speech sounds could be measured with wireless EEG. We recorded EEG during baseline rest state, and listening to three auditory stimuli (metronome, music and speech) for 12 healthy adult participants, using a wireless EEG (Emotiv EPOC+ headset) and a research-grade EEG (Electro-cap with g.tec USBamp.research). The EEG power spectral density (PSD) was analysed to investigate differences in brain activity related to listening to the stimuli compared to baseline rest state. It was expected that the music would produce an auditory steady-state response (ASSR) at the musical beat frequency, visible as a peak in the power spectral density, while the other conditions of rest, metronome and speech would not produce this response. Results. There was no distinguishable ASSR to the music chosen for this study visible in the PSD, compared with silence, listening to speech or a metronome stimulus. Statistical tests revealed a significant difference in the alpha power between music compared to rest, and speech compared to rest, and significant differences between the EEG systems. Conclusions. These unexpected results highlight a need for further investigation using different musical stimuli for recording the ASSR and more robust EEG methods to compare wireless and research-grade systems.

The importance of observing the master's hand: Action Observation Training (AOT) promotes the acquisition of new melodic sequences.

Simone Paolini (1,2), Maria Chiara Bazzini (2), Laura Ferrari (2,3), Antonino Errante (1,4), Leonardo Fogassi (1), Giacomo Rizzolatti (1,2), Maddalena Fabbri-Destro (2), Pietro Avanzini (2), Arturo Nuara (1). (1) Dipartimento di Medicina e Chirurgia, Università di Parma, Italy (2) Consiglio Nazionale Delle Ricerche, Istituto di Neuroscienze, Parma, Italy (3) School of Advanced Studies, Center for Neuroscience, Università di Camerino, Italy. (4) Dipartimento Diagnostico, Unità di Neuroradiologia, Azienda Ospedaliero-Universitaria di Parma, Italy.

Subtheme C - Perception and Performance

Introduction: Via mirror mechanism, motor training approaches based on the alternation of action observation and execution (i.e., Action Observation Training-AOT) promote the acquisition of motor abilities. Previous studies showed that both visual and auditory stimuli may elicit a common motor representation of music-related gestures; however, the potentialities of AOT for the acquisition of musical skills are still underexplored.

Methods: 21 music-naïve participants underwent two blocks of training: AOT and Key -light Observation Training (KOT). AOT consisted of the observation of a melodic sequence played on a keyboard with the right hand by an expert model, followed by the participant's imitation. Observation and execution were repeated six consecutive times (T1-T6). KOT followed the same procedure, except for the visual content of the stimulus, depicting the sequential highlighting of the piano keys corresponding to the melody. The rate of correct notes (C), the trainee-model similarity of key-pressure strength (S), and the trainee-model consistency of note duration (R) were collected across T1-T6.

Results: Both AOT and KOT improved melodic motor performance. Noteworthy, AOT showed a higher learning magnitude relative to KOT in terms of C and S.

Discussion: Action Observation Training promotes the acquisition of key elements of melodic sequences, encompassing not only the accurate sequencing of notes but also their expressive characteristics, such as key-pressure dynamics. The convergence of listening and observation of actions onto a shared motor representation not only explains several pedagogical approaches applied in all musical cultures worldwide, but also gives an "extra weapon" for empowering modern procedures for music training.

Investigating the neurophysiology of melody enjoyment

John O'Doherty1; Roberta Bianco2; Giovanni Di Liberto1
1 ADAPT Centre, School of Computer Science and Statistics, Trinity College, The University of Dublin, Dublin, Ireland; 2 Neuroscience of Perception & Action Lab, Italian Institute of Technology, Rome, Italy,

Subtheme C - Perception and Performance

Listening to music of any kind can be a pleasurable activity. This phenomenon is enabled by complex neural circuitry encoding and predicting sound sequences, and their connection with the reward system. Recent neurophysiology research with non-invasive and invasive electrical recordings could pinpoint how the human cortex encodes the multiple facets of melody. Yet, there remains considerable uncertainty on how such cortical processes lead to melody enjoyment.

Prior behavioural studies found a quadratic relationship between complexity and self-reported enjoyment of music, where people are unlikely to enjoy music that is too simple or too complex, instead preferring pieces which are at an intermediate complexity sweet-spot. In this work, we propose to investigate the neurophysiology of melody enjoyment by probing the relationship between melodic complexity, its corresponding neural encodings, and melody enjoyment To this end, we will present a novel electroencephalography (EEG) experiment involving the natural listening of melodies, with informational manipulations allowing us to control their complexity. Participants will be asked to rate the enjoyment experienced throughout the listening task with a slide potentiometer. By targeting a representative range of melodic complexity, from simple to complex pieces, we will discuss the possibility of disentangling neural signatures of enjoyment and of melodic prediction, which is possible due to the presence of pieces with similar enjoyment ratings but very different complexity. We will present analyses attempting to isolate such neural indices by means of multivariate Temporal Response Function analyses (mTRF), a methodology used for relating features of a continuous sensory input with the corresponding neural response.

Bimanual symmetric/ asymmetric piano task reveals differential time-courses for brain activation in novice pianists

Alicja M. Olszewska 1, Maciej Gaca 1, Dawid Droździel 1, Katarzyna Jednoróg 2, Artur Marchewka 1*, Aleksandra M. Herman 1.
1 Laboratory of Brain Imaging, Nencki Institute of Experimental Biology of the Polish Academy of Sciences, Warsaw, Poland. 2 Laboratory of Language Neurobiology, Nencki Institute of Experimental Biology of the Polish Academy of Sciences, Warsaw, Poland * equal contribution senior authors

Subtheme C - Perception and Performance

Musical training exemplifies the acquisition of bimanual skills through sustained practice. However, the bimanual aspect of musical training was rarely investigated in the context of neuroplastic changes over extended durations. This longitudinal study tracked a group of twenty-four young adult novice pianists over their initial twenty-six weeks of piano training and compared them to trained musicians. The novices performed a piano playing task in the fMRI scanner using an MRI-compatible keyboard at six time-points, in increasing time intervals, while the musicians performed the task once. Brain activation and training-induced changes were assessed in bimanual symmetric and asymmetric conditions. Executing the piano task elicited canonical auditory-motor brain activation patterns in the novices. However, the two conditions exhibited significant differences in the motor, parietal and insular cortices bilaterally, and in the right dorsal premotor cortex and left cerebellum. The time-course of neuroplastic reorganisation depended on the bimanual demands of the task. In the symmetric condition, brain activation in the insula and right inferior frontal gyrus decreased continuously, while the activation in the cortical and subcortical areas of the motor network increased at various stages of training. In the asymmetric condition, regions-specific decreases in brain activation were observed in the supplementary motor, parietal, and insular cortex, and the cerebellum. Before training, brain activation differences were observed between the novices and musicians only in the asymmetric condition; these differences were not present upon training completion. These findings highlight the transition from spatial attention to automated movements during piano training. In the asymmetric condition, the additional demands of bimanual coordination in novices were related to increased brain activation in the motor system, which diminished as training progressed. Thus, the changes in task-related brain activation were highly context-dependent and demand-driven, a factor to consider when designing and evaluating music-based health interventions.

The influences of musical preferences on brain responses during sleep

Annika Partmann, Björn Rasch
Cognitive Biopsychology and Methods, Department of Psychology, University of Fribourg, Fribourg, Switzerland

Subtheme C - Perception and Performance

Individual preferences strongly influence emotional responses to music. During wakefulness, the same musical genre (e.g. Heavy Metal) can induce positive emotions in some listeners, while others will judge such musical stimuli as "disturbing noise". During sleep, noise typically has disruptive effects on sleep architecture. However, it is still unknown to what extent individual preferences influence the effect of musical stimuli from different musical genres on sleep continuity and brain responses during sleep. In this study, we will recruit healthy participants with different musical preferences: 25 participants will prefer Heavy Metal music, while 25 participants will prefer Pop music and dislike the other genre. Participants will spend one adaptation and one experimental night in the sleep laboratory at the University of Fribourg. During the experimental night, all participants will listen to 4000ms excerpts of popular Heavy Metal and Pop songs during non-rapid-eye-movement (NREM) sleep, while polysomnography including EEG, EOG and EMG will be measured. We predict that musical excerpts from Heavy Metal music will have sleep disturbing properties, but mainly in participants who dislike this genre. In participants preferring Heavy Metal music, K -complex like responses to these musical excerpts will be stronger (as indicated by a larger negative amplitude approximately 700-800 ms after stimulus onset) due to the sleep-maintaining function of event-related K-complexes. In addition, it is expected that preference will reduce the occurrence of arousals directly following stimulation. Our data analysis will unravel whether and to what extent preference plays a role in modulating the evoked response or if the underlying musical features of a stimulus are solely responsible for the emerging patterns. Data collection has commenced and we expect to present initial findings for 20 participants in June.

EEG reactivity to musical features in musicians and non-musicians

1 Edoardo Passarotto, 2 Matteo De Stefani, 1 Emanuela Formaggio, Francesco Piccione, 1 Maria Rubega, 2 Vincenzo Soravia, 1,4 Stefano Masiero.
1. Department of Neuroscience, Section of Rehabilitation, University of Padova, Padova, Italy, 2. Conservatorio Statale di Musica "Francesco Venezze", Rovigo, Italy. 3. Azienda Ospedale Università di Padova, Padova, Italy, 4. Padova Neuroscience Center, University of Padova, Italy
Subtheme C - Perception and Performance

Introduction. Passive music listening is an interesting form of integrative treatment because it is inexpensive, portable, and easy to implement. Previous research has shown promising results in the treatment of cognitive and neurological disorders. However, it remains unclear which characteristics of music are most responsible for these effects. To address this limitation, we measured brain activity responses during passive listening to four naturalistic musical stimuli with different structural, acoustic, and perceptual characteristics. We also investigated the effects of musical expertise on these activation patterns.

Methods. 15 healthy subjects participated in the experiment, divided into non-musicians (NM, N = 5) and musicians (M, N = 10) groups.
Electroencephalographic data

(EEG, 31-channel system) were recorded and we investigated the EEG reactivity during music listening compared to a silent condition by power spectral analysis. 22 features were extracted from the musical stimuli, analyzing their MIDI and audio recordings. Bayesian mixed-effects regression models were run to assess the effects of musical features on the EEG power spectral density. Results. We found a substantial reactivity in the alpha band (8-12 Hz) in the NM group, especially in centroparietal areas, in response to several musical features such as pitch density, $\beta = -0.17$ [-0.31, -0.04], rhythmic entropy, $\beta = -0.17$ [-0.29, -0.04], and melodic complexity, $\beta = -0.12$ [-0.22, -0.02]. Similar effects were present in the M group, but to a lesser extent and shifted to frontal regions.

Discussion. According to the literature, the alpha band reactivity found in our results is likely related to musical information processing. The reduced reactivity found in musicians may be due to their expertise and familiarity with the musical language. In conclusion, our findings may help to maximize the effectiveness of treatments based on passive music listening. In the coming months, we will test our method on clinical samples.

The Cortico-Striatal-Cerebellar Pathways of Forming Beat- and Interval-based Temporal Predictions.

Ana Luísa Pinho (1, 2); Velda Addo (1, 3); Verena Rafael (1); Katsiaryna Buchko (1); Jörn Diedrichsen (1, 2, 4); Jessica Grahn (1, 3),
(1) Brain and Mind Institute, (2) Department of Computer Science, (3) Department of Psychology, (4) Department of Statistical and Actuarial Sciences – Western University, London Ontario, Canada

Subtheme C - Perception and Performance

We examine the neural correlates and behaviour phenotype underlying the cognitive ability in humans to form temporal predictions during periodic and aperiodic stream of events. Neuropsychological and imaging studies have provided causal evidence for the existence of two neurocognitive mechanisms involved in the mediation of beat- and single-based predictions with direct contributions from the basal ganglia and the cerebellum, respectively. Yet, little is still known about the pathways of time processing in these two contexts, and to what extent sensory inputs from the cortex can alter them. To this end, we developed six tasks probing beat- and interval-based sequences of events, varying in the type of timing output (production, perception and non-temporal feature discrimination) and sensory domains (auditory and visual).

Behavioural results on 39 participants show a likely benefit in performance for the beat conditions when compared to the interval conditions, particularly for auditory tasks, thus suggesting a putative selective contribution from basal ganglia during beat-based sequences. Neuroimaging results from functional Magnetic Resonance Imaging data acquired on 31 participants, show bilateral representations of the dorsal striatum and the cerebellum during the encoding of temporal sequences. Importantly, these representations remain present in the dorsal striatum when contrasting the encoding of beat versus interval for the auditory tasks, indicating an up-regulation of this area when periodicity is also present. Results also show a significant difference of activation between the dorsal striatum and cerebellum during encoding of the production task in comparison with the other two tasks, and thus highlighting activation selectivity of temporal predictions across timing tasks. Upcoming data analyses are intended to provide further insights about the neurocognitive dissociation of these two subcortical regions, particularly in relationship with the cortex, that is involved on forming temporal predictions. We also plan to investigate how musical training and sophistication influence this context-dependent ability.

Brain dynamics of music improvisation

Teresa Queiroga (1,2), Boris Kleber (1), Leonardo Bonetti (1,2,3), Henrique M. Fernandes (1), Morten L. Kringelbach (1,2,3), Peter Vuust (1).
1 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music, Aarhus/Aalborg, Denmark; 2 Centre for Eudaimonia and Human Flourishing, Linacre College, University of Oxford, Oxford, UK; 3 Department of Psychiatry, University of Oxford, Oxford, UK

Subtheme C - Perception and Performance

Music is an integral part of human life involving both listening and music making. However, there is a clear distinction between performing pre-composed pieces and engaging in the spontaneous creative process of real-time music improvisation. Music improvisation encompasses the creation and assessment of melodic and rhythmic sequences on the spot, as well as the coordination of performances with fellow musicians. In a group setting like a jam session, musicians often demonstrate a remarkable capacity to continuously anticipate and monitor each other's actions, even in cases where they had never played together before. Such intricate processes involve real-time sensory and perceptual encoding, motor control, performance monitoring, and memory retrieval. Examining the neural dynamics of improvisation is relevant for understading creativity in general and comprehend situations wherein the ability to adapt, generate novel and practical ideas within constrained timeframes is essential. Despite the growing interest, most studies struggle to capture the swift changes in brain activity, both during the actual improvisation and the preparatory phase leading up to it. In our studies, we extend on previously validated functional Magnetic Resonance Imaging (fMRI) experimental designs to address this gap and take on a holistic approach to study music improvisation. While inside the Magnetic Resonance Imaging and magnetoencephalography (MEG) scanners and using a compatible keyboard, participants are asked to either imitate (control condition) or improvise (target condition) in response to music sequences, focusing on either rhythm or melody. The use of MEG will offer novel insights into the temporal dynamics of neural activity, uncovering the speed at which different regions become active to reveal patterns that align with distinct phases of the creative process. Ultimately, we aim to develop a comprehensive model of the neural dynamics of music improvisation and, in a broader sense, the nature of creativity.

Is absolute (perfect) pitch a hinderance for musical ability?

Dr. Ébano Resende de Souza,
Dr. Marisa Hoeschele
Musicality and Bioacoustics group, Acoustics Research Institute (ARI), Austrian Academy of Sciences (OeAW)

Subtheme C - Perception and Performance

Perfect or absolute pitch (AP) is typically considered to be an asset for any musician, however it is not well understood and may have some drawbacks. From a case study among students from the Musicology and Analysis Department of the Conservatoire National de Musique et Danse de Paris*, we noted important issues raised by the students: 1) confusion and misunderstanding about the AP definition, 2) difficulty among students in identifying whether or not they have AP, 3) the relevance of timbre for AP identification among these students and, 4) students that had partial AP abilities reported difficulties in some musical activities. Among our findings we can highlight: 1) the strong relationship between AP identification and primary instrument; 2) the importance of the piano (pointed as the easiest timbre for recognition) and the voice (which occupies an important place among the hardest timbres for recognition, due, probably, to the overlap between AP label and the lyrics of the song) during AP identification and, 3) the loss of musical pleasure indicated by a considerable number of AP possessors. This last highlight especially calls for further research. We are therefore currently developing a project to understand to what extent AP perception can hinder RP perception and therefore the joy of music. * Supervisors: Dr. Adrien Mamou-Mani (CNSMDP/ IRCAM) Dr. Michèle Castellengo (LAM)

Predictive coding in natural music: time-resolved modeling of expectations in polyphonic music

Paul Robert (1,2), Mathieu Pham Van Cang (3), Manuel Mercier (1), Agnès Trébuchon (1,2,4), Benjamin Morillon (1,2), Luc Arnal (3), Keith Doelling (3).
1 Institut de Neurosciences des Systèmes, Aix-Marseille Université, Inserm UMR 1106, Marseille, France; 2 Institute for Language, Communication, and the Brain, Aix-Marseille Université, Marseille, France; 3 Institut Pasteur, Université Paris Cité, Inserm UA06, Institut de l'Audition, Paris, France; 4 APHM, Hôpital de la Timone, Service de Neurophysiologie Clinique, Marseille, France

Subtheme C - Perception and Performance

When listening to music, we continuously form expectations based on our musical background and on the present musical context. These expectations lead to behavioral and neural effects in line with the predictive coding theory, and play an important role in our ability to enjoy music. However, previous research relied either on heavily controlled experiments with artificial stimuli, or on modeling approaches restricted to monophonic music. These paradigms suffer important limitations in terms of generalizability to ecological settings, and do not allow to investigate the full range of cognitive and affective processes occurring in real life music listening. To bypass these limitations, we designed and trained a recurrent neural network (RNN) that yields time-resolved predictions about upcoming notes in real pieces of western polyphonic music. We first compared it with IDyOM, a well established model of melodic expectations (Pearce, 2012). Reanalyzing the EEG data (n=20) from Di Liberto and colleagues (2020), we show that the surprise (prediction error) estimated with our RNN better predicts the brain response to monophonic music than with IDyOM. We then acquired MEG (n=27) and intracranial EEG (n=10) data with polyphonic piano music. We extracted the surprise, uncertainty and timing predictions from the model's expectations and showed their encoding in the brain response to music across both datasets. This model, designed to approximate the prediction task a human listener would perform, is also more effective at predicting brain responses than the current state-of-the art Google Magenta's generative Performance RNN model. This modeling approach contributes to the generalization of the predictive coding theory to ecological settings, and provides a new tool for studying musical expectations beyond artificial or monophonic stimuli.

Distinct neural mechanisms underpinning interpersonal synchronization: evidence from a body-swap study in EEG hyperscanning

Mattia Rosso1; Peter Keller2; Bavo van Kerrebroeck3; Pieter-Jan Maes1; Marc Leman1; Peter Vuust2
1 IPEM - Institute for Systematic Musicology, Ghent University, Ghent, Flanders, Belgium; 2 Center for Music in the Brain, Aarhus University, Aarhus, Denmark; 3 SPL - Sequence Production Lab, McGill University, Montreal, Quebec, Canada

Subtheme C - Perception and Performance

Temporal coordination plays a pivotal role in various human activities, enabling effective communication and collaboration beyond the domain of joint music-making. A recent study (Rosso et al., 2023b) showed that when two individuals assume each other's first-person perspective, their synchronization is enhanced due to a stronger coupling. In the present work, we investigated the neural dynamics underlying interpersonal synchronization and how these are affected by embodying another human via body-swap illusion. Twenty dyads (N=20) performed a joint finger-tapping task in immersive virtual reality. The visual scene was manipulated across conditions, such that participants would see the partner's hand from a second-person ecological perspective (2P) or from a first-person embodied perspective as if the partner's hand belonged to their own body (1P). In the uncoupled control conditions, participants would see their own hand in 1P and 2P. EEG hyperscanning analyses revealed two distinct mechanisms at play during interpersonal synchronization: 1) neural entrainment, quantified as the convergence of low-frequency oscillatory components towards a common frequency, and 2) beta modulation, quantified as the power modulation of a ~20 Hz component as a function of self - and other-generated movements. Crucially, while both dynamics were significantly induced in conditions of visual coupling between the partners, only beta modulation exhibited sensitivity to the manipulation of visual perspective, being significantly enhanced when perceiving the partner's hand in 1P. Our results suggest functionally different roles for the two mechanisms in integrating the temporal information produced by the partner. We propose that neural entrainment serves to track the partner as a distal rhythmic stimulus, whereas beta modulation underpins the integration of the other's effector into one's bodily representation. Our study highlights the potential of embodiment and body-swap technology for supporting the acquisition and consolidation of rhythmic and fine motor skills in musical training, physical therapy, neurorehabilitation, and prosthetics.

Individual Differences in U-Shaped Groove Sensation Modeled by Metrical Predictability Linked to Musical Engagement Factor in Goldsmiths Musical Sophistication Index

Tomohiro Samma1; Sotaro Kondoh1; Takahide Etani1,2; Shinya Fujii3;
1 Graduate School of Media and Governance, Keio University, Kanagawa, Japan; 2 School of Medicine, College of Medical, Pharmaceutical, and Health, Kanazawa University, Ishikawa, Japan; Advanced Research Center for Human Sciences, Waseda University, Saitama, Japan); 3 Faculty of Environment and Information Studies, Keio University, Kanagawa, Japan

Subtheme C - Perception and Performance

Groove, the pleasurable sensation of wanting to move with music, is associated with the degree of syncopation in the musical rhythm. The groove sensation typically peaks at a moderate level of syncopation, creating an inverted U-shape curve. This curve is modeled as the precision-weighted prediction error, the product of the degree of syncopation and metrical predictability. Theoretically, metrical predictability is thought to depend on individual differences in musical sophistication. However, the connection between individual differences in U-shaped groove sensation and the Goldsmiths Musical Sophistication Index (Gold-MSI) has not been empirically clarified. Our study aimed to explore how individual differences in metrical predictability, a key element of U-shaped groove sensation, could be explained by variations in musical sophistication. Nineteen students (11 females) participated and listened to 15 drum patterns of differing rhythmical complexities. They rated their groove sensation, including pleasure and the desire to move. Participants' musical sophistication and reward sensation were assessed using the Gold-MSI. Following the approach by Witek et al. (2014), a U-shaped groove sensation (total subjective scores of "wanting to move" and "pleasure") curve was fitted using quadratic regression for each participant. Additionally, we fitted the slope of a linear function representing metrical predictability to model the U-shaped curve individually. To identify predictors of individual differences, multiple regression analysis with stepwise selection was employed with the slope of the linear function representing metrical predictability as the dependent variable and the subcomponents of the Gold-MSI as independent variables. The analysis revealed that metrical predictability was linked to the Active Engagement factor from Gold-MSI ($\beta = 0.00076$, $SE = 0.00037$, $t = 2.05$, $p = 0.055$).

These results suggest that individual differences in U-shaped groove sensation can be modeled by metrical predictability linked to active musical engagement, as measured by Gold-MSI.

Neural representations of self- and other-produced actions in joint piano performance

Natalie Kohler [1,2], Anna M. Czepiel [3,4], Örjan de Manzano [5,6], Giacomo Novembre [7], Peter E. Keller [8,9], Arno Villringer [1], Daniela Sammler [2,10].
[1] Department of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany. [2] Research Group Neurocognition of Music and Language, Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany. [3] Department of Music, Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany. [4] Department of Psychology, University of Toronto Mississauga, Mississauga, Ontario, Canada. [5] Department of Cognitive Neuropsychology, Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany. [6] Research Department of Neuroscience, Karolinska Institute, Stockholm, Sweden. [7] Neuroscience of Perception and Action Laboratory, Italian Institute of Technology, Rome, Italy. [8] Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Aarhus, Denmark. [9] The MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Sydney, Australia. [10] Department of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Subtheme C - Perception and Performance

During ensemble performance, musicians predict their own and their partners' action outcomes to smoothly coordinate in real time. The audio-motor system is thought to contribute to these predictions by running internal forward models that simulate self- and other-produced actions. Our recent fMRI study in piano duos lent evidence to this idea, reporting stronger activity & functional connectivity in cortico-cerebellar audio-motor networks when pianists were motorically familiar (compared to unfamiliar) with their partner's part. Although these activity/connectivity changes may be explained by the simulation of familiar partner actions in addition to one's own actions, the neural representation of partner actions in one's own audio-motor system remained elusive. Here, we used multivariate pattern analysis (MVPA) to dissociate the neural representation of self- and other-produced actions in audio -motor regions. Pianists played familiar right-hand melodies in a 3T MR-scanner, in duet with a partner who played the corresponding left-hand basslines in an adjacent room.

In half of the pieces, pianists were motorically familiar (or unfamiliar) with their partner's left-hand part. MVPA was applied in primary motor and premotor cortices (M1, PMC), cerebellum, and planum temporale of both hemispheres to classify which piece was performed. Pieces could be robustly classified in all regions. Classification accuracies were higher in left than right M1, reflecting the neural representation of self-produced right-hand melodies. PMC showed the opposite lateralization, with higher accuracies in the right than left hemisphere, reflecting the neural representation of other-produced left-hand basslines. Although accuracies in right PMC trended to be higher when pianists were familiar with the left-hand part, in line with a training-based origin of these motor representations, similar representations may have emerged for unfamiliar left-hand parts, via audio-motor transfer over the course of the interaction. Overall, these findings provide novel insights into the dynamic embodiment of self- and other-produced actions during ensemble performance.

Online assessment of musical ability in 10 minutes: Development and validation of the Micro-PROMS

Hannah Strauss, Stephan Reiche, Maximilian Dick & Marcel Zentner
University of Innsbruck, Austria

Subtheme C - Perception and Performance

While the Profile of Music Perception Skills (PROMS; Law & Zentner, 2012) offers various test versions tailored to researchers' needs, a gap existed for an overall measure suitable for time-sensitive situations, subjects with limited attention spans (e.g., children, the elderly, or clinical samples), or cases where there is no need to disentangle individual components of musical ability, such as when using musical ability as a control variable alongside other measures. The present project hence aimed at creating a concise, yet psychometrically robust screening tool based on the PROMS, providing an overall measure of general musical ability. To this end, we conducted three studies to conceive and validate a very short version of the PROMS, termed Micro-PROMS. Study 1 involved identifying suitable stimuli based on aggregated data from previous studies and assessing the psychometric properties of two stimulus sets. In Study 2, we refined the test version to strike the optimal balance between key properties and compared it to the Full-PROMS. Finally, Study 3 investigated test-retest reliability as well as convergent, discriminant, and criterion validity of the final test version. The results revealed adequate internal consistency (= .73) and test–retest reliability (ICC = .83). Convergent validity of the Micro-PROMS was supported by its correlation with the MET ($r = .59$, $p < .01$), while discriminant validity was demonstrated by its weak correlations with short-term and working memory ($r \lesssim .20$). Furthermore, criterion-related validity was evidenced by significant correlations between the Micro-PROMS and external measures of musical proficiency (r = .37, ps < .01), as well as with Gold-MSI General Musical Sophistication ($r = .51$, $p < .01$). With its brevity, robust psychometric properties, and suitability for online administration, the Micro-PROMS addresses a gap in tools available for the objective assessment of musical ability.

Does divergent thinking relate to expertise? Introducing a novel test of creative ideation in music

Kanthida van Welzen (1,2), Fredrik Ullén (1,2), and Örjan de Manzano (1,2);
1 Department of Cognitive Neuropsychology, Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany; 2 Department of Neuroscience, Karolinska Institutet, Stockholm, Sweden

Subtheme C - Perception and Performance

The standard psychometric approach for studying creativity is to use divergent thinking tests, where participants are typically asked to generate multiple responses to open-ended questions. Several studies have found positive correlations between divergent thinking and real-life creativity, although relatively small. Since creativity relies heavily on expertise, the variance in real-life creativity explained by divergent thinking could potentially be increased by using more domain-specific tests. To address this hypothesis, a musical divergent thinking test (MDTT) was designed, in which musicians had to create 30 improvised continuations to each of 5 prime melodies. The improvisations were scored on complexity and edit distance to the prime melody. The latter structural measure might indicate distance travelled through a melodic space, similar to how semantic distance is used to indicate associative ability in verbal divergent thinking. The MDTT was compared to a traditional verbal divergent thinking test (Alternate Uses Test) in a sample of 30 amateur and 32 professional pianists. Professionals significantly outperformed the amateurs on the MDTT, but no group difference was found on the verbal test. Interestingly, performance on the MDTT produced the well-known serial order effect with a stronger effect in professionals than amateurs. These results suggest that while the cognitive processes of divergent thinking in different domains may show similarities, domain-specific divergent thinking is the better indicator of real-life achievement. In general, the findings underscore that important insights may be gained from studying creative cognition in a domain-specific manner, with ecological tests based on expertise-relevant materials, such as the MDTT.

Changes in room acoustics engage spatial sound processing: an MMN study

Marise van Zyl, Takako Fujioka
Center for Computer Research in Music and Acoustics (CCRMA), Stanford University, USA

Subtheme C - Perception and Performance

Previous research has shown that spatial information in sound is processed in the brain preattentively. Specifically, stimulus changes in room acoustics (with a different reverberation) or sound source location (with a different binaural cue) elicit mismatch negativity (MMN). However, it is unclear how these two auditory -feature processes interact with each other, if at all. In this study, we examine MMN and P3a by using an oddball paradigm with complex tones as standard stimuli, originating from a central location and within a given reverberation condition - either big or small. Three deviant types - reverb, location (60 degrees right), and both reverb and location - were presented randomly each at 7.5%. We also used complex tones with either 300 Hz or 2000 Hz fundamental frequency to separate interaural time difference (ITD) and interaural level difference (ILD) binaural cues. We tested two alternative hypotheses: (1) reverberation and sound location are processed independently, predicting the summation of responses for reverb and location deviants would be similar to the response to the double deviant, (2)Alternatively, reverberation and location processing could interact with each other, predicting that the double deviant response is significantly different from two single deviant summation. Results followed the second hypothesis for MMN amplitude. Furthermore, ANOVA showed a significant interaction between frequency and deviant types because of stronger negativity for 300Hz than 2000 Hz. No interactions were found for P3a. Our data suggest that a reverberation change with binaural cue is processed quite similarly to the binaural cue itself at the preattentive level, indicating the integration of the room acoustic information into spatial object separation.

The Music Mindedness Questionnaire: A Tool for Rapid Assessment of Musical Competence and Appreciation

Julia Vigl, Hannah Strauss, Marcel Zentner
Department of Psychology, University of Innsbruck, Innsbruck, Austria

Subtheme C - Perception and Performance

Although music is ubiquitous and universal, there are significant individual differences in its processing and appreciation. Recognizing the need to capture this diversity, several musical aptitude tests and self-report scales are now available. However, navigating the variety of measures and finding concise questionnaires is challenging, especially in studies with time constraints, when musicality is not the primary focus, or when it is important to minimize participant burden. Therefore, this study introduces the Music-Mindedness Questionnaire, a brief instrument for rapid screening of two fundamental aspects of musicality: musical competence and musical appreciation. Two versions of the questionnaire, a 14-item version (MMQ) and an eight-item short version (MMQ-S), are presented and validated in tree studies. Study 1 (N = 1784) included item generation, piloting, and confirmatory factor analysis (CFA), which revealed a bi-factorial structure and a good to excellent model fit. Study 2 (N = 1052) validated the MMQ Competence subscale against the Profile of Music Perception Skills and external indicators of musical ability. In Study 3 (N = 306), we examined test-retest reliability and extended the validation to include additional measures of musical aptitude and indices of musical sophistication and reward. We observed high retest reliability and robust criterion correlations between the Competence subscale and music perception skills, and between the Appreciation subscale and musical engagement, musical reward, and emotional responses to music. Results indicate that the MMQ is a reliable and valid instrument for assessing musical appreciation and competence. Its brevity makes it an efficient option for researchers who wish to include music-related variables in their research efforts, providing a valuable resource for scholars across disciplines.

The influence of improvisational creativity on flow in flamenco duos

Atilla J. Vrasdonk1; Tor Endestad1; Peter E. Keller2; Jonna K. Vuoskoski1
1 RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, Department of Musicology & Department of Psychology, University of Oslo, Oslo, Norway; 2 Center for Music in the Brain, Dept. of Clinical Medicine, Aarhus University, Aarhus, Denmark, MARCS Institute for Brain, Behaviour and Development, Western

Sydney University, Sydney, Australia.

Subtheme C - Perception and Performance

The "flow" state is often desired during creative and athletic activities, serving as an intrinsic motivator for enhanced immersion and performance (Csikszentmihalyi, 1996). While improvisation is known to promote flow (Limb & Braun, 2008; Luzcnik et al., 2021), the impact of varying degrees of improvisational creativity on flow intensity remains unclear. This study aims to address this gap by examining flow in professional flamenco dancers and musicians, who are traditionally trained to improvise together, making it an ideal art form to study these concepts in both domains. Eleven duos of flamenco musicians and dancers were instructed to perform a rehearsed piece, freely improvise, or combine improvised and rehearsed parts on two rhythmically distinct flamenco palos (genres). Video and audio recordings were collected, and participants provided subjective ratings of their experience after each performance. Linear mixed models (LMM) analysis showed that highest flow was experienced in performances where duos were allowed to freely improvise, followed by mixed performances and fixed performances respectively, confirming that flow in an ensemble can be modulated through varying degrees of improvisational freedom. The best-fitting LMM revealed several factors that positively influenced the experience of flow, including connection with the partner, improvisational creativity, absorption by activity, and rhythmic complexity. These findings underscore the importance of group dynamics, individual focus, and creative output in achieving a state of flow in an improvising ensemble and contribute to the development and refinement of existing theories and models on flow. Based on these results, two follow-up studies are planned. The first study will employ Computational Information Theory methods to analyze the recorded performances and identify auditory and visual markers of flow. The second study will investigate the underlying brain mechanisms of improvisation and flow by using functional near-infrared spectroscopy (fNIRS) headsets on the improvising duos.

Investigating internal motor simulation in response to music stimuli with varying degrees of rhythmic complexity

Jonna K. Vuoskoski1; Jan Stupacher2
1 RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, Oslo, Norway. 2 Center for Music in the Brain, Aarhus University, Aarhus, Denmark

Subtheme C - Perception and Performance

The "Action Simulation for Auditory Prediction hypothesis" (ASAP; Patel & Iversen, 2014) postulates that the simulation of periodic movement in the motor planning regions provides a neural signal that helps the auditory system predict the timing of upcoming beats. One potential neural index for internal motor simulation is mu-suppression; a drop in mu-power (usually defined as the frequency band 8–13 Hz, originating from the sensorimotor areas). The present study investigated mu-power in response to music stimuli systematically varying in terms of rhythmic complexity and groove, compared to random rhythms. If the prediction of upcoming beats is indeed achieved through the internal simulation of periodic movement, beat-based music stimuli should evoke more mu-suppression in comparison to random rhythms. Furthermore, the degree of rhythmic complexity and experienced groove should also modulate mu-suppression. Healthy adults aged 18-40 were recruited to the experiment. A power analysis suggested that a minimum of 34 participants is required to achieve 0.80 power to detect a medium effect size of f = 0.25 (in a repeated-measures design). Thus, the target sample size was set at 40 participants. Participants were presented with 5 different versions (low, medium, high, and very high complexity, and random) of 3 rhythm patterns with melody (all 120 BPM), resulting in 15 stimuli in total. After each excerpt, participants rated their experience of groove, the ease of perceiving a beat, and their enjoyment. The stimuli were repeated 5 times in separate blocks. Continuous EEG was be recorded using a BioSemi ActiveTwo system with 64+8 active Ag-AgCl electrodes. The Goldsmiths Musical Sophistication index and the Interpersonal Reactivity Index (measuring trait empathy) will be included as covariates in the analyses, as previous findings suggest that trait empathy may facilitate mu-suppression. Data collection is currently still ongoing, and results will be presented at the conference.

Neural correlates of major, minor, and disharmonic chords presented during sleep

Anna Wick, Björn Rasch
Cognitive Biopsychology and Methods, Department of Psychology, University of Fribourg, Fribourg, Switzerland;

Subtheme C - Perception and Performance

Musical chords can be considered as the smallest musical elements that carry emotional information. During wakefulness, different musical chord categories (i.e. major or minor) can induce different emotions and elicit distinct neural correlates. However, it is unknown whether our brain continues to process musical chords differentially when chords are presented during sleep. To address this gap, we presented musical stimuli to 35 young and healthy participants during nighttime non-rapid eye movement (NREM) sleep. Individual chords consisted of major, chords, minor chords, and disharmonic tone triads with whole and half-tone intervals. Sleep was recorded using polysomnography in the sleep laboratory. Our analysis of the event-related responses during sleep revealed significant differences between the three musical chord categories. Specifically, major chords induced the highest negative amplitude approximately 800 ms after chord onset during NREM sleep stage N2. The negative amplitudes for minor chords were intermediate, and lowest for disharmonic chords. A similar, but weaker result pattern was observed during slow-wave sleep (SWS). Data analysis is ongoing, and results of the time-frequency analysis will be provided at the conference. In conclusion, our results demonstrate that the differential processing of musical chords continues during sleep and is influenced by harmonic features according to Western cultural musical context. Future research should investigate whether presenting music during sleep could positively influence both subjective and objective sleep quality and serve as a sleep aid.

Bridging the gap between the theoretical understanding of music and musical action in higher music education

Jeremy Wing Kwan Wong
Sibelius Academy, University of the Arts Helsinki, Finland

Subtheme C - Perception and Performance

This poster presents an ongoing practitioner-research (Cochran-Smith & Lytle, 2009) doctoral study, addressing the prevalent gap observed in music students who encounter challenges bridging theoretical knowledge and practical application in their musical pursuits (Gutierrez, 2019). Previous research indicates a deficiency either in their understanding of music theory or in the application of acquired knowledge. This study explores the relationship between theoretical comprehension of music and active musical engagement,

with a specific focus on instrumental group improvisation as a pedagogical approach. It conceptualizes improvisation as a pivotal tool for building a bridge between theoretical thinking of music and musical action (Reybrouck, 2006), drawing from the insights of the 4E framework in cognitive science, which encompasses cognition as embodied, enactive, embedded, and extended (Schiavio & Schyff, 2018). This poster presentation reports the preliminary findings of a pedagogical intervention (13 sessions of 90 minutes each) that was carried out among professional music students in a higher music education institution in Finland during the spring semester of 2024. The intervention explored the educational possibilities of students' use of improvisation to support the construction of knowledge in music-theory classes. Additionally, it examined how theoretical knowledge can inform and shape improvisational decisions, fostering awareness of the practical applications of music theory for music making, also beyond the classroom. The poster focuses on the preliminary findings related to students' experiences based on data generated through diaries and micro-phenomenological interviews (Petitmengin, 2006).
Keywords: 4E Cognitive science, Music theory learning, group improvisation, micro-phenomenological interview, pedagogical intervention

Groove and Beat Alignment Perception in Cochlear Implant Users

Leo Yao, Samantha O'Connell, Raymond L. Goldsworthy.
Bionic Ear Lab at Keck Medicine of USC, Los Angeles, California

Subtheme C - Perception and Performance

Background: Modern cochlear implant (CI) technology is excellent for speech comprehension, but struggles with music perception. CI users have trouble with pitch, timbre, and harmony perception, but have good rhythmic and temporal perception Looi et al. (2012). Groove perception, however, has not thoroughly investigated. The purpose of this study is to investigate differences in groove perception between CI users and NH listeners.
Methods: Twenty CI users and fourteen NH listeners completed two online tasks. Participants rated 20 songs and their corresponding drum beats taken from the Lucerne Groove Research Library (https: // www. grooveresearch. ch/) on familiarity, pleasure, and urge to move (groove). They also completed a beat alignment test (BAT) created by Iversen and Patel (2008). Participants were played 36 songs and determined if a beep track was "on" or "off". These beeps were either aligned with the beat or misaligned due to tempo or phase. We hypothesized that CI users would perceive less groove due to deficits in pitch and timbre perception. We predicted that familiarity would

have a strong positive correlation with groove and pleasure ratings, and CI users would perform worse at the BAT.

Results: Preliminary results show that NH listeners performed better than CI users in the BAT. CI users were especially worse during the phase misalignment condition. For the rating task, there was a strong positive correlation between groove and pleasure ratings, as well as groove and familiarity ratings for both groups. Familiarity had a greater positive effect on CI users' urge to move ratings.

Conclusion: Music is one of the great joys in life, yet CI users aren't able to appreciate it as fully. Understanding how CI users perceive musical groove differently could lead to greater music appreciation through technological improvements and other methods, such as musical training.

Auditory perception of children with autism-spectrum-disorder

Bettina Zeidler: Music Psychology and Brain Research Section, Institute of psychology, University of Graz, Austria.
Richard Parncutt: Music Psychology and Brain Research Section, Institute of psychology, University of Graz, Austria.
Peter Schneider: Music Psychology and Brain Research Section, Institute of psychology, University of Graz, Austria.
Annemarie Seither-Preisler: Music Psychology and Brain Research Section, Institute of psychology, University of Graz, Austria

Subtheme C - Perception and Performance

Core symptoms of autism spectrum disorder (ASD) are difficulties in the development of language and social interaction skills, which highlights the importance of auditory perception. Interestingly, linguistic deficits were found to be lower when stimuli were embedded in a musical context (e.g., sung vs. spoken). Moreover, studies have shown better pitch perception and reduced auditory time perception in autistic subjects. The aim of the current study was to systematically investigate musical aspects of auditory perception in ASD to develop new treatment options. Fifty-seven subjects (7-15 y) participated, 27 of whom were diagnosed with ASD (6 females) and 30 without developmental disorders (16 females). All participants completed the following tests: (1) audiometry for air and bone conduction (Schneider P. et al., 2022); (2) KLAWA difference threshold tests for elementary sound parameters (Schneider, R., 2015); (3) sound differentiation test (Minning, 2010); (4) pitch perception preference test (Schneider, P. et al., 2005); (5) working memory test (Titze & Tewes, 1994). Results showed that individuals with ASD were characterized by decreased hearing thresholds for air conduction, higher difference thresholds for attack time ($p=0.041$, $U=277.0$), and lower performance in sound differentiation ($p=0.034$, $U=262.0$) and auditory memory (repetition of number sequences in reverse order; $p=0.031$, $U=274.0$). The below-average performance may be directly related to communication difficulties in ASD. Moreover, a larger proportion of the autistic group were 'spectral listeners' (68%) than in the control group (53%). In this regard, peculiarities in the hemispheric lateralization may play an important role. There is evidence that individuals with ASD activate the right hemisphere more strongly (Haesen et. al., 2011), which is relevant for the considered auditory tasks and could also explain the increased proportion of spectral listeners (Schneider, P., et al., 2005). The results of the current study bear promising implications for further developments in music therapy.

Music and mind wandering: the case of maladaptive daydreaming

Lilya Abergel (Laboratoire Mémoire, Cerveau et Cognition, Université Paris Cité, Paris, France), Ilaria Bufalari (Dipartimento dei Processi di Sviluppo e Socializzazione, Università la Sapienza, Rome, Italy), Laura Fusar-Poli (Dipartimento dei Processi di Sviluppo e Socializzazione, Università la Sapienza, Rome, Italy), Marco Sperduti (Laboratoire Mémoire, Cerveau et Cognition, Université Paris Cité, Paris, France), Laura Ferreri (Department of Brain and Behavioral Science, University of Pavia, Pavia, Italy)

Subtheme D - Memory and Cognition

Music is considered as a catalyst for mind wandering, eliciting immersive daydreaming states. Its emotional impact promotes introspection and spontaneous mental drifts, underscoring its role in facilitating wandering thoughts and inner experiences. Maladaptive Daydreaming (MD) is a condition characterized by an extensive and compulsive engagement in structured fantasies, significantly impairing academic, interpersonal, and vocational functioning. Despite anecdotal reports linking music to MD induction, systematic investigations into its underlying mechanisms have not been conducted so far. To address this gap, we conducted an online survey involving 137 individuals with 83 MD (67f, mean age= 30.3239.38) and 54 controls (37f, mean age= 33.72311.83). Findings revealed music's superior efficacy over other media (such as movies or books) in both triggering and maintaining daydreaming states, particularly among those with MD. We also observed that music, particularly when eliciting pleasurable responses and positive emotions, operates by enhancing imaginative, emotional, and perceptual decoupling processes, thereby shaping the phenomenological content of daydreaming experiences. More specifically, while in the control group, music promotes fantasies more focused on memories and anchored in reality, it makes fantasies longer and more vivid in the MD group. Overall, these results underscore music's significance as a powerful evocative and emotional stimulus crucial for inducing and modulating immersive daydreaming episodes in both normal and pathological functioning.

Are human voices 'special' in the way we attend to them?

Liv Merve Abrahamsson(1), Laura Bishop(2,3), Jonna K. Vuoskoski(1,2,3), Bruno Laeng (1,3),
Department of Psychology(1), Department of Musicology(2), RITMO Center for Interdisciplinary Studies in Rhythm, Time and Motion(3), University of Oslo, Oslo, Norway

Subtheme D - Memory and Cognition

When people attend to a target within a rapid sequence of information, the human attentional system appear to fail temporarily for a short period of time, reflecting a robust temporal limitation in our information processing ability. This phenomenon is called the 'attentional blink' (Raymond et al., 1992). Previous research has introduced pupillometry as a useful marker of cognitive processing in the visual attentional blink paradigm (e.g., Zylberberg, Oliva, and Sigman, 2012; Wierda, van Rijn, Taatgen, and Martens, 2012). Thus far, no study has investigated the auditory attentional blink phenomenon using pupillometry. In an experiment with 56 participants, we tested the intensity of attention (as measured via pupillary dilations) associated with selectively attending to human voices, cello sounds, and dog barks using the auditory variant of the attentional blink paradigm. We tested what we call as the 'human voice advantage hypothesis', that is, human voices will escape the attentional blink effect. Our results show that human voice targets can effectively overcome the temporal limits of selectively attending to auditory information. These findings suggest that human voices could require a less intense attentional allocation, or noradrenergic potentiation, as compared with other auditory stimuli.

Replay and consolidation of motor learning

Marie-Frédérique Bernier (1,2), Roxane Hoyer (2,1), Françoise Lecaignard (3), Alain Nicolas (3), Olivier Bertrand (3), Geneviève Albouy (4), Philippe Albouy (1,2),
1. Université Laval, Québec, Canada. 2. CERVO, Québec, Canada. 3. Lyon Neuroscience Research Center -Lyon 1 University, Lyon, France. 4. University of Utah, Salt Lake City, USA.

Subtheme D - Memory and Cognition

The neural processes and networks underlying the beneficial effect of sleep on motor memory consolidation are well described. Neuro-imagery studies showed that motor learning is consolidated through a network including the primary motor cortex, supplementary premotor cortex, striatum, cerebellum and the hippocampus. The latter is thought to be involved in the practice of a motor sequence, but also during rest periods, where reactivations of practice-related hippocampal activity have been reported. However, the oscillatory dynamics associated with those reactivations and their link with motor memory consolidation remain to be characterized. The goal of this study is to identify the presence of replay profiles of a newly learned motor sequence using magnetoencephalography (MEG) data. Thirty-three healthy participants (age range: 22.733.6 years) were trained on a motor sequence learning task (performed with the left non-dominant hand) while their brain activity was monitored with MEG. Participants were divided in 2 groups according to whether they were allowed to sleep (Sleep Group, N = 17) or were totally sleep-deprived (Sleep Deprived Group; N = 16) during the first post-training night. All participants were retested on the task in the MEG three days later. Motor performance was assessed with a measure of speed (i.e., the time between two button presses). Behavioral results show increased speed at retest (as compared to training) in both groups. We then used multivariate classification techniques applied to MEG data to identify neural patterns associated with each button press and investigate their dynamics during inter-practice rest periods. Ongoing analyses aim to identify the reactivation of the learned sequence during rest periods and contrast replay metrics (number of replay) between sessions and groups. These analyses will help define the relationship between replay, sleep, and consolidation of motor learning in humans, knowledge with a strong translational potential for clinical populations or musical instrument integration.

The cost of music curiosity and its impact in learning: evidence from laboratory and natural settings

Gemma Cardona1,2; Xim Cerda-Company2,3; Enrico Sozza1,2; David Cucurell1,2; Laura Ferreri4; Antoni Rodriguez-Fornells1,2,5;
1 Department of Cognition, Development and Educational Psychology, University of Barcelona, Barcelona, Spain; 2 Cognition and Brain Plasticity Unit, Bellvitge Biomedical Research Institute, L'Hospitalet de Llobregat, Spain; 3 Computer Science Department, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain; 4 Department of Brain and Behavioral Sciences, University of Pavia, Pavia, Italy; 5 Institució Catalana de Recerca i Estudis Avançats, Barcelona, Spain

Subtheme D - Memory and Cognition

Curiosity, a fundamental human drive, triggers reward-related dopaminergic pathways, enhancing cognition and memory consolidation. In the present study, we investigated how curiosity during music listening influences exploratory behaviours and learning outcomes, in both laboratory and natural settings. In Exp. 1 (laboratory setting), participants (N=63) performed an exploration/exploitation trade-off paradigm assessing their willingness to pay for exploring new, unfamiliar electronic music. In Exp. 2 (natural setting), participants (N=150) attended a DJ set and indicated their willingness to pay for songs or related information. Both experiments included a recognition/recollection memory test 24 hours later. Results showed that heightened music-induced curiosity states enhanced exploration behaviour (i.e., increased willingness to pay for obtaining new information) and long-term memory performance. Individual differences in music preferences and sensitivity to music reward were also influential. Remarkably, a classifier trained on laboratory data (Exp. 1) accurately predicted the exploration behaviour in a natural setting (Exp.2) based solely on subjective curiosity ratings. This study sheds light into the interplay between curiosity, decision-making, and memory.

Altered neural substrates for auditory discrimination in Multiple Sclerosis and their implications for cognitive fatigue

Francesco Carlomagno2, Elvira Brattico2,3, Paolo Taurisano1, Madia Marika Biasi1, Giusy Tancredi1, Alessia Manni1, Antonio Iaffaldano1, Giulia Paparella1, Daphne Gasparre1, Marina de Tommaso1, Damiano Paolicelli1,
1 Department of Educational Sciences, Psychology, Communication, University of Bari, Italy, 2 Department of Translational Biomedicine and Neuroscience (DiBraiN), University of Bari, Italy, 3 Department of Clinical Medicine, Aarhus University, Denmark

Subtheme D - Memory and Cognition

In individuals with multiple sclerosis (MS), cognitive function is negatively affected by cognitive fatigue, i.e., difficulty in concentrating, memorizing, recalling, and word -finding. We here tested whether the impact of cognitive fatigue could extend even to the neurophysiological underpinnings of a simple cognitive task of sound discrimination. Seventeen individuals with early-stage MS and 12 healthy controls were recorded with magnetoencephalography (MEG) while they engaged in discriminating rare target sounds from repetitive sounds (standards), while concurrently ignoring rare non-target sounds. Utilizing standard MEG procedures for data preprocessing, artifact removal and averaging for evoked responses quantification and minimum norm estimation for source analysis. We revealed an enhanced early P300 response to the target sound in MS patients as compared to controls, which was localized in the posterior region of the right superior temporal gyrus. Furthermore, a later P300 to target sounds localized in associative parietal areas was found exclusively in MS patients, indicating a compensatory adaptation for performing the cognitive task in MS. These results highlight the impact of the MS disease even on simple cognitive discriminatory functions and their neural substrates, with implications for putative sound- and music-based interventions for contrasting cognitive fatigue in MS.

Auditory Working Memory for pitch and rhythm: An activation likelihood estimation meta-analysis

Castro, Candela; Alain, Claude; Thaut, Michael;
University of Toronto. Toronto, Canada,

Subtheme D - Memory and Cognition

This study investigated the neural substrates of auditory working memory (AWM) for tonal and rhythmic stimuli, aiming to identify consistent activation patterns across diverse studies. Although there is previous research on AWM, most of the literature is focused on sound location and sound source. For this reason, a meta-analysis of neuroimaging studies was carried out to identify brain regions reliably recruited across multiple experiments or studies involving working memory for pitch and rhythm. Using Activation Likelihood Estimation (ALE), neuroimaging results from ten selected studies were analyzed. The dataset revealed robust activations in the left Superior Frontal Gyrus (SFG) and right Inferior Frontal Gyrus (IFG). Separate analyses were conducted for the rhythmic and tonal conditions independently. Tonal working memory activations included the left SFG, right Middle Frontal Gyrus (MFG), and left Anterior Cingulate Cortex (ACC), while the rhythmic condition did not produce significant results, possibly due to the limited number of foci in rhythmic studies. It was hypothesized to observe prefrontal, temporal, and parietal activations, which was only partially supported, with consistent bilateral prefrontal cortex activations observed but not temporal and parietal, probably because of the heterogeneity of tasks and contrasts, and the small number of papers. Limitations include a small number of studies, especially in rhythmic conditions, insufficient statistical power for rhythmic analyses, and a broad categorization of AWM. Despite these limitations, the study highlights critical regions in AWM, such as the left SFG, right IFG, and ACC, emphasizing their roles in manipulating tonal information and sustaining attention during complex auditory tasks. Future research should address these limitations and build upon this foundation to deepen insights into the nuanced neural mechanisms underpinning auditory working memory for tonal and rhythmic stimuli.

Background Music on Attentional Networks in Parkinson's Disease Patients: Preliminary Results

F. Ciongoli (1), N. Guerrero Barbero (2), C. García-Sánchez (2, 3) , & M. Calabria (1)
1 Faculty of Health Sciences, Universitat Oberta de Catalunya, Barcelona, Spain. 2 Movement Disorders Unit, Neurology Department, Hospital de la Santa Creu i Sant Pau, Barcelona, Spain. 3 Centro de Investigación en Red-Enfermedades Neurodegenerativas (CIBERNED), Spain

Subtheme D - Memory and Cognition

Objective The main aim of this study is to explore how background music may influence performance in attentional tasks in patients with Parkinson's Disease (PD). Additionally, the study seeks to identify interindividual differences predicting attentional performance with background music. Method Twenty-six PD patients were randomly assigned to two groups: “low” (n=12) or “high”(n=14) arousal music. Participants completed the Attentional Network Task (ANT), identifying the direction of a central arrow, presented with congruent/incongruent flankers and different cues (central, double, oriented, none), while exposed to background music (low or high-arousal). The ANT's performance enables the evaluation of three critical attentional networks - alerting, orienting, and executive control - through specific measures based on reaction times (RT). The ANT further allowed for assessing the accuracy in identifying the direction of the arrow in both congruent and incongruent flanker conditions. Before the cognitive task, participants also completed the Barcelona Music Reward Questionnaire (BMRQ), which assesses the subjective musical reward experience of individuals. Results The study's analysis revealed no significant differences in the ANT performance between the two groups exposed to low and high arousal music. However, further analysis investigating the role of interindividual differences uncovered two significant findings related to the BMRQ's Sensory-Motor (SM) score. Specifically, the SM scores were found to be a negative predictor of the Alerting Effect ($p = 0.013$), and a positive predictor of the accuracy in congruent trials ($p = 0.004$). Conclusion Our preliminary findings indicate that PD patients with higher sensory-motor engagement with music exhibited enhancing alerting efficiency and accuracy in attentional tasks when background music is played. Together, these results highlight the impact of sensory-motor engagement with music on specific components of attentional functioning in patients with PD.

Linking a musical memory gamified task to large-scale health data via electronic health records: a feasibility study in a clinic waiting room

Kelly Corcoran 1, Tanguy R. du Mérac 1, 2, Foster Johnson 3, John Ashley, Burgoyne 4, Henkjan Honing 4, Douglas M. Ruderfer 2, 5, 6, 7, Miriam Lense 1, 7, 8, 9, Reyna L. Gordon 1, 2, 7, 8, 9,
1. Department of Otolaryngology – Head and Neck Surgery, Vanderbilt University Medical Center, Nashville, TN, USA; 2. Vanderbilt Genetics Institute, Vanderbilt University, Nashville, TN, USA; 3. College of Arts and Sciences, Vanderbilt University, Nashville, TN, USA; 4. Music Cognition Group, Institute for Logic, Language, and Computation, University of Amsterdam, the Netherlands; 5. Department of Biomedical Informatics, Vanderbilt University, Nashville, TN, USA; 6. Center for Precision Medicine, Vanderbilt University Medical Center, Nashville, TN, USA, 7. Vanderbilt Brain Institute, Vanderbilt University, Nashville, TN, USA, 8. Department of Psychology, Vanderbilt University, Nashville, TN, USA, 9. Vanderbilt Kennedy Center, Vanderbilt University Medical Center, Nashville, TN, USA

Subtheme D - Memory and Cognition

Research designs utilizing large-scale data collection across diverse populations, or big data, represent a major step towards personalizing clinical applications of music. To advance these designs, we aim to establish feasibility of patients participating in music cognition research via a flexible -length, gamified musical memory task in a clinic waiting-room setting and linking to large-scale health data via electronic health records (EHR). This approach harnesses the intrinsic motivation and validity of gamified (and musical) tasks (Honing, 2021) to engage a diverse adult participant population representative of the clinical population already present at the medical center. We implemented the That’s My Song game, which involves recognizing short fragments of music (15s) and maintaining an auditory image of recognized music during short periods of silence (4s). The game uses musical fragments from the Billboard Hot 100 charts for the decades of interest first selected by the participants. Self-report musicality questions are interspersed between the scored game rounds. Our pilot phase of the study enrolled N=187 participants in Vanderbilt University Medical Center Otolaryngology outpatient clinics; 90.9% have fidelity of procedure scores indicating usable data. Of the usable data, participants are mean age 3 SD = 55.22 316.2 years (range 18.7-86.24), 47.06% male, 51.76% female, 1.18% other gender identity. Of participants who completed one full round (N = 90), the mean game score was 2.50 3 3.48 as compared to scores of 3.27 3 3.50 for previous versions of the game in non-clinical populations. We will map ICD codes from participant EHR data to PheCodes in preparation for a phenome-wide association study (pheWAS) to explore the connections between health phenotypes and game scores. This pilot is groundwork for future studies linking individual differences in musicality traits (e.g., music memory tasks or self-reported music achievement) to risk and resilience for health traits (e.g., age-related cognitive impairment).

What makes music memorable? A magnetoencephalography study on the neural mechanisms of passive listening vs encoding of music

Gemma Gemma Fernández-Rubio (1), Leonardo Bonetti (1), Morten L. Kringelbach (1, 2), Peter Vuust (1), & Elvira Brattico (1, 3).
(1) Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music, Aarhus/Aalborg, Aarhus, Denmark; (2) Centre for Eudaimonia and Human Flourishing, Linacre College, University of Oxford, Oxford, United Kingdom; (3) Department of Education, Psychology, Communication, University of Bari Aldo Moro, Bari, Italy

Subtheme D - Memory and Cognition

Memory is a core cognitive function that involves encoding, storage, and retrieval of information. Previously, we examined the spatial and temporal neural bases of memory recognition in music. We found that recognition of familiar music prompted the progressive activation of hippocampal and cingulate regions as the musical sequences unfolded, whereas listening to unfamiliar music activated the superior temporal gyrus, Heschl's gyrus, and Rolandic operculum for the complete duration of the sequences. In this study, aiming to enhance our comprehension of all facets of memory mechanisms, we shifted our focus from memory recognition to encoding of music. To do this, we investigated the neural differences between passively listening to and actively encoding (i.e., memorizing) musical sequences. Participants were presented with seven-note melodic phrases and were instructed to either listen or memorize them while their brain activity was recorded with magnetoencephalography (MEG). Outside the scanner, they were presented with previously memorized (i.e., old) and novel melodies (i.e., new) and were asked to report whether these were old or new. The old/new auditory recognition test was administered on the same day as the listen/memorize task, one day later, and ten days later. Preliminary analyses confirm that the neural activity is stronger in MEG sensors corresponding to auditory brain regions during passive listening, whereas greater contributions from sensors related to memory brain regions occurred while

participants actively memorized the melodies. Activity in the latter regions was correlated with accuracy scores from the old/new auditory recognition test. Further analyses will be conducted to (1) examine note-by-note differences in neural activity between listening and encoding conditions, (2) locate the source of the neural activity, and (3) refine the correlation between the neural activity during the encoding condition and the accuracy scores from the old/new auditory recognition test at the different timepoints.

Influences of musical practice on resilience strategies: the case of people presents at the Bataclan during the terrorist attacks of November 13, 2015

Elodie Fraile1, Jean-François Orianne2, Francis Eustache1, Maxime Mauduy3, Denis Peschanski4, Mathilde Groussard1$* and Hervé Platel1 $;
1 UNICAEN, PSL Research University, EPHE, INSERM, U1077, CHU de Caen, Cyceron, Neuropsychologie et Imagerie de la Mémoire Humaine (NIMH), Normandie Université, Caen, France; 2 Université de Liège, Institut de Recherche en Sciences Sociales (IRSS), Liège, Belgique; 3 Université Paris Cité, Laboratoire de Psychologie Sociale : contextes et régulation (LPS, UR 4471), Institut de Psychologie, Boulogne-Billancourt, France; 4 Université Paris I Panthéon Sorbonne, HESAM Université, EHESS, CNRS, UMR8209, Paris, France;
$ authors contributed equally

Subtheme D - Memory and Cognition

Although the protective role of music after traumatic exposure has been suggested in several works [1], no study has investigated the place of music when trauma is associated with a musical context, as in the case of the terrorist attack on the Bataclan concert hall on November 13, 2015. The aims of this study are to explore the role of frequency of musical practice on the association between the severity of post-traumatic stress disorder (PTSD) and resilience strategies. Adults exposed to the Bataclan attack (n=50) with an average age of 36.7 3 7.15 years completed questionnaires assessing PTSD symptom severity (PCL-5), coping strategies (Brief Cope Inventory) deployed and post-traumatic growth (Posttraumatic Growth Inventory), one and three years after the attack. Moderation analysis were carried out to investigate the links between symptomatologic profile of the participants and their musical practice when the traumatic event can be associated with music. One year after the traumatic exposure, the moderation analysis revealed no significant results. Three years after traumatic exposure, frequency of musical practice significantly moderated upwards the association between PTSD symptom severity and two coping strategies: problem-solving (p=.048; B= 0.010; β=0.235) and positive thinking (p=.011; B= 0.016; β= 0.345). Interestingly, problem-solving and positive thinking coping strategies are among the active coping strategies linked to adaptive behavioral responses [2] suggesting that this study did not reveal any weakening effect of musical practice in this particular traumatic context, but rather an absence of effects or a protective effect. These findings call for further research into the underlying cerebral mechanisms involved. [1] Fraile et al. (2023). Frontiers in Psychology [2] Wood & Bhatnagar (2014). Neurobiology of Stress

Melodies in Slumber: Neural Decoding of Musical Expectations in Human Sleep

Michelle Michelle George[1], Cagatay Demirel[2], Marc Schwartz[3], Ugur Can Akkaya[4], Martin Dresler[2], Thomas Andrillon[1,5]
1. Paris Brain Institute, Sorbonne Université, Paris, France, 2. Donders Institute for Brain, Cognition and Behaviour, Radboud University Medical Centre, Nijmegen, the Netherlands, 3. Center for Brain and Cognition, Computational Neuroscience Group, Department of Information and Communication Technologies, Universitat Pompeu Fabra, Barcelona, Spain, 4. Institute of Art and Music, TU Dresden, D-01062 Dresden, Germany, 5. Monash Centre for Consciousness and Contemplative Studies, Faculty of Arts, Monash University, Melbourne, Australia

Subtheme D - Memory and Cognition

The daily rhythm of falling and staying asleep diminishes our awareness of the external world. While certain acoustic features in meaningful speech and sounds continue to be tracked during sleep, these are strongly modulated by neural oscillatory markers including isolated k-complexes and highly synchronized slow waves (< 4Hz). Here, we aim to explore if the sleeping brain is capable of tracking melodic variations. We will analyze 64-channel EEG recordings from 23 participants as they sleep to a musical composition backed by a drone, incorporating form variations with melodic and rhythmic conditional rules. We will apply a variable-order Markov Chain model to compute note-level expectations of pitch and onset timing over different short-term memory capacities. Using multivariate temporal response functions (TRF), we then aim to correlate these expectations with distinct cortical patterns associated with musical anticipation. We hypothesize that continuous slow waves alter the temporal information integration window, leading to a restricted capacity for encoding high-level representations in music. Specifically, we aim to explore the relationship between the timing and characteristics of slow waves, the TRFs for varying working memory capacities, and the neural decoding performance. By utilizing naturalistic stimuli, such as melodies shaped by long-term exposure, we contribute to the knowledge gap regarding the impact of music on the neurophysiology of sleep, and further debate on what it means to be conscious while asleep. Keywords: temporal response function, TRF, neural encoding, EEG, Markov-chains, melodic regularities

Melodies do not improve short-term memory recall of unrelated word lists

Isabella Ramirez, Laura M. Getz University of San Diego, San Diego, CA, USA

Subtheme D - Memory and Cognition

Mnemonic devices and jingles paired with musical melodies are used from the time we are young to help remember information; for example, the ABCs or the Fifty-Nifty United States songs. Despite these colloquial uses, research is mixed on the effectiveness of utilizing music to improve learning and memory. In two experiments, we tested the effects of melodies on short-term memory performance of unrelated word lists compared to a spoken control condition. Participants heard lists of 15 two-syllable words either spoken, sung to a familiar melody (e.g. Yankee Doodle), or sung to an unfamiliar melody. Each word list included 5 positive-valence, 5 negative-valence, and 5 neutral words in a random order. After each list, participants were asked to freely recall the words in any order and were then asked to complete an old-new recognition task. We found that participants recalled and recognized significantly more words in the spoken word condition than either melody condition, suggesting that adding melodies to the word lists diverted attentional resources away from the memorization task. Participants also recalled more positive and negative words than neutral words overall. We ran a second experiment with the addition of a second familiar melody condition in which we showed the title of the song and played the melody alone before each word list. This was done to ensure that the melody was indeed familiar and to eliminate the need for participants to focus on figuring out what song was being played during the word list. We found that this additional reinforcement of the new melodies did not enhance word list recall or recognition compared to the non-reinforced familiar melodies, and all melody groups were still worse than the spoken condition. These results indicate that at least for short-term recall, the colloquial belief of music aiding memory did not hold true.

Neural Correlates of Music-Evoked Nostalgia in Younger and Older Adults

Sarah Hennessy[1]; Petr Janata[2]; Jonas Kaplan[1]; Talia Ginsberg[1]; Assal Habibi[1]
[1] Brain and Creativity Institute, University of Southern California, Los Angeles, CA, USA; [2] Center for Mind and Brain, University of California Davis, Davis, CA, USA;

Subtheme D - Memory and Cognition

Nostalgia is a mixed emotion that is often evoked by music. Nostalgic music may induce temporary improvements in autobiographical memory in individuals with cognitive decline. However, the neural mechanism underlying music-evoked nostalgia and its associated memory improvements is unclear. We aimed to elucidate how nostalgia-evoking music may help retrieve autobiographical memories in individuals with AD by first clarifying these processes in healthy younger and older adults. Methodological constraints including the lack of personally-tailored and experimentally controlled stimuli, have limited systematic understanding of this mechanism. We utilized an innovative method to identify three categories of songs (1) personalized nostalgic, (2) familiar non-nostalgic, and (3) unfamiliar stimuli matched for musical features. In 57 participants (29 aged 18-35; 28 aged 60 and older), we investigated the functional neural correlates of music-evoked nostalgia using fMRI. We observed three main findings: 1) Listening to nostalgic music, more than familiar non-nostalgic or unfamiliar music, was associated with bilateral activity in the default mode network (DMN), reward network, supplementary motor regions, medial temporal lobe, and cerebellum. 2) Psychophysiological interaction models (PPI) indicated that listening to nostalgic music involved functional connectivity of Heschl's gyrus (HG) with self-referential (angular gyrus, PMC) and affect-related regions (insula). In contrast, non-nostalgic music was associated with co-activation of HG with other feature-processing regions (i.e., STG, supramarginal gyrus). 3) While the neural response to nostalgic music in younger adults was modified only by trait-level factors (i.e., nostalgia proneness, cognitive ability), the response in older adults was modified only by state-level factors (i.e., felt valence, autobiographical memory details). This suggests that while neural correlates of nostalgic music listening may stabilize across the lifespan regarding person-level characteristics, they become more variable with differences in stimulus-dependent affect and memory. Findings may serve as a foundation for understanding the neural basis of music-evoked nostalgia for future clinical interventions.

Music training as a predictor of Executive Functioning performance: a latent variable approach

Emmelyne Jack1; Peter Koval1; Sarah Wilson1,2
1 Melbourne School of Psychological Sciences, University of Melbourne, Australia; 2 Department of Medicine, Epilepsy Research Centre, University of Melbourne, Australia.

Subtheme D - Memory and Cognition

Music training has been linked to enhanced working memory, yet the extent of its impact on other executive functions remains unclear. Working memory includes processes of retention, transformation, and substitution, well captured by tasks of working memory updating. A shared mechanism is proposed to underlie the core executive functions of working memory updating, inhibition and cognitive set-shifting, due to high intercorrelations in task performance. Thus, this study investigated whether music training confers benefits for working memory updating, and whether these benefits extend to inhibition and cognitive set-shifting. A total of 246 participants (age: M = 19.6 years, SD = 2.4) varying in their degree of music training (training: M = 4.0 years, SD = 4.3) completed three measures of each core executive function. Preliminary analyses indicated that individuals with music training exhibited superior performance on two of the three working memory updating tasks, showing small but significant positive correlations with their duration of music training (rs = .15, .27). No associations were found between music training and performance on inhibition nor cognitive set-shifting tasks. Confirmatory factor analysis supported a correlated factor model, revealing strong associations between working memory updating, inhibitory control, and cognitive set-shifting. Structural equation modelling further supported an association between duration of music training and working memory updating ($r = .41$, $SE = .10$, $p < .001$), but not inhibition nor cognitive set-shifting. In the present study musicians consistently demonstrated superior working memory updating performance, however there was no evidence supporting a musicians' advantage for inhibition nor cognitive set-shifting. This suggests that music training may engage working memory mechanisms independently rather than activating a common executive functioning mechanism. The findings corroborate the benefits of music training for working memory, particularly highlighted in instrumental learning research. In contrast, the present study does not support far-transfer benefits to other executive functions.

Out of Sync? Inhibitory Control and Working Memory Predict Rhythm Production Abilities in Patients with Neurocognitive Deficits

Löser, A. S.1,2, Dalla Bella, S.3,4,5, Keller, P. E.6,7, Villringer, A.1,2, Obrig, H.1,2, & Engel, A.1,2. 1 Clinic for Cognitive Neurology, University Hospital Leipzig, Leipzig, Germany. 2 Max Planck Institute for Human Cognitive and Brain Sciences, Department of Neurology, Leipzig, Germany. 3 International Laboratory for Brain, Music, and Sound Research (BRAMS), Montreal, Canada. 4 Department of Psychology, University of Montreal, Montreal, Canada. 5 Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada. 6 The MARCS Institute for Brain, Behaviour & Development, Western Sydney University, Sydney, Australia. 7 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Aarhus, Denmark

Subtheme D - Memory and Cognition

Deficits in rhythm perception and production have been reported in a variety of psychiatric, neurodevelopmental and neurologic disorders. Since correlations between rhythmic abilities and cognitive functions have been demonstrated in neurotypical individuals, we here investigate whether and how rhythmic abilities are associated with cognitive functions in 35 participants with neurocognitive deficits due to acquired brain lesions. We systematically assessed a diverse set of rhythm perception and production abilities including time and beat perception and finger-tapping tasks. Neuropsychological tests were applied to assess separable cognitive functions. Using multiple regression analyses we show that lower variability in aligning movements to a pacing sequence was predicted by better inhibitory control and better working memory performance. Working memory performance also predicted lower variability of rhythmic movements in the absence of an external pacing sequence and better anticipatory timing to sequences with gradual tempo changes. Importantly, these predictors remained significant for all regression models when controlling for other cognitive variables (i.e., cognitive flexibility, information processing speed, and verbal learning ability) and potential confounders (i.e., age, symptom strength of depression, manual dexterity, duration of illness, severity of cognitive impairment, and musical experience). Thus, all rhythm production abilities were significantly predicted by measures of executive functions. In contrast, rhythm perception abilities (time perception / beat perception) were not predicted by executive functions in this study. Our results, enhancing the understanding of cognitive underpinnings of rhythmic abilities in individuals with neurocognitive deficits, may be a first mandatory step to further

potential therapeutic implications of rhythm-based interventions in neuropsychological rehabilitation.

The Influence of Stimulus Uncertainty on Inter-subject Synchronization of Cortical MEG Activity and Continuous Ratings in Natural Music Listening

Iris Mencke (1,2), Kai Siedenburg (1,3), Diana Omigie (4), Niels Trusbak Haumann (5), Elvira Brattico (5,6), Sebastian Puschmann (7).
1. Department of Medical Physics and Acoustic, Carl von Ossietzky University of Oldenburg, Germany. 2. Department of Music, Max Planck Institute for Empirical Aesthetics, Germany. 3. Institute of Signal Processing and Speech Communication, Graz University of Technology, Austria. 4. Department of Psychology, Goldsmiths, University of London, United Kingdom. 5. Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Denmark. 6. Department of Education, Psychology and Communication, University of Bari Aldo Moro, Italy. 7. Department of Human Medicine, Carl von Ossietzky University of Oldenburg, Germany

Subtheme D - Memory and Cognition

Inter-subject correlations (ISC) have proven useful to study neural responses in the context of naturalistic stimuli. ISC during listening has been shown to be modulated by attention, musical training, familiarity of musical genres and it has been used to study musical engagement. However, it remains an open question how stimulus uncertainty and style-specific musical training interact to influence ISC during naturalistic music listening. The study aimed to investigate whether ISC is (potentially jointly) influenced by i) the levels of uncertainty naturally present in music and ii) different style-specific musical training. Using magnetoencephalography (MEG), brain activity was recorded in response to tonal (low uncertainty) and atonal (high uncertainty condition) piano excerpts from the Western tradition. Separately, continuous ratings (CR) of surprisal and liking were collected. The sample comprised 20 non-musicians (NM), 19 musicians specialized in classic-romantic, i.e. tonal music (CM), and finally, 19 musicians specialized in contemporary classical, i.e. atonal music (CCM). Data analysis is still ongoing, but so far the results of the CR data analysis showed that ISC of surprisal ratings was lower in the atonal condition for all three groups, confirming our main hypothesis of a negative effect of musical uncertainty on ISC. The MEG data analysis showed significant ISC over bilateral temporal lobe (right > left), for all three groups and in both uncertainty conditions. Different from the behavioral analysis, higher ISC values were found for the atonal vs. the tonal condition. However, the CCM group once more showed increased ISC compared to both other groups in left temporal lobe for both conditions. The study provides novel insights, firstly, into how musical uncertainty influences behavioral and neural inter-subject synchronization and secondly, into how not only familiarity of genres, but also specific forms of professional music training can modulate that influence.

Transfer effects of music learning on verbal working memory and their interaction with language background

Peixin Nie1,2,3, Vesa Putkinen4,5, Mari Tervaniemi1,2,3,
1. Faculty of Educational Sciences, Department of Education, University of Helsinki, Helsinki, Finland, 2. Cognitive Brain Research Unit, Faculty of Medicine, University of Helsinki, Helsinki, Finland, 3. Centre of Excellence in Music, Mind, Body and Brain (MMBB), Faculty of Educational Sciences, University of Helsinki, Finland, 4. Turku PET Centre, University of Turku, Turku, Finland, 5. Turku University Hospital, Turku, Finland

Subtheme D - Memory and Cognition

Introduction. Transfer effects of music training have been controversial in recent years. Inconsistent results have been found regarding the relationship between musical training and verbal working memory (WM) even when using identical outcome measures. The factors which led to these inconsistent results have remained unclear. The current poster summarizes my PhD project, in which I investigated the effect of music training and music expertise on verbal WM with different language backgrounds. I explored whether and how native language interacts with the music-training effects. Methods. The first study was part of a larger longitudinal intervention study in Chinese-speaking school-aged children. Verbal WM, measured with digit span forward and backward scores, was compared between children with and without one-year music training. The second and third studies, conducted in an online setting during the COVID-19 pandemic, compared verbal WM and tone memory of adult musicians and non-musicians in Finnish and Chinese-speaking samples. Results In the longitudinal study, the Chinese musically trained children outperformed the children without music training on verbal WM manipulation (digit span backward) but not on verbal WM maintenance (digit span forward). In the online study, verbal WM maintenance and manipulation did not significantly differ between Chinese adult musicians and nonmusicians, whereas Finnish musicians outperformed Finnish non-musicians. Tone memory was more advanced in Chinese speakers than in Finnish speakers and had a mediation effect on the relationship between musical expertise and verbal WM. Conclusion. The studies indicated that the transfer effects of music learning on verbal WM were different in Chinese and Finnish participants. Interrelated associations were revealed between the transfer effects, native language background, and tone memory. The findings call for more attention to language background while investigating the transfer effect of music.

Neurophysiological correlates of short-term conscious recognition of sounds: Insights from magnetoencephalography

Serra, E. 2,3,1, Lumaca, M.1, Brattico, E.1,4, Vuust, P.1, Kringelbach, M. L.1,2,3 Bonetti, L.1,2,3*.
1 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music, Aarhus, Aalborg, Denmark, 2 Centre for Eudaimonia and Human Flourishing, Linacre College, University of Oxford, Oxford, United Kingdom, 3 Department of Psychiatry, University of Oxford, Oxford, United Kingdom, 4 Department of Education, Psychology, Communication, University of Bari Aldo Moro, Italy

Subtheme D - Memory and Cognition

Understanding the dynamic processes of information retrieval and updating within the brain is a central focus in memory research. This study explores short-term auditory conscious recognition using a same-versus-different auditory paradigm within the framework of predictive coding (PC), which investigates the interplay between experience-informed predictions and incoming sensory information. Using magnetoencephalography (MEG), we captured the neurophysiological correlates associated with a single-sound, short-term memory task. Twenty-six healthy participants were tasked with discerning whether presented target sounds matched standard stimuli strings, with a white noise interlude promoting conscious memory retention. Behavioural outcomes verified participants' proficient task execution, revealing a recognition rate of 98.15% for same target sounds and 95.41% for different target sounds. MEG sensor-level analysis unveiled that recognition of same target sounds evoked two significantly stronger negative components in the event-related field compared to different sounds. The initial component, identified as N1, peaked 100ms post-target sound onset, while the second component manifested as a slower negative response between 300 and 600ms after target sound onset. These effects were prominent in various MEG sensor clusters, particularly in temporal and parietal regions of the scalp. Conversely, different target sounds produced scattered and smaller clusters of enhanced activity compared to same sounds, peaking beyond 600ms post-target sound onset. Source

reconstruction through beamforming algorithms identified the involvement of auditory cortices, hippocampus, and cingulate gyrus in both target sound conditions. Our findings align with PC principles and previous research on the neural mechanisms underlying automatic auditory recognition. Notably, the study emphasizes the significance of early and later negative brain responses for the successful prediction of previously encountered sounds in the context of conscious short-term memory. Overall, these results contribute to our understanding of the intricate processes involved in auditory memory.

Music Listening interventions for subacute fatigue and cognitive recovery post-brain injury: literature review and patient public engagement prior to design and testing

Dr Alex Street1; Dr Nina Wollersberger1; Dr Jonathan Pool1; Dr Sheryl Parke2; Louise Gilbert3; Jessica Blake4
1 Cambridge Institute for Music Therapy Research, Anglia Ruskin University, Cambridge, UK; 2 Colman Centre for Specialist Rehabilitation Services; Colman Hospital, Norwich, NR2 2PJ; Norfolk Community Health and Care NHS Trust; Department of Clinical Psychology and Psychological Therapies, Norwich Medical School, University of East Anglia; 3 Stroke Early Supported Discharge Team, Norfolk Community Health and Care NHS Trust; 4 Colman Centre for Specialist Rehabilitation Services. Colman Hospital, Norwich, NR2 2PJ; Norfolk Community Health and Care NHS Trust; Specialist Occupational Therapist and ARC East of England Research Fellow

Subtheme D - Memory and Cognition

This poster will report scoping review, and staff and service user interview data on music listening for fatigue management following brain injury (ABI). 86% of 11,000 UK stroke survivors report experiencing fatigue, yet there is a paucity of evidence exploring effective interventions. Effective management of fatigue optimises cognitive recovery. Recent evidence suggests that subacute stroke survivors who listened daily to their preferred music report feeling less fatigued. Our scoping review aimed to establish how music listening has been used for managing fatigue after ABI. None of the 13 included full texts focused on fatigue as a primary outcome, but some reported secondary and related effects including: improved subjective rating of fatigue, grey matter volume increases corelated with self-reported fatigue reduction, improved verbal memory, attention, mood, and motivation when compared to audiobook listening, improved vitality and alertness. People with aphasia may benefit more in verbal memory and language recovery from listening to vocal music rather than instrumental music and audiobooks. Scoping data, current fatigue management recommendations and service user and staff interview responses will be correlated to design and trial a music listening intervention in subacute inpatient ABI for fatigue management. Potential benefits identified by service-users and staff were: listening for a specified and uninterrupted period might be beneficial (reminders would be needed), music with exercise or as a non-physical relaxation aid. Potential barriers identified included: setting aside time, need for technical support. Music selection was considered important - avoiding less enjoyable music that ‘may increase fatigue.’ Overall, our review has found music listening may be an acceptable and effective intervention for those with post-ABI fatigue, which could be developed to help them engage in the recommended three-hours of daily rehabilitation – in-line with UK Stroke rehabilitation guidelines, which also state that more research into music therapy-based interventions is required.

Do musicians have better short-term memory than nonmusicians? A multi-lab study

Francesca Talamini - University of Innsbruck, Austria.
Massimo Grassi - University of Padova, Italy.
Gianmarco Altoè - University of Padova, Italy.
Christ Aryanto - University of Sheffield, UK.
Aíssa Baldé - Iscte, University Institute of Lisbon, Portugal.
Deniz Başkent - University of Groningen, University Medical Center Groningen, the Netherlands.
Laura Bishop - RITMO, University of Oslo, Norway.
Graziela Bortz - State University of Sao Paulo, Unesp, Brazil.
Fleur Bouwer - University of Leiden, the Netherlands;
Elvira Brattico - Center for Music In the Brain, The Royal Academy of Music/Dept. of Clinical Medicine, Aarhus University, Denmark.
Anne Caclin - Université Claude Bernard Lyon 1, INSERM, CNRS, Centre de Recherche en Neurosciences de Lyon CRNL U1028 UMR5292, Bron, France;
Axelle Calcus - Université libre de Bruxelles, Belgium;
Giulio Carraturo - University of Bari, Italy;
Barbara Carretti - University of Padova, Italy;
Antonio Criscuolo - Maastricht University, the Netherlands;
Simone Dalla Bella - International Laboratory for Brain, Music and Sound Research (BRAMS), University of Montreal, Canada;
Anne Danielsen - RITMO, University of Oslo, Norway;

Delphine Dellacherie - University of Lille, France; Walter Dowling - University of Texas at Dallas, USA; Véronique Drai-Zerbib - Université Bourgogne Franche Comté, France; Tor Endestad - RITMO, University of Oslo, Norway; Victor Escribano - University of Barcelona, Spain; Laura Ferreri - University of Pavia, Italy; Anna Fiveash - The MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Australia; Noah Fram - Vanderbilt Music Cognition Lab, Vanderbilt University Medical Center, USA; Eleonora Fullone - University of Pavia, Italy; Filippo Gambarota - University of Padova, Italy; Lucia Gonzalez Sanchez - University of Barcelona, Spain; Reyna Gordon - Vanderbilt Music Cognition Lab, Vanderbilt University Medical Center, USA; Jessica Grahn - University of Western Ontario, Canada; Mathilde Groussard - Université de Caen Normandie, France; Lucrezia Guiotto Nai Fovino - University of Padova, Italy; Assal Habibi - University of Southern California, USA; Heidi Hansen - RITMO, University of Oslo, Norway; Eleanor Harding - University of Groningen, University Medical Center Groningen, the Netherlands; Kirsty Hawkins - Goldsmiths University of London, UK; Steffen Herff - The MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Australia; Kelly Jakubowski - Durham University, UK; Maria Jol - Leiden University, the Netherlands; Stefan Koelsch - University of Bergen, Norway; Sonja Kotz - Maastricht University, the Netherlands; Bruno Laeng - RITMO, University of Oslo, Norway; André Lee - Hannover Institute of Music Physiology and Musicians Medicine, Germany; Frederico Leite - State University of Sao Paulo - Unesp, Brazil; Miriam Lense - Vanderbilt Music Cognition Lab, Vanderbilt University Medical Center, USA; Cesar Lima - Iscte - University Institute of Lisbon, Portugal; Paulina Martín Sánchez - University of Granada, Spain; Daniel Müllensiefen - Goldsmiths University of London, UK; Niloufar Najafi - Leiden University, the Netherlands; Maria Gabriela Oliveira - State University of Sao Paulo - Unesp, Brazil; Katie Overy - University of Edinburgh, UK; Andrew Oxenham - University of Minnesota (APC lab), USA; Edoardo Passarotto - Hannover Institute of Music Physiology and Musicians Medicine, Germany; Herve Platel - Université de Caen Normandie, France; Marco Roccato - University of Padova, Italy; Italo Rodrigues Menezes - State University of Sao Paulo - Unesp, Brazil; Antoni Rodriguez -Fornells - University of Barcelona, Spain; Rafael Román -Caballero - University of Granada, Spain; M. Paula Roncaglia-Denissen - University of Groningen, University Medical Center Groningen, the Netherlands; Frank Russo - Faculty of Arts, Toronto Metropolitan University, Canada; Farrah Sa'adullah - The MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Australia; Daniela Sammler - Max Planck Institute for Empirical Aesthetics, Frankfurt, Germany; Séverine Samson - University of Lille, France; E. Glenn Schellenberg - Iscte - University Institute of Lisbon, Portugal; Nora Serres - RITMO, University of Oslo, Norway; Robert Slevc - University of Maryland, College Park, USA; Lauren Stewart - Goldsmiths University of London, UK; Hannah Strauss - University of Innsbruck, Austria; Swathi Swaminathan - University of Western Ontario, Canada; Mari Tervaniemi - University of Helsinki, Finland; Rachel Thompson - University of Maryland, College Park, USA; Barbara Tillmann - LEAD – CNRS UMR5022, Université Bourgogne Franche Comté, France; Renee Timmers - University of Sheffield, UK; Petri Toiviainen - University of Jyväskylä, Finland; Laurel Trainor - McMaster University, Canada; Jed Villanueva - University of Southern California, USA; Claudia von Bastian - University of Sheffield, UK; Peter Vuust - Center for Music In the Brain, The Royal Academy of Music/Dept. of Clinical Medicine, Aarhus University, Denmark; Kelly Whiteford - University of Minnesota (APC lab), USA; Jonathan Wilbiks - University of New Brunswick Saint John, Canada; Florian Worschech - Hannover Institute of Music Physiology and Musicians Medicine, Germany; Vitor Yamaguchi - State University of Sao Paulo - Unesp, Brazil; Ana Zappa - University of Barcelona, Spain; Marcel Zentner - University of Innsbruck , Austria

Subtheme D - Memory and Cognition

Musicians have often been studied as models of expertise-related brain plasticity, and an important open question is whether music training can lead to cognitive benefits. As longitudinal studies are only a few, most of studies have often compared musicians with non-musicians to observe possible cognitive differences. A common finding is that musicians have better memory than non-musicians, however, most of these studies had small sample sizes and lacked controls for possible confounding variables. Moreover, although the existing literature suggests that the effect size of this advantage is moderate, no study was adequately powered to reliably estimate an effect of this magnitude. For this reason, together with leading experts in the field, we designed a multi-laboratory study to provide a community-driven, shared and reliable estimate of the musicians' memory advantage, and to set a method and standard for future studies comparing expert musicians and non-musicians. Thirty-five research units from fifteen different countries are currently participating in the project. Participants have to complete a variety of tasks: musical, verbal and visuospatial spans to assess short-term memory, n-back task for executive function, Raven Matrices and WAIS-IV vocabulary for intelligence, and other tasks to assess individual differences in musicality, personality and socio-economic status. Data collection began in March 2023 and will end in May 2024. We expect to recruit over 500 expert musicians (ten or more years of musical experience) and 500 paired non -musicians in a laboratory experiment. Results will be presented at the conference. This project aims to provide the basis for good research practices in studies comparing expert musicians and non-musicians, and to contribute to the ongoing debate about the possible cognitive benefits of musical training.

Enhancing memory consolidation during sleep through EEG-synchronized sound - design of an experiment

Tinke van Buijtene1; Perfecto Herrera1; Thomas Andrillon2,3; Sergi Jordà1;
1 Music Technology Group, Department of Information and Communications Technologies, Universitat Pompeu Fabra; 2 Paris Brain Institute, Sorbonne Université, Inserm-CNRS, Paris, France; 3 Monash Centre for Consciousness & Contemplative Sutdies, Faculty of Arts, Monash University, Melbourne, Victoria, Australia

Subtheme D - Memory and Cognition

Memory is a fundamental aspect of cognition: the cornerstone for learning and decision-making. During sleep, specifically through the rhythms of slow oscillations (SO), our brains consolidate memories acquired throughout the day. This study proposes an innovative exploration to use rhythmic, EEG-synchronized sound to enhance this intricate process and its functions. The use of sound in modulating sleep architecture has recently been explored, yielding promising findings for enhancement of sleep-related benefits. These studies have, however, exclusively used brief sound clicks, occasionally without consistent EEG-synchronization, and further auditory exploration has been overlooked. Moving forward, sound-focused experimentation will be crucial to understand the complex interplay between sound and slow waves (SW), enabling us to refine auditory parameters for optimal SW enhancement. Here, we introduce a closed-loop auditory stimulation (CLAS) system, using continuous sound, modulated in real-time by EEG feedback. To our knowledge, this will be the first CLAS system used to study the efficacy of continuous, adaptive sound in enhancing SW activity and its functions. Twenty subjects will partake in a home-based experiment, including an adaptation night and two experimental nights featuring CLAS interventions with either continuous, amplitude-modulated sound or pink noise clicks, counterbalanced across subjects. Our interest lies in identifying paradigm-driven differences through examining their respective effects on EEG, particularly the elicitation of SO

and their amplitude. Using the well-validated and comfortable ZMax headband, our design reflects a step towards making our research findings directly translatable into a therapeutic tool optimized for daily use. This study stands at the innovative intersection of neuroscience and music, harnessing the therapeutic potential of sound to aid memory consolidation during sleep. By presenting this study, we aim to initiate a broader conversation on the expansive potential of sound as a powerful tool for non-invasive modulation of brain activity during sleep.

Enhanced Auditory Processing and Executive Function in Musicians

Jed Villanueva and Assal Habibi
Brain and Creativity Institute, Dornsife College of Letters Arts and Sciences, University of Southern California, Los Angeles, CA, USA

Subtheme D - Memory and Cognition

Music training has been found to improve executive functions, but factors like bilingualism obscures our understanding of this relationship since fluency in two languages may engage similar brain regions. The present study attempts to disentangle this relationship by investigating school-aged monolingual musicians and nonmusicians in a cross-sectional design. Group differences in peak latency and mean amplitude for event-related potentials (ERPs) associated with executive function were hypothesized in auditory oddball (i.e., N1, P2, P3a, and P3b) and visual go/no-go tasks (i.e., P2, N2, P3, ERN, Pe). Linear models analyzed reaction time and accuracy (d'); repeated measures ANOVAs analyzed latency and amplitude. In the auditory task, musicians performed 0.52 points more accurately than controls ($\beta = -0.52$, $SE = 0.26$, $t = -2.03$, $p = 0.046$) due to improved responding to oddball tones. In turn, the N1 elicited by the oddball exhibited a trending group difference in amplitude at Cz ($F(1, 68) = 3.67$, $p = 0.06$), but was mediated by age. Accuracy strongly correlated with P3b amplitude, with stronger associations observed among musicians ($r = 0.62$, $p < 0.001$) than nonmusicians ($r = 0.52$, $p < 0.001$). In the visual task, musicians trended 0.32 points higher in accuracy ($\beta = -0.32$, $SE = 0.20$, $t = -1.62$, $p = 0.11$), with a significant group difference in Pe amplitude at Cz ($F(1, 68) = 5.33$, $p = 0.024$). Both findings were mediated by age. Musicians showed a stronger correlation between accuracy and Pe amplitude ($r = 0.44$, $p < 0.001$) than nonmusicians ($r = 0.16$, $p = 0.02$). These findings suggest that musicians may possess enhanced selective attention towards auditory stimuli or improved inhibitory control when responding to non-target stimuli. Preliminary evidence from the visual domain suggests musicians may have greater proficiency in recognizing their mistakes and subsequently adjusting their decision-making process.

Effects of recalling autobiographical music performance memories on performance self-evaluation and heart rate variability

Aiko Watanabe, Tomohiro Samma, Sotaro Kondoh, Shinya Fujii
Keio University, Kanagawa, Japan

Subtheme D - Memory and Cognition

The autonomic nervous system (ANS) plays a critical role in musical performance. While previous studies have primarily reported a positive correlation between sympathetic activities and music performance anxiety, there was a dissociation that the competition winner exhibited lower anxiety with higher sympathetic activation (Yoshie et al., 2009), indicating that the relationship between ANS and musical performance achievement remains controversial. Performance memory recall can be a candidate for modulating the ANS to influence musical performance since previous research has suggested recalling positive or negative memory affects heart rate variability (HRV) differently (Kop et al., 2011). However, the effects of recalling positive or negative performance memories on ANS are yet to be fully understood. Thus, we examined how recalling autobiographical performance memories impacts musicians' self-evaluation of performance and HRV. Eighteen professional wind instrumentalists (13 female, aged 40.72 3 9.7) performed under three conditions (recalling no-memory, positive memory, negative memory) and evaluated their performance achievement. We measured their electrocardiograms to assess the SD2/SD1 values, an HRV measure indicative of sympathetic activity. The Kruskal-Wallis test showed a significant difference in performance achievement among recall conditions (χ^2 = 8.159, $p < 0.05$), and Dunn's multiple comparison test showed that positive memory significantly increased performance achievement compared to negative memory (p-adjusted = 0.0077). Additionally, a linear mixed-effects model was used to analyze the effects of recall conditions on SD2/SD1. Considering differences in recall conditions as a fixed effect and subject-specific variability as a random effect, we found a significant increase in SD2/SD1 for positive memory compared to no-memory ($z = 2.545$, $p = 0.029$). These results suggest that recalling positive performance memories in advance enhances subjective achievement and influences the ANS balance by increasing sympathetic activation, which can be beneficial for musicians' preparation for performance.

Musical Presentation of Verbal Information Improves Working Memory Performance in Healthy Aging and Amnestic Mild Cognitive Impairment

M.W. Derks-Dijkman 1,2; R.S. Schaefer 3; R.P.C. Kessels 1;
1 Radboud University, Donders Institute for Brain, Cognition and Behaviour, Nijmegen, The Netherlands; 2 Klimmendaal Rehabilitation Center, Zutphen, The Netherlands; 3 Leiden University, Health, Medical & Neuropsychology unit, Institute for Psychology, Leiden, The Netherlands

Subtheme G - Development and Aging

Both working (WM) and episodic memory (EM) are negatively affected by healthy aging. Memory impairment typically occurs in amnestic mild cognitive impairment (aMCI). In Alzheimer's dementia (AD) promising results of musical mnemonics (i.e., musical presentation of verbal information) on EM performance have been found. However, effects of musical mnemonics on WM performance have not been studied in aging, (a)MCI or AD. Therefore, we performed two studies on effects of musical mnemonics on WM performance in cognitively unimpaired young (YA) and older adults (OA) and persons with aMCI. Results are discussed in line with the model formulated in our systematic review, consisting of cognitive processes activated by musical mnemonics depending on stimulus complexity and personal aspects of persons with(out) cognitive impairment. 32 sequences of digits were pre -recorded in four conditions: sung to an unfamiliar pitch sequence with rhythmic pattern ('melody') or without ('pitch'), spoken to an unfamiliar rhythmic pattern ('rhythm') or without ('spoken'). Musical expertise was assessed using the Self-Report Inventory of the Goldsmiths Musical Sophistication Index. Respectively, 20 YA and 27 OA, and 32 OA and 32 aMCI participated in our studies. Rhythm facilitated WM performance in YA and OA. Pitch and melody affected performance negatively only in OA. Musical training did not moderate the effect of musical presentation. In OA and aMCI, rhythm facilitated performance, while pitch and melody again negatively affected performance. Musical expertise increased the beneficial effect of musical mnemonics. Rhythm enhanced WM in YA, OA and aMCI, regardless of WM performance differences, possibly through temporal chunking mechanisms. Pitch may have increased stimulus complexity, resulting in WM overload in OA and aMCI. Thus, rhythmically spoken presentation may be a potentially helpful strategy for remembering some information temporarily. Future research may consider different aspects of the musical stimulus (e.g., tonal aspects) and different verbal stimuli (e.g., words).

Rhythm to prime conversational dynamics

Emma Berthault[1], Sophie Chen[1], Daniele Schön[1]
[1]Aix Marseille University, Inserm, Institut de Neurosciences des Systèmes (INS), Marseille, France

Subtheme E – Language and Social Interaction

Speech perception and speech comprehension are enhanced when speech is preceded or accompanied by a rhythmic temporal cue (audio, such as a metronome, or motor, such as tapping). This is possibly due to an enhancement of stimulus-brain coupling at speech-relevant frequencies. Nonetheless, the influence of rhythm on conversational dynamics and the underlying neurophysiological processes remains relatively unexplored. Despite this gap, the concepts of rhythm, timing, and prediction play crucial roles within conversational dynamics. Notably, inter-utterance delays frequently occur below 200 milliseconds, despite the complexity of response and the speech production process (600 msec or more). This indicates an anticipation of both temporal dynamics and content during conversations. To investigate this point, we conduct an EEG experiment where participants engage in a musical task followed by a sentence-completion task, a proxy of a simple verbal interaction. In this task, participants had to orally complete sentences « as if they were spoken by the same individual ». Importantly, we manipulated several levels of predictibility of the stimuli. Our investigation adopts a multi-level analysis approach, encompassing phonetic features (fundamental frequency, intensity), completion dynamics (reaction time) and neurophysiological correlates. We compare interactional patterns of these dependent variables across predictive modulation levels. This is grounded in the hypothesis that music influences prediction mechanisms, providing insights into improved completion via a stronger stimulus-brain coupling.

The geometry of interpersonal synchrony in human dance

Félix Bigand (1), Roberta Bianco (1), Sara F. Abalde (1), Giacomo Novembre (1);
(1) Neuroscience of Perception & Action Lab, Italian Institute of Technology (IIT), Rome, Italy

Subtheme E – Language and Social Interaction

Collective dance is unanimously acknowledged as a universal human practice, yet little is known about the underlying mechanisms that support such synchronized behaviour. How does interpersonal synchrony emerge in human dance? To address this question, we recorded full-body kinematics from dyads of laypersons freely dancing to music in a 'silent disco' setting. To unveil how vision of a partner and audition of music contribute to the emergence of synchronized behaviour, we orthogonally manipulated visual contact (whether participants could see each other) and musical feedback (whether participants were dancing to the same music). Using a data-driven method, we were able to decompose full-body kinematics of 70 participants into 15 principal movement patterns, reminiscent of common dance moves, explaining over 95% of kinematic variance. We find that both music and partners drive synchrony, but through specific dance moves. This leads to the emergence of distinct kinds of synchrony that occur in parallel, and according to a geometric organization: hand gestures and full-body lateral movements synchronize through visual contact, while anteroposterior movements such as head bob synchronize through music. One specific dance move – vertical bounce – emerged as a supramodal pace setter of coordination, exhibiting synchronization through both visual contact and music, and at the pace of the musical beat. These findings reveal that human dance is supported by a geometry of interpersonal synchrony. This geometry enables dancers to synchronize to music and partners simultaneously by allocating distinct synchronies to distinct spatial axes and body parts.

Neural encoding of music, self, other and synchrony in dyadic dance

Félix Bigand (1), Trinh Nguyen (1), Sara F. Abalde (1), Roberta Bianco (1), Giacomo Novembre (1), 1. Neuroscience of Perception & Action Lab, Italian Institute of Technology (IIT), Rome, Italy

Subtheme E – Language and Social Interaction

Though dance is a universal form of human expression, the brain mechanisms supporting it are still poorly understood. The neuroscientific study of naturalistic dance is challenging due to its inherent complexity, involving social interaction and multimodal processes. To address this challenge, we applied multivariate temporal response functions (mTRFs) to electroencephalography (EEG) and full-body kinematics data collected from pairs of participants engaging in spontaneous dance to music. Using TRF encoding models, we were able to separate EEG modulations specifically associated with various aspects of dance: (i) music acoustics, (ii) self-generated movements, (iii) other-generated movements, and notably even (iv) interpersonal synchrony. Each model revealed distinct brain responses significantly contributing to EEG activity, elucidating the intricate neural encoding of collective dance. Our findings demonstrate the effectiveness of mTRFs in disentangling the simultaneous yet distinct neural processes involved in complex naturalistic interactions like dyadic dance. This paves the way for further research integrating hyperscanning techniques and kinematic analyses to deepen our understanding of the neuroscience of dance

Using song-based classes to support receptive language skills of infants in hard-to-reach families

Alice Bowmer 1, 2, Lauren Stewart 1, Caspar Addyman 1, Nina Politimou 2, Fabia Franco 3, Bea Waterfield 4
1 Department of Psychology, Goldsmiths University of London, London, UK; 2 Department of Psychology and Human Development, UCL Institute of Education, London, UK; 3 Department of Psychology, Middlesex University, London, UK; 4 Baby College Ltd, Oxford, UK, Corresponding author: Alice Bowmer

Subtheme E – Language and Social Interaction

The importance of providing infants with a rich language environment within the family home is well known. Studies on shared book reading (Trivette, Dunst & Gorman, 2010), and those using LENA technology (Brushe et al., 2021) reveal a clear relationship between the amount and quality of language that the infant hears, and their subsequent competencies in understanding and forming speech sounds (Weisleder & Fernald, 2013). However, increasing the amount of spontaneous verbal interaction that occurs within parent-infant dyads is challenging.

A promising route for increasing an infant's exposure to language is through infant-directed singing. Language embedded within song, is attentionally engaging, repetitive, rich in emotional content and offers high levels of structural regularity (Falk & Tsang, 2020). This study worked with hard-to-reach parents and aimed to support them to develop their early interaction skills with their infants aged 5-13 months. To do this, we partnered with an organisation that offers evidence-based classes for infants, and tailored classes towards increasing parents' use of singing. We tested infants pre and post intervention to see if singing classes would result in significantly improved language comprehension, relative to a control group who engaged in a similar programme of activities without singing.

At baseline, we found that singing was not a universal behaviour amongst this group, and that classes were a promising way of supporting early interactions between parents and their babies. However, it was a significant challenge to recruit and retain these parents in a longitudinal intervention programme of 20 weeks, and levels of attrition were above one third. This poster will report on the receptive language outcomes of infants measured using the UK Communicative Development Inventory (Alcock, Meints & Rowland, 2020), alongside successful strategies for engaging and supporting families from hard-to-reach settings.

Exploring the link between language and rhythm: a meta-analytic study on children.

Desiré Carioti, Martina Riva, Camilla Figini, Maria Teresa Guasti
Department of Psychology, University of Milano Bicocca, Milan, Italy

Subtheme E – Language and Social Interaction

Based on the recent literature, difficulties in tapping or rhythm discrimination represent a risk factor for language development. Our meta-analysis aimed to investigate which language aspects mostly correlate with rhythmic skills. Based on PRISMA's rules, we included in our meta-analytic study, papers containing bivariate correlations, sample size information, population age, and task type. A first search on PubMed identified 2224 records, but after a careful evaluation of abstracts and data, we found only 12 papers respecting inclusion criteria. Different multilevel meta-analyses were run to investigate the correlations between (1) rhythm and phonological processing, (2) morphosyntactic processing, and (3) Rapid Automatized Naming (RAN). The type of rhythmic task (i.e., motor vs. non-motor) and type of languages (classified based on isochrony and morphosyntactic richness) were included as moderators. Results showed a significant correlation between phonologic processing and rhythm (k= 27, r=0.3, p 0.5) from a unique study were removed, the correlation decreased considerably. No correlations between RAN and rhythm were found (k=14; r = 0.14). Our results empirically revealed that rhythm is related to different linguistic aspects, with stronger, but weak, effects on phonological and morphosyntactic processing. These latter results on morphosyntactic aspects need further investigation. Furthermore, based on our literature search, this topic has been poorly investigated and it was investigated mainly on children, thus, it provides several research questions to further explore.

Third graders' beat perception predicts phonological awareness and word reading scores

Csaba Kertész1, Ferenc Honbolygó1,2; Sándor Imre2,3
1 Institute of Psychology, ELTE Eötvös Loránd University, Budapest, Hungary; 2 Brain Imaging Centre, Research Centre for Natural Sciences, Budapest, Hungary; 3 University of Pécs, Faculty of Music and Visual Arts, Institute of Music, Pécs, Hungary

Subtheme E – Language and Social Interaction

An increasing amount of research substantiates the connection between children's rhythm perception and literacy skills. Beat perception as a unique rhythmic skill has been shown to predict phonological awareness and word reading among different age groups mostly kindergarteners and 1st graders. However, we have less knowledge on whether this relationship continues into the later years of education. The present study tested 45 Hungarian 3rd graders' general cognitive abilities (verbal working memory, non-verbal intelligence), language and literacy skills (word reading, phonological awareness), and beat perception. For the latter, we used the Complex Beat Alignment Test (C-BAT; Trainor & Einarson, 2016) and a short version of the Beat Based Advantage (BBA; Ladányi et al., in progress). Our results show that although there seems to be a ceiling effect for the two rhythmic tests in this age group the two rhythmic tests there is a t significant relationship with word reading fluency and precision, phoneme manipulation and segmentation. Furthermore, the association with the „simple" as opposed to „complex" stimuli in the BBA suggests that the ability to make temporal predictions based on an underlying structure seems an important element of phonological and reading development. Our results support the idea that age-appropriate tests of beat perception could be applied to screen reading difficulties as a diagnostic tool while also informing future interventions designed for poor readers.

Neural tracking of sung and spoken narratives: investigating listening effort and engagement

Anna Czepiel, Christina Vanden Bosch der Nederlanden
Department of Psychology, University of Toronto Mississauga, Mississauga, Canada

Subtheme E – Language and Social Interaction

Our brain regularly processes auditory information like speech and music, in which cortical activity follows, or neurally 'tracks', incoming rhythmic patterns. Some studies have shown that neural tracking increases when speech is more easily comprehended, while other studies show neural tracking increases when speech is less easily comprehended. This discrepancy in results might be due to factors such as listening effort. Compared to speech, information presented in song may require less effort to process, as music tends to be more (rhythmically) predictable and engaging. By utilizing these song characteristics, we will assess how neural tracking is related to comprehension, effort, and engagement. In the current study, participants are presented with stimuli in sung and spoken modalities embedded within varying levels of multi-speaker babble noise to further manipulate listening effort. We use controlled stimuli (short acoustically matched sentences, 4 seconds long) as well as naturalistic stimuli of audiobooks and narrative pop songs (one-minute clips, 15 minutes in total per condition). After each trial, participants report comprehension, listening effort and engagement, while electroencephalography (EEG) is recorded. Neural tracking of incoming auditory information (e.g., acoustic envelope) will be assessed offline with cerebro-acoustic phase coherence and multivariate temporal response function (mTRF) modeling. We predict that listening effort will increase with increasing background noise, though this effect will be attenuated in the sung stimuli. If engagement is a factor, we expect stronger neural tracking in the narratives, compared to the short sentences, though we would investigate the robustness of neural tracking methods depending on trial length. We are currently piloting and preregistering these hypotheses and analysis pipeline. In adopting a holistic approach by using a range of stimuli and pinpointing crucial behavioral outcomes, this research will inform our fundamental understanding of neural tracking.

Synchronization of eye-looking to song in autism linked to individual differences in rhythmic music engagement, parent-child musical interactions

Noah R. Fram1; Warren Jones2; Miriam D. Lense1,3
1 Vanderbilt University Medical Center; 2 Emory University, Marcus Autism Center; 3 Vanderbilt Kennedy Center

Subtheme E – Language and Social Interaction

The rhythm of child-directed singing scaffolds social attention; time-locked to the beats of natural, predictable child-directed song, non-autistic and autistic toddlers increase their looking at singers' eyes. Two recent models describe autism as a disorder of predictive coding. By manipulating the predictability of beat timing during singing, we previously demonstrated that autistic toddlers' eye gaze is closely time-locked to a slow-updating model of predictive coding, whereby stimulus variability is largely coded as noise. Here, we assess links between eye-looking timing and individual differences in rhythmic musical engagement, parent-child musical activity, and social skills. Autistic toddlers (n=58) were eye-tracked while watching videos of actresses singing nursery rhymes that were temporally jittered to reduce their beat-based predictability. We assessed temporal alignment of eye-looking by fitting a sinusoidal curve to each participants' frequency of eye-looking on and around either the observed (actual) jittered beats or predictions of when those beats would occur based on models of predictive coding. Childrens' increased rhythmic musical engagement predicted more accurate temporal alignment of eye-looking to the slow-updating model (β=-0.15,p<.05), while more parent-child music-making predicted more accurate alignment of eye-looking to the observed (actual) jittered beat times (β=-0.18,p<.01). Negative coefficients in this model indicate lower phase asynchrony and greater temporal alignment. These results indicate separation of timing skills in autism into two components: pattern-based temporal prediction, associated with broader rhythm skills, and flexible responsiveness to unpredictable stimuli, associated with musical interaction. Such separation points to potential complementary mechanisms underlying (social) musical engagement and aligns with the complex pattern of indirect relationships linking rhythm skills, social skills, and communication skills in autism (Fram et al., 2024). Future work will develop approaches to directly model the role of stimulus phase in modulating eye-looking to advance our understanding of individual differences in the role of rhythm in social development in autism.

Rhythms of Cognition: Exploring the Links between Statistical Learning and Rhythmic Abilities

Claudia Iorio1, Mohammadreza Edalati2, Laurel Trainor3, Anna Fiveash4, Anne Caclin5, Simone Dalla Bella6,7,8, Sahar Moghimi2, and Barbara Tillmann1;
1LEAD - CNRS UMR 5022, Université de Bourgogne, Dijon, France; 2GRAMFC (Inserm U1105), Centre Universitaire de Recherche en Santé, Université de Picardie Jules Verne, Amiens, France; 3LIVELab, McMaster University, Hamilton, Canada; 4MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Sydney, Australia; 5Université Claude Bernard Lyon 1, CNRS, INSERM, Centre de Recherche en Neurosciences de Lyon CRNL, UMR5292, U1028, F-69500, Bron, France; 6 International Laboratory for Brain, Music, and Sound Research (BRAMS), Montreal, Canada; 7 Department of Psychology, University of Montreal, Montreal, Canada; 8 Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada

Subtheme E – Language and Social Interaction

Statistical learning (SL) is a fundamental cognitive process, allowing individuals to extract patterns and probabilistic relationships in their environment. While it spans various domains, such as language and music learning, its relationship with sequencing abilities needs further investigation. Sequencing abilities, which encompass the capacity to perceive, represent, predict, or execute a set of events or actions that follow a particular contextual structure, are fundamental in various aspects of human cognition. One example is rhythm processing of both music and speech materials. Interestingly, recent findings have suggested connections between impaired rhythm processing and impaired serial order memory in children with developmental language disorders. We explore, in adults, the connection between SL, rhythmic abilities and serial order short-term memory using a comprehensive approach, including EEG recordings, behavioral tasks and questionnaire-based evaluations. Our ongoing study employs a traditional SL approach involving exposure to an artificial language presented as a speech stream, where participants are expected to implicitly extract artificial "words" from the sequence. Participants are then exposed to these learned words and non-words in a testing phase. EEG recordings will provide insights into the neural processes underlying SL, including the perception of syllables and the emergence of word chunks. In addition, participants' rhythmic abilities (e.g., rhythm production and perception), serial order short-term memory and musical experience background are assessed behaviorally and with questionnaires, respectively, and potential relations with SL performance explored. By examining the interplay between cognitive sequencing capacities, (i.e., rhythmic processing, serial order processing) and SL, we aim to explore potential correlations between them, anticipating superior SL task performance to align with enhanced rhythmic abilities and better performance in serial order short-term memory tasks. This will lead to offer new perspectives and avenues for defining interventions aimed at rehabilitation in developmental language disorders.

Methods used by singers of Western classical style to enhance the intelligibility of sung text

Veeda Kala; Marju Raju
Estonian Academy of Music and Theatre, Tallin, Estonia

Subtheme E – Language and Social Interaction

Western classical singing is a longstanding cultural tradition that combines both melody and text to convey meaning. However, it can often be challenging for listeners to comprehend the lyrics, for example at an opera performance. There are numerous publications on Western classical singing and its technique, but comparatively little is known about how singers and singing teachers work with text in practice. In this grounded theory research, an attempt is made to find out when and how classical singers work with text and by whom and what are they influenced thereby. Semi-structured personal interviews were conducted with Western style classical singers (N=30) working in Europe (n=25) and North America (n=5) including several voice types. The findings show that there is a list of different approaches among the singers regarding working with the text and improving the text intelligibility. The findings also illuminate many challenges singers face in their work with text/libretto, for example working with many different languages as well as the dialects within those languages. The outcome of this research provides insights into the intelligibility of sung text in Western style classical singing from practical perspective and therefore, it can serve as a valuable contribution to the research in this field.

Participation in music playschool is associated in 4-year-old children's verbal working memory

Tanja Linnavalli (1,2,3), Alicia Lucendo Noriega (1,4), & Jaakko Kauramäki (1,3,5)
1) Centre of Excellence in Music, Mind, Body and Brain, Universities of Helsinki and University of Jyväskylä, Finland, 2) Department of Education, Faculty of Educational Sciences, University of Helsinki, Helsinki, Finland, 3) Cognitive Brain Research Unit, University of Helsinki, Helsinki, Finland, 4) Department of Music, Art and Culture Studies, Faculty of Humanities and Social Sciences, University of Jyväskylä, Jyväskylä, Finland, 5) Department of Psychology and Logopedics, Faculty of Medicine, University of Helsinki, Helsinki, Finland

Subtheme E – Language and Social Interaction

Introduction. The main aim of MUSPRO – music, sports, and prosocial behavior project is to investigate if participation in regular music activities promotes children's social-emotional development and executive functions. Four-year-old children (N = 115) are block-randomized in music, sports, and control groups, and followed for two academic years. The activities are provided in children's kindergartens. Here we present some cross-sectional results based on the first data collection. Methods. We measured children's verbal fluency, verbal working memory, perceptual IQ, and music perception skills. Parents reported children's prior attendance in music playschool, their own music background, and the amount of music activities at home. According to parental reports, 32 Finnish-speaking children had attended music playschool for 2 37 months by the time the baseline measures were conducted. Results. Previous attendance in music playschool was associated with better verbal working memory, but not with verbal fluency or perceptual IQ. Neither the prior participation in music playschool, the amount of music activities at home, or parents' music background was linked with children's music perception skills. Conclusions. Whereas word fluency seems to be mainly connected with parental education level, the development of verbal WM might be supported by participation in the professionally supervised music playschool. The lack of association between children's music perception skills and prior engagement with music may be due to the children's age and developmental phase, or the difficulty of measuring these skills in 4-year-old children.

Singing-induced functional neuroplasticity in chronic post-stroke aphasia: a cross-over randomized controlled trial

Noelia Martínez-Molina[1,2,3*], Anni Pitkäniemi[1,2], Sini-Tuuli Siponkoski[1,2], Nella Moisseinen[1,2], Linda Kuusela[4,5], Sari Laitinen[6], Essi-Reetta Särkämö[7], Johanna Pekkola[5], Susanna Melkas[8], Gottfried Schlaug[9], Boris Kleber[10], Aleksi J. Sihvonen[1,2,8,11], Teppo Särkämö[1,2];
[1]Cognitive Brain Research Unit, Department of Psychology and Logopedics, University of Helsinki, Helsinki, Finland; [2]Centre of Excellence in Music, Mind, Body and Brain, University of Helsinki, Helsinki, Finland; [3]Computational Neuroscience Group, Centre for Brain and Cognition, Department of Information and Communication Technologies, Universitat Pompeu Fabra, Barcelona, Catalonia, Spain; [4]Department of Physics, University of Helsinki, Helsinki, Finland; [5]HUS Medical Imaging Center, Department of Radiology, Helsinki Central University Hospital and University of Helsinki, Helsinki, Finland; [6]Espoo Hospital, Espoo, Finland; [7]Private choir conductor, Vantaa, Finland; [8]Department of Neurology, University of Helsinki and Helsinki University Hospital, Helsinki, Finland; [9]Department of Neurology, UMass Medical School—Baystate and Institute of Applied Life Sciences, UMass Amherst, Amherst, MA, USA; [10]Center for Music in the Brain, Department of Clinical Medicine, Aarhus University and The Royal Academy of Music, Aarhus/Aalborg, Denmark; [11]School of Health and Rehabilitation Sciences, Queensland Aphasia Research Centre and UQ Centre for Clinical Research, The University of Queensland, Brisbane, Australia *contacting author

Subtheme E – Language and Social Interaction

The classical neurological observation that people with severe post-stroke aphasia (PSA) can produce words through singing has inspired the development of singing-based interventions. However, the functional brain reorganization patterns induced by such interventions remain poorly understood. In the present study, nineteen patients with PSA received a 4-month multicomponent singing intervention (singing group) or standard care (control group). We analysed the verbal learning and task-based fMRI activation of two novel songs (trained vs.

untrained during the intervention) at three time points (baseline, 5-month, 9-month). After the intervention, patients with PSA were able to produce more correct syllables and words from the trained compared to the untrained song. fMRI results revealed increased activation to singing along to both songs in a cluster encompassing the right anterior insular cortex (AIC) and superior temporal gyrus (STG). Additionally, we found increased activation in the right posterior superior temporal gyrus (pSTG) to singing along to the trained vs. untrained song. Activation increase in the right AIC-STG cluster correlated with improvement in the verbal learning of the trained song and with responsive speech and communication skills. Right pSTG activation increase correlated with improved communication skills. Collectively, these findings indicate that group-based singing induces functional neuroplasticity changes in the singing network associated with verbal learning and better speech production in chronic aphasia.

Natural Musicality Explains Unique Variance in Children's Reading Fluency

Marta Martins
Instituto Universitário de Lisboa (Iscte-IUL), CIS-Iscte, Lisboa, Portugal

Subtheme E – Language and Social Interaction

It is widely assumed that musical abilities and reading are linked. Most studies focused on the effects of deliberate musical practice in lower-level reading processes, such as phonological awareness and single-word reading, and restricted musical abilities to musical perceptual skills. On natural musicality — musical abilities and behaviors that may result from genetic predisposition and/or informal experience — and on more ecologically valid reading measures, such as reading fluency, there is limited evidence. Here, we asked whether natural musicality, as measured by task-based performance and teachers' reports, explains unique variance in reading fluency of early readers after accounting for demographic, socioeconomic, and cognitive contributions. One hundred and twenty-one elementary school children (64 girls; M age = 8.53, SD = 1.12) participated in this study. Children were musical naïve (i.e., they had no prior musical training) and performed tasks on musical auditory perception, reading fluency and general cognition; teachers reported on children's musicality and parents on their sociodemographic characteristics. A hierarchical linear regression showed that musicality, as measured by task-based performance and teachers' reports, predicted unique variance in reading fluency after accounting for age, sex, parental education, family's income and general cognition. When the teachers' report of children's musicality was considered separately in the model, it explained additional variance to that accounted for task-based performance. These findings support a fundamental link between natural musicality (musical abilities and behaviors) and reading, and this should be considered in studies inspecting musical training benefits on reading. They also suggest that musicality cannot be narrow to musical auditory perception, and, thus, future studies on music and related effects should adopt a more comprehensive approach to assess musical ability and behaviors.

Inducing Self-Related Emotion Evaluation by Modulation the Speaking voice (SEEMS)

Paul Maublanc, Pelle De Deckere, Boris A. Kleber
Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Aarhus C, Denmark

Subtheme E – Language and Social Interaction

Recent studies leveraging real-time acoustic feedback manipulation have provided behavioral evidence to suggest that hearing the emotional tone in one's own voice while speaking can impact the speaker's emotional state. This effect is, however, dependent on the individual's lack of awareness of the manipulation, hinting at the involvement of self-related cognitive processes. To investigate the neural mechanisms underlying this acoustic self-perception phenomenon, we collected fMRI data while participants read text segments depicting everyday situations, designed to be emotionally neutral but varying in arousal. Participants' speaking voices were captured using an active noise-cancelling microphone and played back through headphones via voice manipulation software (DAVID). This acoustic feedback was subject to three conditions without the participants' knowledge: (i) unaltered, or DAVID adjusted the pitch and higher frequencies to simulate acoustic characteristics associated with (ii) happiness or

(iii) sadness. After reading each passage, participants rated their emotional state using a valence-arousal scale. This was done to assess if vocal feedback tilted their emotional response towards the intended manipulation (i.e., responders). At the study's conclusion, an interview aimed to identify explicit detectors—individuals who were consciously aware of the acoustic manipulation. Implicit detectors were recognized by their compensatory pitch responses without conscious acknowledgment of the acoustic change. Both responders and non-responsive detectors were identified in our study. Responders exhibited emotional transfer effects across different manipulation conditions. Preliminary fMRI analyses hint at the involvement of brain regions associated with self-processing, acoustic perception, and emotion, potentially mediating the observed emotional feedback effect. The final MRI analysis will use more refined methods, considering the sequential effects of both the conditions and the scenarios, as well as the classification of participants into responders and detectors. Our conclusions will offer suggestions for optimized design and improved strategies for the presentation of acoustic feedback manipulations and simultaneous scanner noise cancellation.

Exploitation vs. exploration in partner dancing: whether switching partners enhances communication in partner dancing

Martin Miguel; Jonathan Cannon; Laurel Trainor
McMaster University, Hamilton, Ontario, Canada

Subtheme E – Language and Social Interaction

Dancing is a cultural universal. In particular, improvised partner dancing affords meaningful connections with other people and has been shown to provide enhanced physical fitness and coordination, memory and self-confidence. Improvised partner dance requires nonverbal communication about dance intentions. This skill is often learned by trial and error, where the implicit haptic and visual cues that allow coordinating movement are acquired. To achieve this, two strategies could be employed: repeatedly dancing with the same partner or training with multiple partners. The first strategy allows working on repeated communication errors, while the second allows exploring diverse ways in which communication can occur and therefore develop more generalizable techniques. In our ongoing study, we are comparing how these strategies help non-dancers learn to follow nonverbal dance instructions. We are recruiting groups of non-dancers that are paired with experienced confederate dance partners. In each trial, couples will perform a step sequence involving weight changes, walking forward and walking backwards. Only confederates are provided with the step sequence, forcing the participants to follow their partner's dance instructions. They are required to do so as synchronously as possible. We will measure synchrony of movement of each couple using motion capture. Learning strategies will be compared in a between-subjects design. Each experiment will consist of a training and testing phase. In both phases, participants will perform the same movement synchronization task. During training, participants in the single-partner strategy will always dance with the same confederate, while those in the multi-partner condition will be switching between different confederates. During testing, participants will dance with their initially assigned confederate as well as with two new partners. We will compare improvement in synchronization from the first and last dances in each group and test the effect in generalizability by comparing synchronization with familiar versus new partners.

Vowel Perception in Congenital Amusia

Jasmin Pfeifer1, Silke Hamann2
1 Institute for Linguistics, Heinrich-Heine-University, Düsseldorf, Germany;
2 Amsterdam Center for Language and Communication, University of Amsterdam, Amsterdam, The Netherlands

Subtheme E – Language and Social Interaction

Congenital amusia is a disorder that negatively influences pitch and rhythm perception and it is not caused by a hearing deficiency or brain damage. While congenital amusia had long been reported to affect only the musical domain several studies have shown that amusics also have impaired perception of intonation and linguistic tones. In the present study we tested whether congenital amusia also has an influence on linguistically relevant cues other than pitch by investigating the discrimination of German front high vowels We assessed amusics' electrophysiological responses, more specifically the MMN. We tested 11 congenital amusics diagnosed with the MBEA and 11 matched controls. All participants were right handed, had normal hearing and had German as native language. Our stimuli were isolated synthetic vowels varying in either durational or spectral properties. We decided to use mid vowels to avoid periphery effects and to utilize vowels that are close to each other in their height and front-back dimension in the vowel space, but that differ in quality and/or quantity. We assessed amusics' MMN with a multi-deviant oddball paradigm. We used a linear mixed model for the MMN data. We found significant main effects for group: Amusics had a smaller MMN than controls. In addition we found a main effect for cue and a significant interaction between group and cue: Durational differences were harder to detect, especially for amusics. Our study shows that congenital amusia does not only affect the perception of pitch in music and language but also the perception of vowel contrasts, therefore having more far-reaching consequences for speech perception than previously assumed. We showed differences in the MMN, reflecting differences in early auditory change detection.

Neural circuits underlying the preservation of singing production in aphasia

Pitkäniemi, A. (1), Särkämö, T. (1), Siponkoski, S.-T. (1), Brownsett, S. (2), Copland, D. (2), Sairanen, V. (3), Martinez Molina, N. (1,4), Toiviainen, P. (5), Sihvonen, A.J. (1, 2, 6)
1) Cognitive Brain Research Unit, Department of Psychology and Logopedics & Centre of Excellence in Music, Mind, Body and Brain, University of Helsinki, Helsinki, Finland; 2) Queensland Aphasia Research Centre, School of Health and Rehabilitation Sciences, The University of Queensland, Brisbane, Australia; 3) BABA Center, Pediatric Research Center, Department of Clinical Neurophysiology, Children's Hospital, Helsinki University Hospital & University of Helsinki, Helsinki, Finland; 4) Department of Information and Communication Technologies, Universitat Pompeu Fabra, Barcelona, Spain; 5) Department of Music, Art and Culture Studies & Centre of Excellence in Music, Mind, Body and Brain, University of Jyväskylä, Jyväskylä, Finland; 6) Department of Neurology, Neurocenter, Helsinki University Central Hospital, Helsinki, Finland

Subtheme E – Language and Social Interaction

Introduction: The ability to sing the lyrics, melody and rhythm of a familiar song can be preserved in even in severe aphasia. This dissociation has been accounted for by a divergent lateralisation of speech and singing in the brain, also giving an impetus for singing-based rehabilitation methods for aphasia. Nevertheless, the exploration of the underlying structural networks has remained scarce. Here, we used correlational tractography to explore the structural circuits underpinning connected spoken language production and sung production of lyrics, pitch, melodic contour, and rhythm of an over-learnt song in aphasia. Methods: A cross-sectional study with 45 patients with chronic nonfluent post-stroke aphasia was carried out. Multi-shell diffusion-weighted MRI and neuropsychological assessments were obtained to assess structural connectomes [using quantitative anisotropy (QA) based connectometry] associated with performance in language (production of connected speech) and singing (spontaneous singing of Finnish version of Frere Jacques/ Brother John) tasks. Results: Both spoken language production and singing the lyrics of an over-learnt song were mainly supported by the left hemisphere language network and projection pathways. However, while spoken language production mostly engaged dorsal and ventral streams of speech processing, singing the lyrics was associated primarily with the left ventral stream. For all musical parameters (pitch, melodic contour and rhythm), we found a more bilateral network that was, with varying emphases, composed of left-hemisphere dual stream network involved in auditory-motor integration of speech, but also multiple other associative and projection pathways, also in the right hemisphere. Conclusion: Word production through speech and singing appear to share core neuronal circuitry within the left hemisphere, while distinct ventral stream contributions explain frequently observed dissociations in aphasia. The sung production of pitch, melodic contour and rhythm, in turn, seem to rely on a more widespread neural architecture, but also encompass the network involved in auditory-motor integration of speech.

Right-hemispheric structural adaptation in chronic post-stroke aphasia enhanced with melodic intonation therapy

Gottfried Schlaug (1,2), Sebastien Paquette (3), Andrea Norton (1)
1. Music, Neuroimaging, and Stroke Recovery Laboratories, Dept. of Neurosciences, University of Massachusetts Chan Medical School - Baystate, Springfield, MA, USA; 2. Institute of Applied Life Sciences and Department of Biomedical Engineering, UMass Amherst, Amherst, MA; USA; 3. Dept. of Psychology, Trent University - Peterborough, Ontario, Canada

Subtheme E – Language and Social Interaction

Using voxel-based morphometry of participants with chronic aphasia, we first tested the hypothesis that grey matter density in contralesional homotop vocal-motor regions would be associated with naming ability and speech fluency in a cross-sectional analysis. We then examined causality of these differences by testing for changes within these identified regions over time in a subset of participants who had undergone an intensive experimental therapy consisting of either Melodic Intonation Therapy (MIT) or a matched non -intonation Speech-Repetition Therapy (SRT). Forty-nine patients with moderate to large left-hemisphere lesions (mean lesion vol: 127.3 cc; SD:78.4) and chronic nonfluent aphasia (mean time after stroke at least 6 months) underwent a battery of speech-motor and language assessments and MR imaging during baseline evaluation to be evaluated for a trial testing the effects of an experimental therapy. Our voxel-based morphometry analyses (as implemented in CAT12) focused on the unaffected right hemisphere to determine whether variations in local grey matter density explained variance in speech/language measures. A subset (n=29) of these subjects also underwent intense, longer-term experimental therapies (i.e., Melodic Intonation Therapy or Speech Repetition Therapy), and we used MR images obtained before (baseline) and after therapy (75 sessions of at least 90 minutes each) to assess causality of any of the grey matter variations seen in the cross-sectional analysis. When controlling for lesion severity, cross-sectional analyses revealed that performance on the Boston Naming Test (BNT30) correlated with grey matter density in several right-hemisphere regions, homotopic to left-hemisphere speech-motor/language regions. Longitudinal analyses revealed that only one of those regions within the right inferior frontal gyrus, that which corresponds to Brodmann area 47, was associated with both grey matter density and behavioral changes in response to therapy, indicating that intensive experimental therapy facilitated recovery from post-stroke aphasia might be associated with structural changes in the right-hemisphere.

Experiences of Joint Individual Therapies of a Music Therapist and a Language and Speech Therapist in the Rehabilitation of Children on the Autism Spectrum (ASD)

Anne Takamäki
Avainmusiikki Tmi in Hämeenlinna, Finland;
University of Jyväskylä, Finland;
Finnish Society for Music Therapy.

Subtheme E – Language and Social Interaction

The poster presentation will discuss experiences of joint individual therapies of a music therapist and a language and speech therapist in the rehabilitation of children on the autism spectrum (ASD), from the professional music therapist´s point of view. In Finland, the rehabilitation of ASD children is happening in their everyday life, it is intense and pervasive and planned individually according to each client´s needs. It is mostly covered by Social Insurance Institution of Finland (SIIF) as Intensive Medical Rehabilitation. The Finnish (SIIF) model for joint therapies is the client having two individual therapies of which a maximum of 18 sessions can be used as joint therapy sessions (upon referral) and there are some other possibilities for collaboration, too. Pivotal rehabilitation goals with ASD children include strengthening of interaction and social skills, supporting communication and developing skills for playing and imitation. Independent initiative skills, structuring and anticipation methods for everyday life are also important.

Pictures, tablets and other AAC methods are used in guidance situations and for supporting communication. There are quite many common goals in speech and language therapy and music therapy for ASD children. Collaboration of the two therapies can be very beneficial in f.e. enhancing the client´s motivation, motor and language functions through music and staying in joint attention and it allows the versatile use and combinations of different methods from both therapies. The presentation includes experiences of using these methods with several clients, some background information and some improvisation and exercises that have evolved from joint working.

Some GAS goal examples and some discussion from the joint therapy working are also provided.

Causal relationship of theta oscillatory frontotemporal mechanism in the interplay between music complexity and reward

Alberto Ara1; Albert León-Alsina1; Gemma Fàbrega-Camps2,3; Óscar Bedford1; Josep Marco-Pallarés2,3; Robert Zatorre1
1 Montreal Neurological Institute, McGill University, International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal, Canada; 2 Department of Cognition, Development and Educational Psychology, Institute of Neurosciences, University of Barcelona, Spain; 3 Cognition and Brain Plasticity Unit, Bellvitge Biomedical Research Institute (IDIBELL), Spain;

Subtheme F - Emotion and Well -being

The enjoyment of music involves a complex interplay between brain perceptual areas and the reward network. While previous studies have shown that music liking is related to an enhancement of the synchronization between right temporal and frontal brain regions via theta oscillatory activity, the underlying mechanisms of this interaction remain elusive. Specifically, a causal relationship between theta oscillatory activity and musical pleasure has not been firmly established. In the present study we address this question by using transcranial alternating current stimulation (tACS). 24 healthy participants underwent three different sessions. In one session participants received 10 minutes of theta (6 Hz) current stimulation (1mA) at the right auditory cortex (T8 position). As a control condition, in another session they received stimulation at the beta band (25 Hz) with the same parameters. Finally, in another session participants received sham stimulation (only 30 seconds at 6 Hz). After the stimulation in each session, we recorded participants' brain activity using electroencephalography (EEG) while they listened to 18 monophonic musical pieces (Gold et al., 2019) that varied in their information content and familiarity. Our results revealed that only in the theta session, participants gave higher reward ratings for unfamiliar pieces with low complexity compared to the sham session. In addition, we found increased theta connectivity between the right temporal and frontal electrodes for these stimuli when they were most liked in the theta session, but not in the sham or beta session. These findings suggest a causal relationship between theta oscillatory mechanisms that synchronize the right temporal and frontal areas and modulate reward value. These mechanisms play a crucial role in different cognitive processes supported by fronto-temporal loops such as auditory working memory and prediction error generation, which are fundamental to musical reward processing.

The major-minor mode dichotomy in music perception

Giulio Carraturo1,2†, Victor Pando-Naude2†, Marco Costa3, Peter Vuust2, Leonardo Bonetti2,3,4,5, Elvira Brattico1,2*
1 Department of Education, Psychology, Communication, University of Bari, Italy; 2 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University and The Royal Academy of Music, Aarhus/Aalborg, Aarhus, Denmark, 3 Department of Psychology, University of Bologna, Italy, 4 Center for Eudaimonia and Human Flourishing, Linacre College, University of Oxford, UK , 5 Department of Psychiatry, University of Oxford, Oxford, UK

Subtheme F - Emotion and Well -being

Since ancient Greece, major and minor modes in Western tonal music have been identified as the primary responsible musical feature for eliciting emotional states. As such, the underlying correlates of the major-minor mode dichotomy in music perception have been extensively investigated through decades of psychological and neuroscientific research, providing plentiful yet often discordant results. Specifically, crucial questions remain about the several factors contributing to the affective perception of major and minor modes, at times very different among individuals. Moreover, major and minor mode perception has never been quantitatively compared in literature. This comprehensive systematic review and meta-analysis aimed to provide a qualitative and quantitative synthesis of major-minor mode perception and its behavioural and neural correlates. The qualitative synthesis resulted in 69 studies, showing great diversity in how the major-minor dichotomy has been empirically approached. Most studies reviewed were conducted on adults, considered participants' expertise, employed real-life musical stimuli, performed behavioural evaluations, and were carried out among Western listeners. Behavioural, electroencephalography, and neuroimaging meta-analyses (36 studies) consistently showed that major and minor modes elicit distinct neural and emotional responses. Based on our findings, we propose the Major-Minor Mode(l) of music perception and its behavioural and physiological correlates, incorporating individual factors such as age, expertise, cultural background, and emotional disorders. This work further delves into the cultural implications of the major-minor dichotomy in music, examining its origins and universality across different world cultures. By unravelling the roles of individual differences and acoustic characteristics, we contribute to a general understanding of the development of musical dichotomies in the world societies. Limitations, implications, and suggestions for future research are discussed, including putative clinical applications of major-minor dichotomy and best practices regarding stimulation paradigms for musical mode investigation.

Stress, Resilience and Dystonia - exploring psychological and neuroendocrinological risk factors of movement disorders in musicians

Julian Burek1; Stine Alpheis1, 2, 3; Christopher Sinke1; Florian Worschech1; Eckart Altenmüller1
1 Hannover Medical School, Hannover, Germany; Institute of Music Physiology and Musicians' Medicine, Hannover University of Music, Drama and Media, Germany; 2 Department of Musicians' Health, University of Music Lübeck, Germany; 3 Institute of Medical Psychology, CBBM, University of Lübeck, Germany

Subtheme F - Emotion and Well -being

Objective: Musician´s dystonia (MD) is a task-specific movement disorder which is considered to be of multifactorial origin. While its pathophysiology is still unclear, recent work investigates the impact of stress as a risk factor of developing focal dystonia. Adverse childhood experiences (ACE) are known to influence the hypothalamus-pituitary-adrenal axis, which plays a major role in the physiological stress response. This study investigates whether MD patients have experienced more ACE and therefore show increased stress reactivity and

whether resilience can be a possible protective factor from stress related movement disorders. Methods: Forty participants who suffer from musician's dystonia were compared to 39 matched healthy musicians. While undergoing functional magnetic resonance imaging, the "Montreal Imaging Stress Task" was administered. At six different time points, saliva samples were taken to measure the cortisol release of the participants. These cortisol measurements were analyzed by calculating the area under the curve . Furthermore, the participants completed two psychological assessments, the "Childhood Trauma Questionnaire" and the "Connor -Davidson Resilience Scale". Results: Musicians dystonia patients reported significantly higher childhood trauma scores than healthy controls. Regarding resilience MD patients did not differ significantly from healthy participants. However, the MD patients showed trends towards lower scores on the dimensions "emotion-regulation" and "adaption/flexibility" of the resilience questionnaire. The area under the curve analysis showed that male MD partients had an increased cortisol release during the stress task in comparison to healthy male musicians. Resilience and childhood trauma scores did not influence the participants' cortisol levels.
Conclusion: Our study showed that the higher ACE rates of MD patients were not associated with increased cortisol release under stress and that the two groups did not differ in their resilience. However, differences in cortisol release were observed between male MD patients and male healthy musicians, while there were no differences between the female participants.

The role of age, gender, and musicianship in individual musical reward sensitivity among the Italian population

Giulio Carraturo[1,2], Laura Ferreri[3], Gemma Cardona[4], Urbano Lorenzo-Seva[5], Antoni Rodriguez-Fornells[4], & Elvira Brattico[1,2]
[1]Department of Education, Psychology, Communication, University of Bari Aldo Moro, Italy; [2]Center for Music in the Brain, Department of Clinical Medicine, Aarhus University and The Royal Academy of Music, Aarhus/Aalborg, Aarhus, Denmark; [3]Department of Brain & Behavioral Science, University of Pavia, Italy; [4]Department of Cognition, Development and Educational Psychology, Institute of Neurosciences, University of Barcelona, Barcelona, Spain; [5]Faculty of Sciences of Education and Psychology, University Rovira i Virgili, Tarragona, Spain

Subtheme F - Emotion and Well -being

Music is a primary source of pleasure for humans. Nevertheless, there is large interindividual variability in how individuals experience and derive pleasure from music and music-related activities. With this study, we aim to investigate sensitivity to musical reward as a function of age, gender, and musicianship across Italian population after validating the Italian version of the extended Barcelona Music Reward Questionnaire (eBMRQ), the most in-depth and comprehensive tool for investigating the diverse characterization of individual sensitivity to musical pleasure. For the validation process, we first conducted forward and backward translation from the original English version. The new Italian version was administered to 1012 participants fluent in Italian from the North and the South of Italy through online surveys (age range 18-86 years old; M = 34.9, SD = 16.9, females 74%). Unrestricted Confirmatory Analysis was computed for both six-factor and single-factor models. The effect of gender, age, and musicianship on eBMRQ scores was analyzed through Analysis of variance (ANOVA). The quality assessment of the factor solution indicated that both the six dimensions and the overall dimension of the Italian eBMRQ exhibited acceptable quality and reliability. All factors were significantly correlated with each other, in line with previous adaptations of the BMRQ. Our sample shows that females reported higher music reward sensitivity compared to males, except for Social Reward subscale. Reward sensitivity was significantly higher among musicians and amateurs compared to non-musicians, although this pattern did not emerge for Sensory-motor and Mood Regulation subscales. Also, overall musical reward sensitivity decreased with age. These results suggest the feasibility of applying the Italian version of eBMRQ as a reliable tool in the field of affective and clinical music-related research. Furthermore, the significant associations reported between eBMRQ scores, gender, age, and musicianship contribute to emphasizing the impact of individual factors on music reward sensitivity.

Sounds for Sleep: Unveiling Individual Preferences for Personalized Sonic Interaction Design for Healthy Sleep

Abhishek Choubey, Sandra Pauletto
KTH Royal Institute of Technology, Stockholm, Sweden

Subtheme F - Emotion and Well -being

Quality sleep is essential for human health, yet sleep disorders are on the rise (McArdle et al 2020). For example, among young adults in Australia, 41% of females and 42.3% of males reported at least one sleep disorder (McArdle et al 2020). Digital healthcare and smart devices can be critical in exploring solutions to alleviate sleep problems. In this context, music and sound-based therapy are employed widely. While there is evidence supporting the use of music to promote good sleep (Jespersen et al. 2015), research on other types of sounds is limited. Moreover, studies on the design of related therapeutic approaches and devices are minimal. To bridge this gap, our research encompasses a planned study aimed at understanding individuals' preferences for various sounds conducive to healthy sleep. We will conduct a survey that presents participants with diverse audio stimuli, including environmental, everyday, abstract, and musical sounds, among others. Participants will rate these stimuli in terms of their preferences when aiming to fall asleep. Additionally, demographic information, sleep context, musical background, and vigilance levels will be collected to provide a comprehensive understanding of the factors influencing sound preferences in the context of sleep. The overarching project aims to identify sleep-promoting sounds and their acoustic features, leading to the development of a personalized framework for sleep-related sonic interaction design by integrating neurophysiological data. It involves the augmentation of preferred existing sounds found through the study, introducing new sounds, and consideration of suitable sound reproduction devices. Integrating therapeutics and digital technologies, the project seeks to provide tailored and optimal auditory experiences to induce and enhance sleep and deepen our understanding of sound's role in facilitating healthy sleep patterns. This research contributes to the field of digital healthcare, prioritizing holistic well-being. The project is part of the EU MSCA Doctoral Network "Lullabyte".

Altered autonomic balance by Iso principle in heart-broken people: an fMRI study

Ling-Yao Chien, 1, Wen-Jui Kuo, 1,2,3,
1. Institute of Neuroscience, National Yang Ming Chiao Tung University, Taipei, Taiwan; 2. Brain Research Center, National Yang Ming Chiao Tung University, Taipei, Taiwan; 3. Research Center for Brain, Mind, and Learning, National Chengchi University, Taipei, Taiwan

Subtheme F - Emotion and Well -being

Listening music can be an effective way to regulate our imbalanced body state. Investigating the Iso principle used by music therapist shed light on how it works. The concept is that music therapists provide music that matches their client's mood at first, and then gradually change the music to help the client shift to the desired mood. Despite that the Iso principle is commonly known and widely used in music therapy and other creative therapies, there has been little experimental study done on it. To investigate the neural relevance of mood changes induced by music, we organized pieces of music into two contexts. For the congruent condition, based on the Iso principle, there were five pieces of three-minute songs gradually moving from mood-congruent to calm to mood-incongruent. For another condition, the five songs were from mood-incongruent to calm and back to mood-incongruent. The participants were females who had recently gone through an unwanted romantic break-up. To evoke feelings of hurt and sadness, participants were shown a photo of their ex-partner for 10 minutes before and after the music sessions of the two conditions. Based on electrocardiogram (ECG) signals, we observed higher heart rate variability (HRV) in the congruent condition. Moreover, music series in congruent condition led to a slightly higher centrality in medial frontal cortex, middle and superior temporal gyrus, and caudate, and to greater functional connectivities between these brain regions. Conversely, functional connectivity (rsFC) between the right anterior insula (rAIC) and anterior cingulate cortex (ACC) decreased after listening to music in the congruent condition. Overall, our findings demonstrate that mood-congruent music in the beginning results in higher functional connectivities between musical reward regions. It may gradually promote a better sympathovagal balance and potentially modulate on salience detection.

Shared musical pleasure modulates prefrontal activity and enhances inter-neural synchrony: an fNIRS hyperscanning study

Federico Curzel1,2, Arnaud Fournel1, Giacomo Novembre4, Barbara Tillmann2,3, Laura Ferreri1,5,
1Laboratoire d'Étude des Mécanismes Cognitifs (EMC), Université Lumière Lyon; 2, Lyon, France, 2Lyon Neuroscience Research Center (CRNL), INSERM, U1028, CNRS, UMR 5292, Université Claude Bernard Lyon1, Université de Lyon, Lyon, France; 3LEAD CNRS UMR5022, Université de Bourgogne-Franche Comté, Dijon, France; 4Neuroscience of Perception and Action, Italian Institute of Technology, Rome, Italy; 5Department of Brain and Behavioural Sciences, Università di Pavia, Pavia, Italy

Subtheme F - Emotion and Well -being

Throughout our lives, music stands as one of the most enjoyable stimuli, often shared with others in social contexts. Both music and social interactions can activate the mesolimbic dopaminergic system, and listening to music with a friend has been shown to increase the perceived emotional intensity. However, the underlying neural mechanisms of socially shared pleasure remain unexplored. In this fNIRS hyperscanning study, we aimed at characterizing the functional activation of the prefrontal cortex (PFC) and the inter-neural synchrony (INS) related to shared musical pleasure. To this aim, 35 pairs of friends (N=70, mean age = 21.9 3 4.5, non-musicians) listened to their favourite and experimenter-selected music under two experimental conditions: alone in separate rooms (solo), and together (duo). During music listening, participants continuously reported the pleasure felt. The correlations between these continuous pleasure ratings were computed as a measure of interpersonal coherence within the pair. Participants' PFC activity was measured through two 22-channel fNIRS wireless systems. Functional analyses on individual brains showed a pleasure-driven modulation of the PFC: the higher the pleasure reported by participants, the higher the PFC activity ($p < .001$), in particular in the duo condition ($p = .024$). Wavelet Transform Coherence assessing the INS within the pairs revealed higher brain synchrony when participants listened to music together compared to the solo condition ($p < .001$). Most importantly, higher values of interpersonal coherence predicted the INS in the duo condition: the higher the similarity of pleasure responses within the pair, the higher the INS ($p = .014$). In sum, our study reveals for the first time the neural dynamics underlying shared musical pleasure among friends, underlying the profound link between social sharing and music reward.

Hydrokinesiosingingtherapy: two forms of rehabilitation in symbiosis with the benefits of singing and movement in water

Mirella De Fonzo 1, Veronica Sodini 2, Aurora Donzelli 3, Claudia Pastorino 4, Maria D'Oria 5

1 Centro Studi Neurocanto, Brugherio, Italy; 2 Idrokinesiterapeuta, Genova, Italy; 3 SIPPed (Società Italiana Psicologia Pediatrica), Siracusa, Italy; 4 SIC (Scuola Italiana Cantoterapia), Genova, Italy; 5 Centro Studi Neurocanto, Foggia, Italy.

Subtheme F - Emotion and Well-being

Two forms of rehabilitation in symbiosis make singing exercise and physiotherapy a completely unique form of rehabilitation which combines and surpasses in their original form the same relative benefits, already considered as "forms of treatment", approved in isolation in their specific context, therefore with validated scientific evidence. The assumptions. Hydrokinesiotherapy is a rehabilitation therapy that takes advantage of the many properties of water, thus meaning "movement performed into water for therapeutic purposes." Since singing exercise is also considered a form of rehabilitation, it follows that singing is suitable to increase and enhance the rehabilitation therapy of several pathologies, not only in the orthopaedic and neurological fields.

Following this short experimentation, the authors' intention is to continue from September with an established and comprehensive project with children with autism or special disabilities. Hypothesis. If singing into water has a greater active effect on the organism (exploiting the physical properties of a body inside water), samples are extracted from a specific population during hydrokinesiotherapy exercises, and then tested with the second group that, under immersion, singing into water can increase the benefits (exploiting the properties of "bone conduction of sound" within the human organism). Study. A swimming pool, in which hydrokinesiotherapy is usually practiced by trained medical personnel, will be used. Having split the sample into two groups with the same type of population and pathology, the control group will be the one that does not perform singing but standard hydrokinesiotherapy only, and the second one will be administered the singing action at the same time. The observation sheets will be coordinated by the hydrokinesitherapist in charge. Results. The performances of the two groups will be compared in order to consider their differences. The results of the study will be selected following the parameters of a necessary protocol. Discussion. Having obtained the results in the two groups in light of our basic theory and hypothesis, we will go on to detect the parameters of the examined sample in order to ascertain how and if the results changed with the complementary use of singing into water.

Testing the Mediating Role of the Nucleus Accumbens in Musically Induced Hypoalgesia

Elise Desbarats, Mathieu Roy
McGill University, Montreal, Canada.

Subtheme F - Emotion and Well -being

Preferred music has been shown to be the most effective type of music for pain relief, yet we lack a precise understanding of its impacts on pain cognition. We investigated the role of preferred music and activity in mesolimbic reward areas in musically induced hypoalgesia using functional magnetic resonance imaging techniques. First, 15 participants (%F = 86.6 , Mage = 19) listened to self -selected music and control versions of those songs (scrambled music, silence) while giving continuous pleasure ratings. They then performed a music-listening task in an MRI scanner. Preferred music and control stimuli were presented once with four 8-second thermal pain stimulations and once without. Participants rated the pain of these stimulations and their enjoyment of each excerpt on scales of 0-100. We analyzed behavioral ratings and contrasted neural activation during pain stimulations in each condition. Concurrent with previous studies, stimulations in the music condition were rated on average as 4.04 points less painful than pain stimulations paired with scrambled music (M = 53.27, SD = 15.47, p = 0.302), and 8.05 points less painful than stimulations paired with silence (M = 57.28, SD = 14.52, $p < 0.05$). Preliminary neuroimaging data (n = 8) shows that activation was higher in the left nucleus accumbens during pain stimulations in music conditions compared to stimulations delivered in silence. We also observed greater activity in the right nucleus accumbens and dorsomedial prefrontal cortex during pain stimulations in music conditions compared to simulations in scrambled conditions. These initial results follow existing literature describing hypoalgesia in response to preferred music.

Physiological responses to music, speech, and noise.

Ulvhild H. Færøvik1, Kjetil Vikene1, Karsten Specht1, 2, 3. 1Department of Biological and Medical Psychology, Faculty of Psychology, University of Bergen, Norway; 2Mohn Medical Imaging and Visualization Centre, Department of Radiology, Haukeland University Hospital, Bergen, Norway; 3Department of Education, Faculty of Humanities, Social Sciences and Education, UiT the Arctic University of Norway, Tromsø, Norway

Subtheme F - Emotion and Well -being

This study explores the correlation between physiological responses and emotions, given the inherent intertwining of bodily reactions and emotional experiences. Common expressions such as "Trembling with fear," "Butterflies in the stomach," and "heart racing," highlight the fusion of emotions with physiological sensations in everyday language. Electrocardiograms (ECG) and respiration rate (RR) were used to measure physiological responses. Heart rate changes to original music compositions with varying tempos (60, 100, 120 and 150 beats per minute) and modes (major and minor), brown, pink, and white noise and neutral voice recordings were investigated. A sample of 99 participants underwent ECG and RR measurements while listening to original compositions and control sounds. Additionally, participants rated both compositions and control stimuli on the Genova Emotional Music scale (GEMS). Preferences for music genres, circadian chronotypes, and demographic information were also collected. Results indicate a significant decrease in heart rate compared to the baseline after listening to music and control stimuli. Musicians exhibited an increase in heart rate with escalating tempo, a pattern not observed in non-musicians. Intriguingly, there was a latent heart rate increase following the introduction of either brown, pink, or white noise, potentially influencing the outcomes. The findings suggest a psychophysiological distinction in music perception, between musicians and non-musicians, as well as raising the possibility that the use of noise as a control condition may have influenced the results.

Home care and Music therapy with Medically Complex Children - Case Report

Martina Fedele; Annabella Fedele
Santa Cecilia conservatory of Music, Rome, Italy

Subtheme F - Emotion and Well -being

Children with Medical Complexity (CMC) suffer from chronicle pathologies affecting multiple organs. They have significative functional limitations and need electro-medical devices, specialized home cares and intensive treatment programs. In this context of high medicalization, the music therapy benefits on the CMC can be a promising solution to create a moment of well-being, relax and amusement, to provide a global sensorial stimulation, to provide a safe and free space, not subjected; to the stress of goals and expectations. The case reports of V. (6 y.) and G. (12 y.), two CMC whose home care service has been integrated with music therapy sessions since about three years now, will be presented. The reference music therapy methods Benenzon and Nordoff-Robbins were adopted during the therapeutic treatments. These methods promote the active observation and creative improvisation, free expression, inclusion of body and voice in the musical process, the use of conventional and unconventional instruments different in timbres, materials, use, vibrations. The assessment instruments used at the beginning and at the end of the treatments are the professional evaluation of a Neuropsycomotor Therapy of the Developmental Age and satisfaction questionnaires submitted to nurses and parents. The goals achieved during the music therapy sessions have been the improvement of visual, motor and receptive skills, the increase of the self-emotional regulation, relax and vocal production, reduction of muscle tone and improvement of sleep-wake rhythm.

Music's Impact on Neurobiological Adaptations in Chronic Pain: Modulating Nociception, Anxiety, and Depression in Mice"

Montse Flores-García1,2, África Flores de los Heros1,2, Ester Aso1,2, Jennifer Grau-Sánchez3,4, Antoni Rodríguez-Fornells4,5, Sebastià Videla1,2, Jordi Bonaventura1,2, Víctor Fernández-Dueñas1,2.
1Pharmacology Unit, Department of Pathology and Experimental Therapeutics, School of Medicine and Health Sciences, Institute of Neurosciences, Universitat de Barcelona, Barcelona, Spain. 2Neuropharmacology & Pain Group, Neuroscience Program, IDIBELL-Bellvitge Institute for Biomedical Research, Barcelona, Spain. 3School of Nursing and Occupational

Therapy of Terrassa, Autonomous University of Barcelona, Terrassa, Spain. 4Cognition and Brain Plasticity Unit, Department of Cognition, Development and Educational Psychology, Faculty of Psychology, University of Barcelona and Bellvitge Institute for Biomedical Research, Barcelona, Spain. 5Catalan Institution for Research and Advanced Studies (ICREA), Barcelona, Spain.

Subtheme F - Emotion and Well -being

Chronic pain is a debilitating condition often accompanied by anxiety and depression. Current treatment strategies predominantly rely on analgesics, potentially overlooking the emotional aspects. Non-pharmacological interventions, such as music therapy, have gained attraction in clinical settings due to their holistic approach to chronic pain management. However, the precise neurological mechanisms underlying the impact of music remain inadequately understood. In this study, we aimed to assess how music influences nociception, anxiety, and depression in a mouse model of chronic pain induced by unilateral hind paw injection of complete Freund's adjuvant (CFA). Mice were exposed to a regimen of music (Mozart K.205, overnight) during a 14-day period post-CFA injection. Behavioral tests, including the hot plate, elevated plus maze, and tail suspension test, were employed to evaluate the effects of music on nociception and anxiety- and depression-like symptoms. Additionally, we explored the influence of music on dopamine dynamics in the nucleus accumbens (NAcc), a key region implicated in pain processing, anhedonia, and reward. Our results demonstrate that music prevents the decline in NAcc activity observed in CFA-injected mice, exhibiting a sex-dependent reduction in allodynia, anxiety, and depression-like symptoms. These findings underscore the potential of music as a non-pharmacological intervention for chronic pain and suggest the NAcc as a promising therapeutic target for addressing associated symptoms.

The temporal dynamics and interactions of musical pleasure and curiosity: insights from real-life orchestra listening

Laura Ferreri1; Gemma Cardona2; Xim Cerdà3; Olivier Penacchio3; Robert J. Zatorre4; Antoni Rordiguez-Fornells 5
1 Department of Brain and Behavioral Sciences, University of Pavia, Italy; 2 Department of Cognition, Development and Educational Psychology, University of Barcelona & Cognition and Brain Plasticity Unit, Barcelona, Spain; 3 Computer Science Department, Universitat Autònoma de Barcelona, Barcelona, Spain; 4 Montreal Neurological Institute, McGill University & International Laboratory for Brain, Music and Sound Research, Montreal, Canada, 5 Department of

Cognition, Development and Educational Psychology, University of Barcelona & Cognition and Brain Plasticity Unit & ICREA, Barcelona, Spain

Subtheme F - Emotion and Well -being

Pleasure and curiosity are crucial components of the music-reward processes, involving the activation of the dopaminergic mesolimbic system. However, it remains unexplored whether and how they temporally evolve and interact during music listening. Here, we aimed to investigate the temporal dynamics and potential interdependence of curiosity and pleasure in a large live music event. Adults concert -goers (N=608) were asked to continuously report their levels of pleasure and curiosity via a slidebar on their smartphones while listening to a live performance of a XX century minimalist piece largely unfamiliar for most listeners (Arvo Pärt's "Fratres") performed by the Milan Symphonic Orchestra. This was followed by an information-learning phase, in which insights about the structure and composition of the piece were presented to the public in a conference-style format. Then, the same piece was played for a second time, and individuals again rated the pleasure or curiosity felt during listening. Our findings revealed distinct temporal patterns in the evolution of curiosity and pleasure over time, particularly between the two exposures. Permutation cluster analysis showed that curiosity was higher during the initial exposure but decreased during the second exposure, while pleasure exhibited the opposite trend. Differences in curiosity and pleasure states were associated to individual differences in sensitivity to music reward, with highly musical hedonics showing higher ratings than lowly hedonics in curiosity and pleasure over time. Granger-causality analysis revealed that during the first exposure, curiosity Granger-caused pleasure in a lag of 2 and 3 seconds, thus acting as an anticipatory state of pleasure. However, with an increased familiarity and information-learning, pleasure ratings predicted curiosity states during subsequent listening. This study reveals the intricate temporal dynamics of curiosity and pleasure, offering valuable insights into their evolution and mutual influence in a highly ecological music listening setting for the first time.

Group Music Therapy for Proactive Management of Stress and Anxiety

Rachael Finnerty(1) Laurel Trainor (1,2);
1 McMaster University, Department of Psychology, Neuroscience and Behaviour; 2 McMaster University, McMaster Institute for Music and the Mind

Subtheme F - Emotion and Well -being

Advocating for proactive mental health interventions is not a new concept, yet an imbalance continues to exist between reactive and proactive mental health supports. Preventative strategies for undergraduate university students are paramount considering the high levels of anxiety and depression observed among youth and suicide ranking as the fourth leading cause of death among youth globally. This randomized controlled study built upon a previous study which explored online group music therapy for the management of undergraduate student stress and anxiety. The findings of the online study supported the use of group music therapy for proactive wellness, but it was underpowered. The current study followed a similar study design offering in-person group music therapy sessions opposed to online group music therapy. Group music therapy was implemented proactively, meaning students in the study did not necessarily identify with a mental health issue. A total of 148 students were randomly assigned to six-weeks of weekly group music therapy or a control group (student life as usual). Significant average reductions in all measures of stress and anxiety were observed from week 1 to week 6 in the music therapy group in comparison to the control group. The stress and anxiety measures included: (1) State Trait Anxiety Inventory – State Version(STAI-S), (2) Self-rated stress (1-5), (3) Perceived Stress Scale, (4) Cortisol from hair samples. Significant average reductions in anxiety (STAI-S) and self-rated stress (1-5) were also observed from before to after each of the group music therapy sessions. Outcomes were not correlated with personality or music sophistication data suggesting that group music therapy can positively effect stress and anxiety outcomes regardless of differences in personality domains or music training/ interests. This study elucidates the efficacy of group music therapy and the benefits of including group music therapy as part of a proactive student wellness campus culture.

The influence of individual sensitivity to music reward on rhythmic abilities

Eleonora Fullone1,2, Daniele Gatti1, Giorgio Lazzari1, Luca Rinaldi1, Carlotta Lega1, Laura Ferreri1
1 Department of Brain and Behavioral Sciences, University of Pavia, Pavia, Italy; 2 Department of Sciences of the Nervous System and Behavior, Istituto Universitario di Studi Superiori - IUSS, Pavia, Italy

Subtheme F - Emotion and Well -being

Rhythm, a core feature of music, emerges naturally in human from infancy and influences various cognitive (e.g. memory, attention) and affective processes (e.g. arousal, emotions, feeling of communion). Moreover, it is thought to modulate music reward responses through its strong movement-inducing component. This study investigates the relationship between individual differences in multidimensional rhythmic abilities and music reward (i.e., musical hedonia) in a sample of non-musicians (N=121, 18-35 years old). We measured individual rhythmic skills through rhythm production (finger tapping), perception (CA -BAT) and memory (MET) tasks, and musical hedonia through the extended version of the Barcelona Music Reward Questionnaire (eBMRQ). In the finger tapping task, we observed that the higher the musical hedonia, the better the performance along the continuation tapping phase; in the CA-BAT task, higher hedonia scores predicted individual sensitivity in perceiving the variations of asynchronies in the stimuli. No significant results were found in the MET task. Altogether, these findings suggest a main role played by individual music reward sensitivity in rhythmic abilities, especially their perception and production components. Results show a strong relationship between rhythmic skills and musical hedonia, suggesting that participants with higher music reward are more sensitive in the performance of production and perception tasks.

Listening to music as a coadjuvant treatment for chronic pain patients under opiod treatment

Jèssica Garrido-Pedrosa1,2; María F. Porto3; Lorena Zapata4; Ancor Serrano5; Sebastian Videla3, 5; Víctor Fernández-Dueñas3, 6; Antoni Rodríguez-Fornells3, 6; Jennifer Grau-Sánchez7, 8
1 Research group on Complex Health Diagnoses and Interventions from Occupation and Care (OCCARE); Terrassa, Spain;2 Escola Universitària d'Infermeria i Teràpia Ocupacional de Terrassa (EUIT), Universitat Autònoma de Barcelona, Barcelona, Spain; 3 University of Barcelona and Bellvitge Institute for Biomedical Research (IDIBELL), Barcelona, Spain. Barcelona, Spain; 4 Pharmacology Unit, Department of Pathology and Experimental Therapeutics,

School of Medicine and Health Sciences, Institute of Neurosciences, Universitat de Barcelona, Barcelona, Spain; 5 Bellvitge University Hospital, L'Hospitalet de LLobregat, Spain; 6 Catalan Institution for Research and Advanced Studies (ICREA), Barcelona, Spain; 7 Research group on Complex Health Diagnoses and Interventions from Occupation and Care (OCCARE); Terrassa, Spain; 8 Escola Universitària d'Infermeria i Teràpia Ocupacional de Terrassa (EUIT), Barcelona, Spain.

Subtheme F - Emotion and Well -being

Background: Chronic non-cancer pain (CNCP) is as a major public health challenge, significantly affecting the quality of life of individuals. Over recent years, the use of opioids in patients with CNCP has become a cause for concern. In response, alternative interventions, such as music-listening as a form of behavioral therapy, have garnered attention for their potential to reduce opioid dependence and improve pain management strategies. Objective: The primary objective of this study is to provide evidence on the differential effects of listening to music as a coadjuvant maintenance analgesic treatment in CNCP patients undergoing opioid analgesia. Our objectives also include evaluating whether music listening can ameliorate psychological comorbidities such as anxiety and depression, as well as the impact on the quality of life of chronic pain patients. Methods: This is a single-centre, phase II, open-label, parallel-group, pilot ransomised clinical trial with CNCP patients under a minimum four-week regular opioid treatment. Patients are randomized (1:1) to either the experimental group (active listening to music) or the control group (active audiobooks-listening). For 28 days, both groups have to listen daily (for at least 30 minutes) to pre-set playlists. Our objectives also include evaluating whether music listening can ameliorate psychological comorbidities such as anxiety and depression, as well as the impact on the quality of life of CNCP. In addition, we have developed a mobile app to facilitate recording patients' daily experiences, allowing precise monitoring throughout the intervention. Results: The present pilot study is still ongoing but preliminary results suggest that music listening reduces the quantity of pain (compared to baseline visit) and positively influences the psychological well-being of chronic pain patients, thus improving their quality of life. In addition, our observations show that the mobile app is efficiently used by patients, making it a robust tool to promote patient adherence to treatment.

The Impact of Individual Factors and Preferences on Music for Sleep

Silvia Genovese1, Emilia Gómez2, 3; Dirk Pflüger4
1 Aarhus Universitet (Aarhus), Denmark; 2 Universitat Pompeu Fabra (Barcelona); 3 Joint Research Centre - European Commission, Spain; 4 University of Stuttgart (Stuttgart), Germany

Subtheme F - Emotion and Well-being

The use of music as a sleep aid lays its origin in ancient times, and lullabies are rooted in different cultures, sharing common characteristics. Music is today accessible to everyone and commonly used for sleep, with studies showing that people report using a wide variety of music as a sleep aid. Despite this, little research has been focusing on the characteristics of music for sleep. In the same way, little attention has been paid to the individual characteristics of people listening to music before sleeping, and to which specific factors determine the choice of music for sleep. This knowledge is of great importance when considering the prevalence of sleep disorders, particularly insomnia, in modern society. Understanding how individual factors and preferences can influence the choice of music for sleep is essential to develop new effective music interventions for aiding sleep. Our study consists of an online survey exploring how demographics, music preferences and psychological factors can influence the choice of music for sleep, and thus how they are linked to specific music characteristics. The survey has been recently distributed through posts on social media and on websites, to reach as many participants as possible from all over the world. State-of-the-art Music Information Retrieval techniques will be used to characterize music content (e.g., audio) and context (e.g., lyrics) used to sleep in terms of aspects such as tonality, rhythm, instrumentation, or style. Machine Learning techniques will also be exploited to model the influence of individual factors on the choice of sleep music. This study will ultimately lead to the creation of an annotated dataset of music for sleep, to be used in the development of more individualized music-driven solutions and treatments for sleeping disorders.

Music-induced metabolic changes in the brain: a functional PET/MRI study

Harri Harju 1, Andreas Hahn 3,4, Eveliina Rantakylä 1, Kerttu Seppälä 1, Lauri Nummenmaa 1, Vesa Putkinen 1,2,

1 Turku PET Centre, University of Turku, Turku, Finland, 2 Turku Institute for Advanced Studies, University of Turku, Turku, Finland, 3 Department of Psychiatry and Psychotherapy, Medical University of Vienna, Vienna, Austria, 4 Comprehensive Center for Clinical Neurosciences and Mental Health (C3NMH), Medical University of Vienna, Vienna, Austria

Subtheme F - Emotion and Well-being

Background. Music's universal appeal may stem from its ability to induce pleasure. We used functional [18F]FDG-PET and functional magnetic resonance imaging (fMRI) to measure concurrent changes in brain glucose metabolism and haemodynamic activity during pleasurable music listening. Unlike PET imaging with a single-bolus tracer administration, this functional PET (fPET) approach employs constant [18F]FDG infusion and allows the quantification of task-specific changes in glucose metabolism during a single scan. Methods. Twenty-one subjects underwent a 90-min simultaneous PET-MRI scanning. Twenty percent of the tracer was administered as a bolus followed by a constant infusion across the scan duration. The experiment included two 10-min blocks of self-selected pleasurable music and two 10-min blocks neutral auditory stimulation. During the blocks, 45-sec sound stimulation (music or control stimuli) altered with 15-sec silent periods. For the PET data, voxel-wise time activity curves were modelled with a general linear model (GLM) with task-specific regressors for the music and control conditions and a regressor for baseline metabolism. The fMRI data were modelled with a GLM with boxcar regressors (silence vs. sound stimulation) within the music and control blocks. Results. Pleasurable music increased [18F]FDG uptake in the auditory cortex, right inferior frontal gyrus, the pre- and post-central gyri, and in limbic regions such as the nucleus accumbens. The fMRI showed similar activation patterns with increased haemodynamic activity in the auditory, motor and limbic regions during pleasurable music. Conclusions. Our results indicate that pleasurable music induces heightened energy metabolism in the sensory, motor and emotion circuits of the brain and that these effects co-localize with corresponding haemodynamic changes. The results confirm the feasibility of fPET in imaging metabolic changes associated with music-induced pleasure. fPET presents novel possibilities for imaging of synaptic activity underlying human emotions.

Soundscapes of the Mind: The Therapeutic Benefits of Music and Audiobooks for Older Adults with Cognitive Impairment

Ellen Herschel, Savannah Watson, Assal Habibi
Brain and Creativity Institute, Dornsife College of Letters Arts and Sciences, University of Southern California, Los Angeles, California, USA

Subtheme F - Emotion and Well-being

As our global population ages, dementia incidence is expected to rise to over 130 million by 2050. Anxiety and agitation are prominent features of dementia with significant negative impacts on quality of life and wellbeing. Personalized music listening is an accessible and potentially effective tool to improve these negative symptoms. Although prior music-based interventions provided evidence of improvements in agitation and anxiety, most trials compared music listening to a passive control (care as usual). Additionally, there is supporting, albeit limited, evidence of auditory beat stimulation (ABS) in reducing anxiety. Recently, machine-learning AI-based music personalization has expanded the field of individualized music selection. Here we assessed the efficacy and feasibility of an 8-week RCT of ABS-embedded personalized music listening, provided by LUCID, on anxiety, agitation, mood, and well-being in older adults (N=51) aged 65-85 with cognitive impairment (MoCA 10-25) as compared to audiobooks as an active auditory control. We predicted personalized music would more effectively reduce agitation and anxiety and improve well-being compared to audiobooks. Participants listened to 30-minutes of music or audiobooks 4 times a week for eight weeks with pre-post assessments of agitation, anxiety, and mood taken each session. In addition, assessments of agitation, anxiety, caregiver burden, depression, and quality of life were completed pre-post the 8-week intervention. No significant group effects were seen in measures assessing anxiety, agitation, mood, and well-being pre-post 8-weeks of intervention for either group. Session effects showed early impacts: music improved agitation, audiobooks reduced positive affect and happiness, and both groups showed trending improvements in negative affect after listening. However the two groups showed similar benefits by the trial's end, suggesting audiobooks and music are equally effective long-term. While audiobooks may have been too similar to music to tease apart potential benefits, both are feasible interventions for cognitive impairment.

Musical reward in schizophrenia: a neuromelanin-sensitive MRI study

Saki Homma (1), Shinichiro Nakajima* (2), Takahide Etani (1, 3, 4), Sotaro Kondoh (1), Shiori Honda (2), Ryosuke Tarumi (2, 5), Yuka Kaneko (6), Sakiko Tsugawa (2), Sotaro Moriyama (2), Yui Tobari (2), Guillermo Horga (7), Clifford Cassidy (8), Hiroyuki Uchida (2), Yoshihiro Noda (2), Shinya Fujii* (9),
(1) Graduate School of Media and Governance, Keio University, Kanagawa, Japan, (2) Department of Neuropsychiatry, Keio University School of Medicine, Tokyo, Japan, (3) School of Medicine, College of Medical, Pharmaceutical and Health Science, Kanazawa University, Ishikawa, Japan, (4) Advanced Research Center for Human Science, Waseda University, Saitama, Japan, (5) Seikei-Kai, Komagino Hospital, Tokyo, Japan, (6) Faculty of Policy and Management, Keio University, Kanagawa, Japan, (7) Department of Psychiatry, Columbia University, New York, NY, US, (8) Cellular and Molecular Medicine, University of Ottawa, Ottawa, ON, Canada, (9) Faculty of Environment and Information Studies, Keio University, Kanagawa, Japan, *correspondence

Subtheme F - Emotion and Well-being

Anhedonia, an inability to experience pleasure, is one of the core symptoms of schizophrenia (SZ). Although previous studies suggest that the processing of musical reward may be distinct from physical reward and that dopaminergic functions have crucial roles both in musical reward processing and pathophysiology of SZ, the nature of musical reward processing and its association with dopaminergic functions in SZ has yet to be fully elucidated. We hypothesized that the musical reward experience is impaired in patients with SZ. Supplementarily, we also examined whether there is a negative correlation in the patients with SZ between musical reward experience and the neuromelanin (NM) levels in the substantia nigra (SN), which is reported that whose levels are higher in SZ, as an index of dopaminergic functions. We included 22 treatment-responsive SZ patients and 23 healthy controls (HC). Musical reward experiences were assessed with the Barcelona Music Reward Questionnaire (BMRQ). We also measured NM levels in the SN, employing NM-sensitive MRI. The BMRQ score was compared between the SZ and HC groups with a one-way analysis of covariance (ANCOVA) controlling for age, sex, and estimated musical training hours. We also conducted a partial correlation analysis between the BMRQ score and NM levels in SN, adjusting for the effects of the same variables as ANCOVA. The BMRQ scores were lower in the SZ group than in the HC group ($F_{1,40} = 6.10$, $p = 0.018$). However, there were no significant correlations between the BMRQ scores and NM levels

in SN both in HC ($r = 0.021$, $p = 0.931$) and SZ groups ($r = –0.143$, $p = 0.558$). These findings indicate that the experience of musical reward may be attenuated in patients with SZ and that this propensity may not be reflected in the NM levels in the SN.

The interplay of music and psychedelics

Katarina Jerotic1,2; Peter Vuust2; Morten L. Kringelbach1,2
1 University of Oxford, Oxford, UK; 2 Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Aarhus, Denmark,

Subtheme F - Emotion and Well -being

Music and psychedelics have been connected across time and cultures, ranging from shamanic rituals of the Americas and Africa to their modern clinical use in psychedelic-assisted therapy for treatment of disorders such as PTSD, addiction, and treatment resistant depression. Within this line of research, music has been afforded great importance due to its perceived ability to not only relax the participant, but also guide the psychedelic experience. Here, we provide an overview of several perspectives on the interaction between psychedelic use and music. We discuss the brain's functional hierarchy that is relied upon for music perception and manipulated through psychedelics. We explore music's role in Western psychedelic therapy, specifically in encouraging the onset of mystical experiences, moderating the expression and regulation of emotion, and mediating visual imagery. These within-experience effects are important as they have previously been associated with longer-term positive outcomes for patients following the therapy. Moreover, we explore the use of music in rituals that employ psychedelics, as observed within the Santo Daime Church, for example. Furthermore, we inspect the capacity of music to lead to altered states of consciousness in the absence of psychedelic intervention. The interplay of music and psychedelics is a topic with growing interest given increasing excitement relating to the therapeutic efficacy of psychedelic interventions, and the capacity of music to guide and mediate this experience.

Promoting sleep through neural synchronization to music

Kira Vibe Jespersen, Alexandre Celma-Miralles, Peter Vuust
Center for Music in the Brain, Department of Clinical Medicine, Aarhus University, Aarhus, Denmark;

Subtheme F - Emotion and Well -being

Sleep is essential for physical and mental health. Nevertheless, sleep problems are highly prevalent in modern society. Many people listen to music for sleep improvement, and clinical studies have found a beneficial effect of music on sleep quality. Still, it remains unknown how music can facilitate sleep. Sleep is characterised by a reduction in the frequency of the brain waves, and here, we test whether brain wave synchronization to music with a slow beat may facilitate sleep onset. We used a frequency tagging approach on electroencephalographic recordings (EEG) of sleep-onset insomnia participants (N = 60) resting with and without music. Because the study was part of a randomized controlled trial evaluating the effect of music as sleep aid, resting-state EEG was recorded twice for each participant, before and after a 4 -week music intervention period. The participants in the music group could choose their preferred music among sleep playlists of different genres. The beat of the music was determined via manual tapping and verified in the audio spectrogram. The preliminary results show varying degrees of synchronization between low frequency EEG signal and the beat of the music, depending on the salience of the beat. In addition, we evaluated the relationship between neural synchronization to the beat of the music and sleep initiation during the EEG resting-state session. This is one of the first studies to use a frequency tagging approach in a study with a naturalistic music intervention. The findings are an important step forward in the understanding of how music can facilitate sleep. Thereby, the study contributes to the development of evidence-based music interventions for sleep.

Representational Gradients of Musical Emotions in the Cerebral Cortex Modeled by a Convolutional Neural Network

Seung-Goo Kim 1, Tobias Overath 2, Daniela Sammler 1
1 Research Group Neurocognition of Music and Language, Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany,
2 Department of Psychology and Neuroscience, Duke University, Durham, North Carolina, USA

Subtheme F - Emotion and Well -being

Music often evokes strong emotions. Yet, how musical auditory representations are abstracted in the brain and how these different representations contribute to the emergence of felt emotions remains poorly understood. Recent work

suggests that pre-trained audio convolutional neural networks (CNNs) can capture information in real-world music that is relevant to felt emotions and neural activity in the medial prefrontal cortex (mPFC; Kim et al., 2023). Here, we explored (i) whether increasingly abstract representations of music in different layers of the CNN are encoded along a well-established cortical gradient—from unimodal sensory to transmodal associative regions (Margulies et al., 2016), and (ii) how layer-specific CNN embeddings predict human behavioral ratings of musical emotions. We analyzed the fMRI dataset (openneuro-ds003085) of Sachs et al. (2020) in which participants continuously rated their 'Emotionality' and 'Enjoyment' during music listening. Embeddings for sliding 1-sec spectrograms of the music were extracted from all 24 layers of a CNN (VGGish; Hershey et al., 2016), and then used to predict group-averaged fMRI time series and emotion ratings with ridge regression. For each voxel, we determined the best layer (argmax) and the centroid layer in the 24-layer profile of prediction accuracies. We found a marked correspondence between the CNN layer-specific representational gradient of musical information and the cortical gradient (Margulies et al., 2016). This suggests that the transformation of the auditory signal along the cortical hierarchy may involve an abstraction mechanism similar to what the CNN implements, beyond the auditory system. Distinct encoding patterns of participants' 'Emotionality' and 'Enjoyment' ratings across CNN layers suggest that basic and aesthetic emotional experiences may depend on different abstraction levels of the audio signal represented along the cortical gradient. Overall, comparing representational gradients of music in the brain and behavior may open new ways to better understand the multi-layered mechanisms of musical emotions.

Individual differences in the efficacy of music for sleep: the role of musical properties and personal preferences

Kirk, R.1, Panoutsos, G.2, van de Werken, M.3, & Timmers, R.1,4.
1Department of Music, University of Sheffield, UK; 2Department for Automatic Control and Systems Engineering, University of Sheffield, UK; 3SleepCogni, BrainTrain2020 Ltd., Sheffield, UK; 4Healthy Lifespan Institue, University of Sheffield, UK

Subtheme F - Emotion and Well -being

Music is a popular tool for helping with sleep problems (Jespersen et al., 2022), yet discrepancies exist between what researchers typically prescribe as 'sleep music' compared with what listeners report choosing (Kirk et al., in prep) and studies do not typically compare different selections. We tested the effects of two music playlists generated using data and models built on previous studies

(Kirk et al., in prep; Kirk & Timmers, in press) that indicated two streams of potentially optimal music for sleep. Our aim was to see if any improvements in sleep outcomes could be distinguished by the type of music listened to or the preference of the listener. 30 participants listened alternatively to one playlist or the other or silence for three consecutive nights each as they went to sleep. Sleep diaries provided subjective measures of sleep quality (SQ), sleep onset latency (SOL), and sleep efficiency (SE). A follow up questionnaire asked participants to indicate for each playlist how likely they would choose that music to go to sleep with. We found that listening to music at bedtime improved sleep outcomes and that this differed between playlists, however was not reliably associated with the type of music nor the preference of the listener. In 33% of cases, the music that improved sleep the most was not that participant's preferred choice. Participants reported positive experiences of listening to music to sleep, diverging preferences, and surprise at their experiences, suggesting a naivete gap for listeners in using music for sleep. Our findings have key implications for therapeutic applications in particular, and we suggest recommendation systems that combine research based suggestions with listener feedback in order to develop music selections that will help optimise the use of music for sleep.

The Effect of Music in Children Aged 11-15, in the Areas of Anxiety and Depression

Maria-Eleni Nisidi & Elenitsa Kitromilides-Nicolaides.
European University Cyprus, Nicosia, Cyprus.

Subtheme F - Emotion and Well -being

Music training is efficacious at improving quality of life in humans. Through music, emotions and mood can be better regulated (Juslin & Laukka, 2004). Findings have shown that learning a musical instrument helps to enhance motor planning and coordination, visuospatial ability, emotion and impulse regulation in children. Analysis revealed that music training was associated with an increased rate of cortical thickness maturation (Hudziak et al., 2014). In our research, we hypothesized that music training in children is more beneficial than no training to mood (depression) and anxiety. One hundred eighty-four children aged from 11 to 15 years old from the city of Patra (Greece) participated in this investigation. Measures of depression and anxiety were assess using Children's Depression Inventory (CDI) and Spence Children's Anxiety Scale (SCAS) respectively. Results of Mann-Whitney U test showed a significant difference in scores between the two groups for CDI ($p=.008$) and SCAS ($p<.001$) with lower scores in the group of those enrolled in music training. These results suggest that music training, in children, reduce depression and anxiety symptoms which is beneficial for their overall wellbeing.

Enhancing music chills through closed-loop neurofeedback generating tailor-made playlist for individuals using an in-ear EEG device

Sotaro Kondoh (1), Takahide Etani (1,2,3,4), Yuna Sakakibara (1,4), Yasushi Naruse (4), Yasuhiko Imamura (4), Takuya Ibaraki (4), Shinya Fujii (1,4,5)
(1) Graduate School of Media and Governance, Keio University, Kanagawa, Japan, (2) School of Medicine, College of Medical, Pharmaceutical and Health Science, Kanazawa University, Ishikawa, Japan, (3) Advanced Research Center for Human Science, Waseda University, Saitama, Japan, (4) VIE, Inc., Kanagawa, Japan, (5) Faculty of Environment and Information Studies, Keio University, Kanagawa, Japan

Subtheme F - Emotion and Well -being

Music chill is an emotional experience that induces intense pleasure with physical responses such as goosebumps while listening to music. Previous studies have suggested individual differences in music evoking chills. This study examined a closed-loop neurofeedback system using an in-ear electroencephalogram (EEG) to select music inducing chills more effectively for each individual. Ten participants (23.9 3 4.6 years old) listened to self-selected and other-selected music. They reported higher pleasure levels and more chills in self-selected pieces. The acoustic features of self-selected pieces were analyzed by VGGish, a pre-trained neural network, to make a linear lasso model predicting pleasure from the features (Model 1). We simultaneously measured the participants' in-ear EEG using Vie Zone (Vie Inc.) and constructed a general linear lasso model classifying the EEG pattern into the state of listening to the self-selected or control pieces (Model 2). We calculated the acoustic features of 7000+ candidate pieces and estimated pleasure using VGGish and Model 1. The pieces were ranked based on the pleasure and the similarity to self-selected pieces. While listening to the playlists, Model 2 predicted the real-time pleasure from EEG, which was added to the training data of Model 1 to retrain and update the ranking. The (1) "positive-EEG" and (2) "negative-EEG" playlists selected pieces from the top 1% and the bottom 1% of the ranking, respectively. We also presented the (3) "positive-acoustic" and (4) "negative-acoustic" playlists without using EEG in retraining. We thus created four playlists. The positive-EEG playlist elicited the most chills (7.1 3 5.4, mean 3 SD), followed by positive-acoustic (4.1 3 4.8), negative-EEG (2.8 3 2.8), and negative-acoustic (2.4 3 2.3) playlists. One-way repeated measure ANOVA revealed the significant difference in chills among the playlists ($F(3, 27) = 4.14$, $p = 0.016$), suggesting that selecting music from an individual's EEG induces more chills.

Does music training improve emotion recognition abilities?

César F. Lima (1), Leonor Neves (1), Marta Martins (1), Ana Isabel Correia (1), São Luís Castro (2), E. Glenn Schellenberg (1)(3)
(1) University Institute of Lisbon (Iscte), Lisbon, Portugal; (2) University of Porto, Porto, Portugal; (3) University of Toronto Mississauga

Subtheme F - Emotion and Well -being

Associations between music training and nonmusical benefits are generally presumed to reflect plasticity and transfer. Causality remains a disputed issue, however, and the possibility of far transfer from music training to socioemotional skills is underexplored, even though social and emotional processes are central to musical experience. Combining correlational and longitudinal studies, we asked whether music training and ‘natural’ musical abilities relate to benefits in a central component of socioemotional processing, the ability to recognize emotions in vocal and facial expressions. For adults (N = 169) and school-age children (N = 192), we found that music training relates to improved recognition of emotions in vocal expressions, namely in speech prosody and purely nonverbal vocalizations (e.g., laughter), but not in facial expressions. Nevertheless, a similar association was evident for musically untrained individuals with naturally good musical abilities: children and adults with good natural musical abilities also tend to be good at recognizing vocal emotions, independently of their music training. Moreover, the association between music training and emotion recognition was fully explained by musical abilities. In a longitudinal study implemented in a school context over two years (N = 110), music lessons did not improve emotion recognition and general cognitive abilities compared to sports training and no training, despite improving fine-motor skills and auditory short-term and working memory. Altogether, these findings indicate that music training is associated with enhanced emotion recognition in vocal expressions, but we found no evidence that such enhancements stem from plasticity and transfer. Instead, we documented a link between musical abilities and vocal emotional processing that does not require training to emerge. Predispositions should be considered as a contributing factor that can help to explain associations between musical expertise and the recognition of vocal emotions.

Emotional reaction to music in persons with tinnitus

Lise Hobeika (1,2,3), Sophie Dupont (2,4), Alain Londero (5), Séverine Samson (1,3,4)
(1) PSITEC – Psychologie: Interactions, Temps, Emotions, Cognition, Université de Lille, ULR 4072, Lille, France, (2) Sorbonne Université , Institut du Cerveau - Paris Brain Institute - ICM, Inserm, CNRS, Paris, France, (3) Pasteur Institute-Institut de l'Audition, F -75012 Paris, France, (4) Epilepsy Unit and Rehabilitation Unit, Assistance Publique – Hôpitaux de Paris, GHU Pitié-Salpêtrière-Charles Foix, F-75013 Paris, France, (5) Service ORL et CCF, Hôpital Européen Georges Pompidou, Assistance Publique - Hôpitaux de Paris, Faculté de Médecine Paris Descartes - Université de Paris, F- 75015 Paris. France

Subtheme F - Emotion and Well -being

Tinnitus is a medical condition characterized by a subjective perception of sound (ringing in the ears) without any external acoustic stimulus. This intriguing phenomenon is quite common, particularly in musicians due to prolonged exposure to intense noise. Since tinnitus distress is associated with auditory-limbic dysregulation, it might compromise the processing of emotionally evocative sounds and notably of music. However, the emotional judgment induced by musical listening have not yet been examined in tinnitus sufferers. To test the change of emotional responses to music in tinnitus sufferers, emotional rating of consonant and dissonant musical excerpts was assessed in 100 participants with tinnitus (tinnitus group, age 45 3 12) and in 100 matched control participants (control group, 41 3 11), for whom the presence of hearing loss (up to very high frequencies) and hyperacusis has been investigated. The results of linear mixed-effect model that controls for the effect of age, hearing loss, hyperacusis, discomfort hearing levels, depression, anxiety and musical experience, showed that the judgement of emotional valence induced by musical listening was affected by the presence of tinnitus. Participants with tinnitus judged the emotional valence of musical excerpts (i.e. consonant and dissonant) more negative (less pleasant) than persons without tinnitus ($p<0.01$). Moreover, they listen to music for less time each day ($p<0.05$). In conclusion, bothersome chronic tinnitus is linked to more negative emotional reactions to musical stimuli decreasing the feeling of pleasantness induced by the musical listening. This modification of emotional responses to music in tinnitus sufferers, not explained by hearing loss and hyperacusis, will be discussed in the light of a possible alteration of the reward system and potential repercussions on the emotional feeling of musicians suffering from tinnitus.

Frontoparietal network activity is associated with emotion perception judgment in aesthetic experiments with music and dance: A fNIRS study

Maercio Maia; Abrahão Baptista; João Sato; Pedro Montoya; Patricia Vanzella
Center for Mathematics, Computing, and Cognition, Universidade Federal do ABC, São Bernardo do Campo, Brazil.

Subtheme F - Emotion and Well-being

Understanding the neural underpinnings of aesthetic experiences, particularly in music and dance, remains a complex yet compelling area of research. This study aimed to investigate the involvement of the frontoparietal network in emotion perception judgments during aesthetic encounters with music and dance, employing Functional Near-Infrared Spectroscopy (fNIRS) as the neuroimaging modality. Hemodynamic responses in the bilateral dorsolateral prefrontal and right parietal cortices were measured while participants engaged in emotion perception rating tasks. We examined the influence of three distinct auditory stimuli on emotion perception within the context of a video-based dance performance. Participants (n=18) were exposed to a video consisting of a continuous contemporary dance sequence divided into 30-second blocks, each paired with one of three randomly assigned auditory conditions: classical music, techno music, and human breathing sounds. Our results revealed significant activation in the frontoparietal network during aesthetic judgments, indicating robust cognitive and emotional processing. Specifically, we observed differences among auditory stimuli, particularly evident in channels over the right posterior parietal and bilateral dorsolateral prefrontal cortices ($p < 0.05$). These distinctions were more pronounced in deoxyhemoglobin activity in both areas during the judgment process. These findings underscore the critical role of the frontoparietal network in mediating aesthetic experiences involving music and dance, emphasizing its significance in processing emotions and subjectively evaluating artistic stimuli. This study enhances our comprehension of the neural mechanisms underpinning aesthetic perception and elucidates the intricate interplay between cognitive and emotional processes in the context of artistic appreciation.

From Pop to Jazz: Individual differences in music complexity sensitivity predict the development of preference for Jazz music after a 2-month intervention

Ernest Mas-Herrero (1,2), Ana Clemente (3), Josep Marco-Pallarés (1,2)
1 Department of Cognition, Development and Educational Psychology, Universitat de Barcelona, Spain; 2 Institut de Neurosciènces, Universitat de Barcelona, Spain; 3 Department of Cognitive Neuropsychology, Max Planck Institute for Empirical Aesthetics, Germany

Subtheme F - Emotion and Well-being

According to a wealth of theoretical models, music's enjoyment predominantly comes from the expectations it engenders through its regular patterns and, mainly, when those expectations are violated. The relationship between predictability and pleasure can be described by an inverted U-shaped function, with a predictability sweet spot that maximizes pleasure. Yet, little is known about the individual differences in this effect and to what extent it may account for individuals' musical preferences. We determined individuals' predictability sweet spot (PreSS), an index of the degree of predictability most preferred by an individual, by implementing computational models of preference in a novel decision-making paradigm in which 240 melodies—representing 16 different categories of complexity (as measured by information content and entropy)—were compared. Deviations from this optimal level, either towards more or less predictability, lead to a decrease in preference. This measure generates reliable predictions of participants' subjective pleasure with real music and correlates with individuals' musical preferences. Specifically, in two large samples, PreSS positively correlated with preference for Jazz music, independently of exposure. To further study the extent to which PreSS scores reflect a predisposition to enjoy music with more or less complexity, we performed a longitudinal study in which 50 Jazz-naïve participants with a preference for Pop music were exposed to Jazz music for two months (30 min/day, 5 days/week) and scanned before and after the intervention. Although all participants had similar exposure and preference for Jazz music at the beginning, individuals with higher PreSS developed a higher preference for Jazz music by the end of the intervention. Notably, PreSS score was also associated with greater striatal responses to Jazz music after the intervention. These results indicate that musical preferences are, in part, the result of an interaction between exposure and individuals' predisposition to enjoy music with more or less complexity.

Effects of liked and disliked music on psychophysiology

Julia Merrill, Music Department, Max Planck Institute for Empirical Aesthetics, Frankfurt/M., Germany, & Institute of Music, University of Kassel, Kassel, Germany

Subtheme F - Emotion and Well-being

Many studies have demonstrated the positive effects of preferred music. However, just as listeners can have strong reactions to liked music, they can have strong reactions to disliked music. The current study examines the impact of liked and disliked music on psychophysiology. Seventy-five participants listened to both types of self-selected music while psychophysiological measures were recorded. Real-time pleasure ratings of pleasantness were collected, along with post-listening questionnaires assessing the intensity and quality of chills, and reasons for liking/disliking. Linear mixed-effects models analyzed physiological responses. Arousal was slightly higher during pleasant moments but some measures showed no difference between pleasant and unpleasant chills. Most measures increased with higher pleasure intensity, regardless of valence, though respiration rate decreased during intense unpleasant moments. Electromyography (EMG) indicated valence, with unpleasant moments showing higher activity in the corrugator muscle (frowning) and pleasant moments showing higher activity in the zygomaticus muscle (smiling). Responses were moderated by participants' attitudes toward the music regarding the reasons for liking/disliking. Despite music's commonly acknowledged positive effects on the body, the present study sheds light on bodily responses to negatively appraised music, which exhibit minimal differentiation in arousal levels. Surprisingly, increases in zygomaticus (smiling) activity were also observed with disliked music, challenging traditional valence distinctions and rather indicating overall muscle tension in disliked music. The results suggest that disliked music could have negative effects on well-being. The moderating effects underline the importance of considering individual preferences in understanding music's effects on psychophysiology.

Music emotions in seasonal virtual reality environments

Bruno Mesz 1, Nissoite Abdou 2, Milana Dzhamalova 2, Jean-Christophe Sakdavong 2
1 Art and Culture Research Institute (IIAC), Universidad Nacional de Tres de Febrero (UNTREF), Sáenz Peña, Argentina; 2 CLLE CNRS UMR 5263, University of Toulouse, 5 allée Antonio Machado, Toulouse, France

Subtheme F - Emotion and Well-being

There has been little research

on the impact of the visual environment on musical emotions. In order to investigate the effect of two realistic visual seasonal environments (summer/winter) on the emotions felt during musical listening in the context of virtual reality (VR), we used an Oculus Quest 2 headset to present either the summer or the winter landscape to each of 48 participants, together with four musical fragments (moderately sad, tender, happy and scary) taken from the film music database of Eerola and Vuoskoski (2011), asking them to complete the GEMIAC questionnaire (Coutinho and Scherer, 2017) and to rate the congruence of music and visuals after each fragment. After grouping the GEMIAC emotion terms in five valence-arousal clusters: HA-LV (high arousal-low valence), HA-HV (high arousal-high valence), LA-HV (low arousal-high valence), LA-LV (low arousal-low valence) and LA-MV (low arousal-mixed valence) (this last group stands for Melancholic, Sad and Nostalgic, Sentimental emotion pairs in the GEMIAC), our results show that (i) Season had a significant effect on the emotion intensity of some emotion clusters for the tender and happy fragments, which were also the only ones to significatively differ in music-visuals congruence ratings between summer and winter landscapes; (ii) Music-visual congruence had a significant effect on the intensity of some emotion clusters for all the fragments; (iii) In most cases, emotion intensity increased with increasing music-visual congruence; it had an inverted U-shape for the LA-HV cluster in the scary fragment, and also a non-monotonous shape for the LA-HV cluster in the happy fragment. Thus, our findings suggest that visual environments may be important factors to consider in studying musical emotions, for instance while listening in theaters and opera houses, in art installations, or music therapy environments.

Reconsidering the links between music practice, empathy, and prosociality

Dorothée Morand-Grondin; Floris van Vugt; Simon Rigoulot
International Laboratory for Brain, Music and Sound Research (BRAMS), Centre for Research on Brain, Language and Music (CRBLM), department of psychology, University of Montreal, Montreal, Canada

Subtheme F - Emotion and Well -being

Music practice is often assumed to increase empathy and prosociality. However, data in support of this relationship appear to be limited and it is unknown if all components of empathy (cognitive empathy, emotional contagion, emotional disconnection) or only a subset would be affected. Moreover, connections between music practice, empathy and prosociality are still unclear. In order to clarify these relationships, we asked musicians (n=80) and non-

musicians (n=89) to fill questionnaires and perform tasks measuring empathy and prosociality. We hypothesized that musicians would score higher on empathy and prosociality than non-musicians, and that musicians who practice more would show greater effects. Using classical and Bayesian ANOVAs and controlling for gender, our study revealed no difference between both groups on empathy and prosociality, and we found no correlation between these social variables and the amount of music practice. In an exploratory analysis, we found associations between the age of onset of music practice and empathy, suggesting that it is not practice per se but specific components of music practice that have the potential to boost empathy and prosociality. Thus, further research on the subject is needed to better understand the links between music practice, empathy and prosociality, such as more precise measures of empathy and prosociality as well as precisions on different components of music practice that could come into play, such as the age of onset and the type of practice (solo vs. group).

Alpha power dynamics during guided meditation with humming and imagery inspired by Pauline Oliveros' Sonic Meditations

Barbara Nerness1, Tysen Dauer2, Takako Fujioka3
1 Center for Computer Research in Music and Acoustics (CCRMA), Stanford University, USA; 2 CCRMA, Stanford University, USA; 3 CCRMA, Stanford University, USA

Subtheme F - Emotion and Well -being

In 1973, composer-improviser Pauline Oliveros was interested in the science of music-centered meditation. She engaged musicians and non-musicians over ten weeks with meditative listening and participatory vocalizations from her Sonic Meditations, obtaining their electroencephalography (EEG) at two occipital electrodes with a paper-based system. She hypothesized that alpha activity (8-13 Hz) would change after ten weeks (trait effects), but never analyzed the data quantitatively. Our digitization and analysis revealed no trait effects and we could not examine task-related changes (state effects) due to inconsistent task markings. However, recent literature suggests reliable alpha power changes during meditation and music improvisation, warranting a follow-up study using electrodes over the whole head. We examined EEG alpha power during an adapted Sonic Meditation involving listening, focusing on breath, humming, and imagining humming.

Furthermore, we explored whether pitch choice in the humming task (improvisation) had any effect. Eighteen participants successfully completed two 22-minute sessions, one with improvisational freedom (improv) and one with a repeated note (prescribed). Each session contained two repetitions of the same six tasks: eyes-closed, eyes-open, focus-on-breath, listen, hum, and imagine-humming. We recorded participants' EEG and audio of their humming. We compared average alpha power of artifact-free 2-second segments for each task at 4 scalp areas: frontocentral (FC), centro-parietal right (CPR), centro-parietal left (CPL), and parieto-occipital (PO), by 3-way ANOVA (task, task-repetition, electrode-group). Alpha power did not differ between improv and prescribed sessions. The task main effect was significant because alpha power was larger during imagine-humming than eyes-open. The task x electrode -group interaction was significant because imagine-humming enhanced alpha power in FC and PO. Imagine-humming may have required the most effortful, internalized attention, affecting frontal and occipital areas. Our results support Oliveros' hypotheses and uncover frontal state effects during auditory-motor imagery, in line with current literature for mental imagery and meditation.

Designing a choral singing intervention for a psychological study: how to tailor the features of a health-promoting choral singing course for elderly using design thinking

Miriam Napadow[1], László Harmat[1], Örjan de Manzano[2], Susanna Jernelöv[3];
[1] Department of Psychology, Linnaeus University, Växjö, Sweden; [2] Department of Cognitive Neuropsychology, Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany; [3] Division of Psychology, Department of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden

Subtheme F - Emotion and Well -being

A longitudinal study (2022-2024) investigated the relationship between healthy ageing and choral singing using a within subject design. Sixty-one healthy participants aged 65-75 were recruited and underwent a comprehensive battery of assessments, including neuropsychological tests, brain imaging, and various well-being scales. The primary objective of the study was to investigate the neurological mechanisms underlying the potential of choir singing in preventing dementia among healthy elderly individuals. The participants engaged in weekly choir sessions, lasting 1.5 hours each, for eleven months. This period was contrasted with a corresponding timeframe without any intervention. Given that the entire study centered on the effectiveness of the intervention, before launching the choir singing sessions, we conducted a preparatory study on the target group, using the framework of Design Thinking. This set of methods are commonly used in product development and service design in order to improve quality and satisfaction for users/consumers or as in our case: participants. We conducted a focus group session and a workshop with 24 choir singers from 4 different choirs who had similar features to the participants in the upcoming study. The data was presented in an affinity diagram, showing key themes identified as important in order to make choir singing enjoyable and a positive experince, for example the conductor's leadership qualities, motivation, rehearsal room characteristics, equipment, and more. Based on these finding, a design specification was constructed, establishing the content of the intervention. A participant journey map was also created in order to support the researchers in maintaining the perspective of the participants throughout the research project, as a measure of enhancing motivation and prevent drop-out. We conclude that the design thinking framework supports researchers in the decision-making process and implementation of health-promoting interventions, while also offering insight into participants' experiences to customize interventions to their specific needs.

A Comparative Study Between Normal-Hearing Individuals and Cochlear Implant Users on the Role of Lyrics and Melody in Perceiving Emotional Content in Music

Sebastien Paquette1; Audrey Saykaly2; Alexandre Lehmann3
1 Department of Psychology, Trent University, Peterborough, Canada; 2 Laboratory for Brain, Music and Sound Research & Centre for Research on Brain, Language or Music, McGill University, Montreal, Canada; 3 Faculty of Medicine, Department of Otolaryngology – Head and Neck Surgery, Research Institute of the McGill University Health Centre, Montreal, Canada

Subtheme F - Emotion and Well -being

Music is a powerful medium for emotions, and music-based interventions can modulate pain & mood. Lyrics and melody are believed to contribute to music's power to move us. To optimize the therapeutic effect of music, discerning which component shapes an individual's emotional experience is crucial. The role of personal characteristics in influencing musical preferences and how we experience music-related rewards is integral to understanding how musical emotions are perceived. This is particularly true for special populations like cochlear implant (CI) users, who uniquely differ in how they perceive and appraise music. To better understand emotion perception from music in both normal-hearing (NH) individuals and CI users, we conducted an online survey. We asked whether participants (30 CI users and 159 NH individuals) placed greater emphasis on lyrics or melody in different emotional scenarios (happy/sad) and also evaluated how they experienced music-associated rewards. As hypothesized, given that their implants are optimized for speech perception, CI users preferred the lyrical content of music. However, a consistent pattern emerged across both groups. Participants generally favoured the melody for joyful music, while for sad music, they were more inclined toward the lyrics. Gender differences were only observed within the NH group. Furthermore, the study revealed noticeable similarities in how CI users and NH individuals experience music-related rewards (No difference between groups). Still, different demographic variables seem to explain within-group variability. For NH individuals, participant age seemed to influence their musical reward ratings, while it was gender for CI users. This study sheds light on the nuanced interplay of lyrics and melody in shaping emotional experiences in music for both NH individuals and CI users. These findings deepen our understanding of how CI populations engage with and derive emotional rewards from music, contributing to the broader conversation on the universality of musical emotions.

Pleasurable music modulates Q-opioid system activity in the brain

Vesa Putkinen 1,2, Kerttu Seppälä 1,2,4, Jouni Tuisku1,2, Harri Harju 1,2, Lauri Nummenmaa, 1,2,3.
1 Turku PET Centre, University of Turku, Finland, 2 Turku University Hospital, Turku, Finland, 3 Department of Psychology, University of Turku, Finland, 4 Department of Medical Physics, Turku University Hospital, Turku, Finland

Subtheme F - Emotion and Well -being

The Q-opioid receptor (MOR) system mediates incentive motivation and the hedonic components of primary rewards such as food and sex. However, there is no direct in vivo imaging data demonstrating Q-opioid involvement in pleasure derived from aesthetic rewards such as music. We measured MOR activation during listening of pleasurable music and a neutral baseline condition with positron emission tomography using the radioligand [11C] carfentanil with high affinity for MORs. Haemodynamic responses to pleasurable music were measured using functional magnetic resonance imaging (fMRI). The PET results revealed that pleasurable music increased [11C]carfentanil binding potential (BPND) in several cortical and subcortical regions including ventral striatum and orbitofrontal cortex. Individual variation in baseline MOR tone influenced pleasure-dependent haemodynamic responses during music listening in regions associated with interoceptive, auditory and reward processing. Our results provide first neuroimaging evidence that listening to pleasurable music modulates MOR system activation and indicate that the Q-opioid system governs complex aesthetic rewards in addition to biologically salient primary rewards.

Can listening to music improve the well-being of informal caregivers of people with Alzheimer's disease living at home? A case report from the MUSIQUAL protocol

Mathilde Resse (1), Julien Chavant (1), Clémence Lelaumier (1) (2), Florence Fraisse (1), Hervé Platel (1), Mathilde Groussard (1)
1. Inserm, U1077, EPHE, UNICAEN, Normandie Université, PSL Université Paris, CHU de Caen, GIP Cyceron, Neuropsychologie et Imagerie de la Mémoire Humaine (NIMH), Caen, France
2. Univ. Lille, CNRS, UMR 9193 – SCALab – Sciences Cognitives et Sciences Affectives, Lille, France

Subtheme F - Emotion and Well -being

Background: Home care for people with Alzheimer's disease (PwAD) is currently strongly encouraged in France and increasingly provided by informal caregivers (ICs). The impact of this new role can have deleterious consequences for both the ICs' quality of life (stress, fatigue) and the PwAD's (care quality). The effects of listening to music on the PwAD's well-being are now known but only few studies have focused on the ICs' well-being or the benefits of listening to music on the IC-PwAD dyad [1]. Objectives: The aim of the ongoing MUSIQUAL study is to assess the impact of musical listening sessions (MLS), done independently at home, on the ICs' quality of life (QoL) and burnout. Methods: Using an application specifically developed for this study, this program proposes three 20-minute MLS a week on a tablet for 12 weeks. These pieces of music use "U" sequences based on the principles of hypno-analgesia [2]. Self-administered questionnaires assessing QoL and ICs' feelings are completed before and after the MLS. The results of the first IC-PwAD dyad and the caregiver's diary were quantitatively and qualitatively analysed to observe the feasibility of the study. Results: Independent home listening was conducted over 12 weeks, with only 3 MLS out of 36 not carried out. Qualitative analysis reveals a clearer improvement of the IC's QoL (relaxation, sleep quality) than quantitative analysis. Surprisingly, the relaxing effect of music is random for a given extract and seems to depend on the state of mind at the time of listening (anxiety, concerns). Discussion: Our results underline the complementary nature of qualitative and quantitative analyses. The random reactions of the IC to

relaxing music raises questions about the elements to be considered in order to individualise the choice of music offered during MLS. References [1] Allison et al. (2023) [2] Guétin et al. (2014)

Exploring the Relationship Between Mental Health and Music Listening During the Pandemic Among Elders in Canada

Shannie Roberge, B.Sc. (Hons) 1,3,4 ; Marie-Andrée Richard, M.Sc.1,3,4 ; Michel Duchesneau, Ph.D 2,5 ; Isabelle Peretz Ph.D 1,3,4 ; Nathalie Gosselin, Ph.D 1,3,4.
1. Department of Psychology, University of Montreal; 2. Music Faculty, University of Montreal; 3. Centre for Research on Brain, Language and Music – CRBLM; 4. International Laboratory for Brain, Music and Sound Research – BRAMS; 5. Interdisciplinary Observatory for Creation and Research in Music – OICRM

Subtheme F - Emotion and Well -being

The mental health and well-being of the elderly has been a growing concern in recent years, which has been further exacerbated by the COVID-19 pandemic. Our study aimed to measure the impact of listening to music on the mental health in elderly individuals, more specifically on stress, anxiety symptoms (such as ruminations) and mood during the COVID-19 pandemic, but also to compare whether the effects differ between people with or without anxiety or depressive symptoms (ADS). An online survey was completed by 338 Canadians aged 60 years and older, including questions related to the emotional effects of listening to music and standardized measures of anxiety-depressive symptoms (e.g., Generalized Anxiety Disorder). Chi-squared tests were used to compare the score distributions among the groups. In our sample, 23% of respondents reported ADS reaching the screening threshold (ADS+ group). In addition to suffering from ADS, nearly half of the ADS+ group felt isolated ($p < .01$). This ADS+ group was significantly more likely to report that music decreases often or very often their stress and rumination ($p < .05$) than the non-clinical ADS group (ADS- group). In contrast, more people in the ADS- group reported that music listening improved their mood and made them happy ($p < .001$). These findings suggest that music can be beneficial for older adults who suffer from ADS in reducing symptoms of stress and anxiety. Additionally, the results indicate that almost 75% of non-anxious elderly individuals view music as a mood enhancer. These findings suggest that music could be used as a self-care tool to promote good mental health and well-being in the elderly population, particularly in times of social crisis and that the impact is different for people with or without ADS.

A qEEG study of listening to Indian Ragas: Cortical sources and Emotions induced

Abhisek Sahoo, Prashant Tayade, Suriya Prakash Muthukrishnan, Simran Kaur, Ratna Sharma
Department of Physiology, All India Institute of Medical Science, New Delhi, India,

Subtheme F - Emotion and Well -being

A raga is a set of musical notes and their allowed arrangements to form a melody. Indian classical music's ragas are known to affect the human mind but the mechanism is still unknown. And QEEG with its sub-second resolution can be used to study the same. This study was undertaken to find out the cortical sources activated while listening to Indian ragas along with the emotions induced. 30 Indian subjects (Mean age- 26.1 and (SD) - 1.4 years) were asked to listen to 4 Indian ragas of 5 minutes each. 128 channel of EEG signal was recorded which was preprocessed and cortical source localisation was done using sLORETA.The emotions induced while listening to each raga were assessed by using Geneva Emotional Music Scale and Self-Assessment Manikin scale. Results revealed that Raga Bilawal, a raga with all major notes, elicited significantly more joy than other 3 ragas. Raga Todi with 4 minor notes elicited significantly more sadness and tense feeling than other ragas. The cortical sources analysis showed increased activation in cortical regions associated with the extraction of acoustic features of music (superior, middle, and inferior temporal gyruses in addition to fusiform and supramarginal gyrus), Default Mode Network (posterior cingulate cortex, medial prefrontal cortex, and inferior parietal lobule) and emotion generation (precuneus and inferior frontal gyri) while listening to Raga Bilawal and decreased activation in these areas with other 3 ragas as the minor notes increased. We conclude that the notes in ragas can affect brain activity i.e., emotions induced and the DMN activity. Raga with more major notes induces happiness in the listener and activation of DMN areas causing mind wandering and self-referential mental activity than raga with predominant minor notes which decreases DMN activity and induces sadness.

A functional MRI exploration of music-induced emotions towards future music-based interventions
Vabbè dai, fa niente, mi rovino subito anche con lei

Alexandre Sayal 1,2,3, Teresa Sousa 1,3, Miguel Castelo-Branco 1,3,4,5, Inês Bernardino 1,3, Bruno Direito 1,3,6, 1 Coimbra Institute for Biomedical Imaging and Translational Research (CIBIT), University of Coimbra, Portugal, 2 Siemens Healthineers, Portugal, 3 Intelligent Systems Associate Laboratory (LASI), Portugal, 4 Faculty of Medicine, University of Coimbra, Portugal, 5 Institute for Nuclear Sciences Applied to Health (ICNAS), University of Coimbra, Portugal, 6 Centre for Informatics and Systems of the University of Coimbra (CISUC), University of Coimbra, Portugal

Subtheme F - Emotion and Well -being

Music is a universal, emotion-provoking stimulus. Its effects on emotion regulation and reward have attracted much attention in cognitive and affective neuroscience. Over the years, studies have proposed numerous psychological mechanisms through which music gains its emotional impact, highlighting different attributes of the music or the musical experience that mediate them. Here, we aim to advance our knowledge of the underlying brain mechanisms of music-evoked emotions that could support new interventions in emotional disorders. Accordingly, we conducted a personalized experiment by asking participants to choose two excerpts of familiar music that elicited one of nine specific emotions. Following the aesthetic music emotions framework, we assessed a nine-dimensional space: wonder, transcendence, tenderness, nostalgia, peacefulness, power, joyful activation, tension, and sadness. The main goal was to map, using functional magnetic resonance imaging (fMRI), the brain regions that respond in tune with each evoked emotion, and then create a decoding model for these emotions. We acquired fMRI data from 13 healthy participants (8 female, 3237 years old) while they listened to the chosen excerpts with closed eyes, interleaved with blocks of soft white noise. The protocol was optimized to potentiate each evoked emotion while reducing emotional variability. The only instruction given was to allow the songs to drive the emotions freely. The dataset was converted to the Brain Imaging Data Structure, pre-processed using fmriPrep v23, and analyzed with Nilearn. The first results retrieved from group-level activation analysis, contrasting all emotions with noise, highlight the role of several regions, most noticeably the music-specific sub-regions of the auditory cortex, amygdala, putamen, and hippocampus. Different activation patterns across emotions can be found in the hippocampus and putamen. Data-driven analyses will clarify what features (i.e. brain correlates) allow for the automatic discrimination between these music-evoked emotions. Ultimately, this discrimination will guide future music-based interventions.

The interaction between musical familiarity and musical features and how they influence relaxation

Rebecca Jane Scarratt 1, Martin Dietz 2, Peter Vuust 1, Boris Kleber, 1, Kira Vibe Jespersen 1,
1 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Aarhus, Denmark; 2 Center of Functionally Integrative Neuroscience, Institute of Clinical Medicine, Aarhus University, Denmark;

Subtheme F - Emotion and Well -being

High levels of stress are increasing worldwide. While positive stress can increase cognitive functioning, chronic stress can lead to severe physical and mental problems. Finding appropriate ways to reduce this stress will help many of the general population and avoid more serious conditions. Music is a cost effective and implementable at home solution. However, it is unclear which type of music should be used. Physiological research suggests that music should have slow tempo, few dynamic changes, and be instrumental and calm. On the other hand, self-selected music, with different musical features, has also been found to be effective. In an earlier study, we found a large variety in the type of music actually listened to in order to help fall asleep. Few studies have investigated how different variations of musical features influence relaxation and brain processing. Here, participants listened to be Familiar or Unfamiliar and Sedative (slow, calm music) or Energetic (upbeat music) music excerpts while in the functional magnetic resonance imaging scanner. We found a main effect of familiarity with higher activation in both motor cortices, left inferior frontal gryus and the cerebellum. The excitation contrast showed high activation of the temporal cortex, especially the insula. Behavioural responses of relaxation ratings indicated individual differences between participants; for about half of the participants, the biggest difference in relaxation ratings was in Familiarity while for the other half, the biggest difference was in Energy. This indicates that musical perception differs between individual and that the influence of Energy or Familiar is different per individual. Further analyses will investigate the link between ratings and brain activation and research the individual differences further. Our results will inform the general public as well as clinicians and music therapists on how to better select the type of music for relaxation, for example in post-operative settings.

Music rewards in patients with schizophrenia and major depressive disorder revealed by the Japanese version of the Barcelona Music Reward Questionnaire

Shiori Honda1, Yoshihiro Noda1, Yui Tobari1, Karin Matsushita1, Masataka Wada1, Ryosuke Tarumi1 2, Kamyu Ogyu1, Masaru Mimura1, Shinichiro Nakajima1 3, Shinya Fujii4;
1. Department of Neuropsychiatry, Keio University School of Medicine, Tokyo, Japan; 2. Seikei-Kai Komagino Hospital, Tokyo, Japan; 3. Multimodal Imaging Group, Research Imaging Centre, Centre for Addiction and Mental Health, Toronto, Canada; 4. Faculty of Environment and Information Studies, Keio University, Kanagawa, Japan

Subtheme F - Emotion and Well -being

Background: Anhedonia, a loss of pleasure and motivation, is common in schizophrenia (SCZ) and major depressive disorder (MDD). It may involve dopaminergic dysfunction in the mesolimbic system, crucial for music reward processing. This study investigates the potential impairment of music reward processing in SCZ and MDD and its relation to symptom severity. Methods: The study included 87 patients with SCZ, 74 patients with MDD, and 109 healthy controls (HCs). All participants were examined using the Japanese version of the Barcelona Music Reward Questionnaire (J-BMRQ), which we have recently translated and validated to assess individual differences in music rewards. Anhedonia symptoms were assessed with the physical anhedonia scale (PAS). In addition, psychotic symptoms were assessed with the Positive and Negative Syndrome Scale (PANSS), and depressive symptoms with the Quick Inventory of Depressive Symptomatology (QIDS). BMRQ and PAS scores were compared across the groups, controlling for age, sex, and musical experiences with analyses of covariance (ANCOVA). Furthermore, we explored the relationship between clinical symptoms and music rewards with Pearson's correlation analyses. Results: The ANCOVA and post-hoc analyses showed that the MDD had significantly lower BMRQ scores ($p=0.004$) than the HCs and SCZ. On the other hand, PAS scores showed significant differences across the three groups, increasing in order from HCs to SCZ, and highest in MDD (MDD vs. HCs, $p<0.001$; MDD vs. SCZ, $p=0.001$; SCZ vs. HCs, $p=0.014$). Moreover, correlations were found between the J-BMRQ and QIDS scores in the MDD ($r=0.485$, $p<0.001$), while not in the SCZ ($r=-0.045$, $p=0.680$). Conclusions: This study revealed differences in music rewards between the MDD and SCZ groups, despite similar clinical anhedonia symptoms. This indicates a discrepancy between clinical anhedonia and music-specific anhedonia in these disorders. Future research should integrate psychological, neuroimaging, and other biological measures to

understand the neural bases of music reward processing.

Investigating the Impact of Synchrony, Music, and Touch on Prosocial Behaviour in Children: A Video Paradigm Study

Gabriella Vizzutti, Maria Witek, Department of Music, University of Birmingham, Edgbaston, Birmingham, UK

Subtheme F - Emotion and Well -being

Humans are inherently social beings and engagement in musical activities enhances prosocial behaviour, crucial for children's development. Prosocial behaviour, defined as voluntary actions benefiting others or fostering harmonious relations, is also influenced by interpersonal touch. This study investigates whether music and synchrony can positively impact prosocial outcomes as effectively as interpersonal touch. Through video paradigm, we examined how synchrony, touch, and music influence prosocial ratings in children, exploring synchronised music-making as a substitute for touch. Forty children aged 7-12, representing ten nations, participated in a within-subject design study adapted from Stupacher's 2017 research. Participants viewed videos of two stick figures walking together and rated their relationship. Ratings were based on the Inclusion of Other in Self (IOS) scale. The figures were presented in eight conditions; acoustic accompaniment, walking synchrony, and touch. Statistical analyses show synchrony, touch, and music enhance prosocial responses. Bayesian analyses reveal that touch had the strongest overall effect on IOS, while synchrony has a greater impact on well-being and likability. Post-hoc comparisons found comparable IOS ratings when figures were synchronously walking without touch compared to asynchronously walking with touch. IOS results were similar in conditions where figures were walking in synchrony to a metronome to conditions where they were walking asynchronously to music. The average IOS ratings were higher when comparing conditions where figures walked in synchrony to music without touch, as opposed to conditions where figures were walking asynchronously to a metronome with touch. These findings suggest that synchrony and music may be comparable touch in promoting prosociality in children. Given the scarcity of interpersonal touch in the digital age and in the aftermath of the COVID-19 pandemic, attention should be given to alternative forms of social interaction, such as synchronic music-making, which may offer similar benefits for social cohesion when touch is not feasible.

Exploring the lived experience of flautists' performance-related health and wellbeing

Jiayi Wang IOE, UCL's Faculty of Education and Society, London, UK

Subtheme F - Emotion and Well-being

The study has investigated the lived experience of flautists, focusing on their experiences and perceptions of performance-related physical discomfort, injury and related mental health challenges that they have encountered in practice and performance. The aims of the research have been to provide flautists with an opportunity to reflect on any physical or psychological performance issues in their own words, and to understand the subjective meaning of these experiences. A qualitative approach was used for gathering data. All the fieldwork was undertaken during or immediately after the Covid-19 pandemic. Consequently, the participating flautists were deliberately selected using professional networks on the basis of the combined characteristics of their personal backgrounds and experiences, as well as being able to participate remotely. There have been two data collection phases. Phase 1 was a specially designed pre-interview questionnaire drawing on themes from appropriate literature. Phase 2 was built on the pre-interview questionnaire responses and was designed as semi-structured interviews, undertaken on Zoom, and included a 'River of Flute-playing Experience' activity during the interview. The 'River of Experience' method is an autobiographical research tool. Participants were asked to write down their experiences and challenges at various key points along their drawing of a meandering river. The combined data analyses drew on thematic analysis. The eight participants reported a personal history of performance-related health and wellbeing challenges that they had faced at some point in their lives. The findings reveal that flautists encounter health-related challenges associated with their practice and performances, and the data suggest that they each require (i) an understanding of likely performance-related health challenges and (ii) supportive resources to assist them in managing these challenges. The research highlights the importance for flute teachers in having practical knowledge of injury prevention in order for such knowledge to be a key component of their teaching.

Individual endogenous rhythms maximize music-induced pain reduction

Wenbo Yi, Caroline Palmer, Mathieu Roy;
Department of Psychology, McGill University, Montreal, Canada

Subtheme F - Emotion and Well -being

Music is a non-invasive, economically efficient method for mitigating pain perception. Prior studies indicate that musical preferences and auditory entrainment can augment pain reduction. However, the effects of specific musical attributes and individual differences on music-induced hypoalgesia are not yet fully understood. The current research examined the influence of musical tempo and individuals' endogenous rhythms in the reduction of pain sensitivity. We hypothesized that musical rates that are matched to individuals' endogenous rates will maximize the hypoalgesic effect by strengthening their neural entrainment with the music. First, participants' intrinsic optimal entrainment rates were determined by measuring their spontaneous production rates. Subsequently, one of the four styles (Popular, Classical, Dance, International) of unfamiliar musical excerpts was sounded at rates tailored to each participant's spontaneous rate, as well as at tempi 15% faster and 15% slower. Participants were asked to rate their perceived pain levels from arm-applied heat stimuli (adjusted to each individual's pain sensitivity) in four different conditions: pain with music presented at the participants' spontaneous rate, music presented 15% faster, music presented 15% slower, or pain without music. Consistent with our hypothesis, the music presented at the participants' spontaneous rates yielded the greatest reduction in perceived pain ratings. These findings demonstrated person-specific effects of musical tempo on pain perception and present further support for neural entrainment as a mechanism of music-induced hypoalgesia. The use of novel music presented at individuals' spontaneous rates allows music therapists to maximize tempo for individualized optimal pain management.

Pacing and Leading Mood with Music Based on Rhythmical Physiological Parameters

Heinrich Zimmermann
Zimmermann Research GmbH
Thun Switzerland

Subtheme F - Emotion and Well -being

As a seasoned researcher and developer, I have explored the intersection of psychology, musicology, neurophysiology, and mathematics. My focus lies in the development of ecosystems in which rhythms and melodies flow back and forth between humans and machines. In this study, I delve into the potential of rhythmical and melodic human-machine interaction. By analyzing vocal expressions and beat-to-beat heart rate measurements, machines curate musical patterns that are in resonance with the mood. The machines should then try to steer the mood in a desired direction, e.g. from stress to relaxation. In the musical ecosystem, human subjects engage in regular interactions with music-generating machines. These machines exhibit diverse characteristics, systematically varied for experimentation. Before and following each interaction session, vocal expressions, and the heart rate variability (HRV) of the participants are evaluated. Initial findings demonstrate encouraging correlations between the distinctive features of machine-generated music, vocal expressions, and the HRV. Under specific conditions, participants express and show enhanced relaxation after engaging in sessions in the musical ecosystem.

Choir singing is associated with enhanced structural connectivity in the ageing brain

Nella Moisseinen1, Lotta Ahveninen1, Noelia Martínez-Molina1,2, Viljami Sairanen3,4, Susanna Melkas5, Boris Kleber6, Aleksi J. Sihvonen1,7,8† and Teppo Särkämö1†,
1 Cognitive Brain Research Unit, Centre of Excellence in Music, Mind, Body and the Brain, Department of Psychology and Logopedics, Faculty of Medicine, University of Helsinki, Helsinki, Finland; 2 Centre for Brain and Cognition, Department of Information and Communication Technologies, University Pompeu Fabra, Barcelona, Spain; 3 Department of Radiology, Kanta-Häme Central Hospital, Hämeenlinna, Finland; 4 Baby Brain Activity Center, Children's Hospital, Helsinki University Hospital and University of Helsinki, Helsinki, Finland; 5 Clinical Neurosciences, Neurology, University of Helsinki; 6 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Denmark; 7 Centre for Clinical Research, School of Health and Rehabilitation Sciences, University of Queensland, Brisbane, Australia; 8 Department of Neurology, Helsinki University Hospital, Finland, † Equal contribution

Subtheme G - Development and Aging

The global ageing of populations calls for effective, ecologically valid methods to support brain health across adult life. Previous evidence suggests that music can promote white matter (WM) microstructure and grey matter (GM) volume while supporting auditory and cognitive functioning and emotional well-being as well as counteracting age-related cognitive decline. Adding a social component to music, choir singing is a popular leisure activity among older adults, but a systematic account of its potential to support healthy brain structure, especially in relation to ageing, is currently missing. The present study used quantitative anisotropy (QA) -based diffusion MRI (dMRI) connectometry and voxel-based morphometry (VBM) to explore the relationship of lifetime choir singing experience and brain structure at whole-brain level. Cross-sectional multiple regression analyses were carried out in a large, balanced sample (N = 95; age range 21–88) of non-singers and amateur -level choir singers across the whole age range and within subgroups defined by age (young, middle-aged, and older adults). Independent of age, choir singing was associated with extensive increases in WM QA in commissural, association, and projection tracts across the brain. Corroborating previous work, these overlapped with language and limbic networks. Enhanced corpus callosum microstructure was associated with choir singing experience across all subgroups. In addition, choir singing experience was selectively associated with enhanced QA in the fornix in older participants. No associations between GM volume and choir singing were found. The present study offers the first systematic account of amateur-level choir singing on brain structure. While no evidence for counteracting GM atrophy was found, the present evidence of enhanced structural connectivity fits well with age-typical structural changes. Corroborating previous behavioural studies, the present results suggest that regular choir singing holds great promise for supporting brain health across the adult life span.

Musicianship-Related Structural and Functional Cortical Features Are Preserved in Elderly Musicians

Jan Benner 1; Oana G. Rus-Oswald 2,3; Julia Reinhardt 2,4,5; Céline Bürki 3; Markus Christiner 6,7; Elke Hofmann 8; Peter Schneider 1,6,7; Christoph Stippich 9; Reto W. Kressig 3; Maria Blatow 10.
1 Department of Neuroradiology, University Hospital Heidelberg, Heidelberg, Germany; 2 Department of Neuroradiology, Clinical Neuroscience Center, University Hospital Zürich, University of Zürich, Zürich, Switzerland; 3 University Department of Geriatric Medicine FELIX PLATTER, Basel, Switzerland; 4 Division of Diagnostic and Interventional Neuroradiology, Department of Radiology, University Hospital Basel, University of Basel, Basel, Switzerland; 5 Department of

Cardiology and Cardiovascular Research Institute Basel, University Hospital Basel, University of Basel, Basel, Switzerland; 6 Centre for Systematic Musicology, University of Graz, Graz, Austria; 7 Vitols Jazeps Latvian Academy of Music, Riga, Latvia; 8 Academy of Music, University of Applied Sciences and Arts Northwestern Switzerland (FHNW), Basel, Switzerland; 9 Department of Neuroradiology and Radiology, Kliniken Schmieder, Allensbach, Germany; 10 Section of Neuroradiology, Department of Radiology and Nuclear Medicine, Neurocenter, Cantonal Hospital Lucerne, University of Lucerne, Lucerne, Switzerland

Subtheme G - Development and Aging

The brain of professional musicians exhibits distinct structural and functional cortical features; however, little is known about how these features evolve during aging. This multiparametric study aimed to examine the functional and structural neural correlates of lifelong musical practice in elderly professional musicians. We assessed gray matter metrics of the brain using high-resolution magnetic resonance imaging (MRI) in 16 elderly professional musicians (age >70), 15 elderly non- musicians and 16 young music students. Furthermore, we evaluated functional blood oxygenation level-dependent (BOLD) activations in auditory and non-auditory regions by functional MRI (fMRI) using an attentive tone-listening task. At the whole-brain level our results showed a general reduction of gray matter in the elderly as compared to the young participants, corresponding to widespread natural brain atrophy. We found group-specific structural correlations with age and musicianship in several clusters including superior, middle, and inferior frontal as well as perirolandic areas. In addition, elderly musicians exhibited a likewise increased gyrification of auditory cortex as compared to the young musicians. During fMRI, the elderly non-musicians activated predominantly auditory regions, whereas the elderly musicians additionally co-activated a much broader network of auditory association areas, primary and secondary motor areas, and prefrontal and parietal regions comparable to the young musicians. Also, group-specific functional correlations with age and musicianship were observed in frontal and parietal regions. In conclusion, despite naturally occurring senescence, the elderly musicians maintained musicianship-specific structural and functional cortical features. We identified structural and functional brain regions discriminating elderly musicians from non-musicians, which might be of relevance for the aging musicians' brain. To what extent lifelong musical activity may have a neuroprotective impact needs to be addressed in further longitudinal studies.

The Child Musicality Screening: A new questionnaire to assess Musicality in 3-10-year olds

Verena Buren1; Daniel Müllensiefen2; Anna Monschau1; Sever-Laurentiu Sava2; Franziska Degé1
1 Department of Music, Max Planck Institute for Empirical Aesthetics, Frankfurt/Main, Germany; 2 Department of Psychology, Goldsmiths University of London, London, UK;

Subtheme G - Development and Aging

Background.Musicality in childhood is often measured using perception tests that neglect the complex nature of musicality. However, studies have shown that musicality is multifaceted (Buren et al., 2021). Hence, assessment methods that capture musicality more broadly are needed. Aim. The aim of this study is to develop a screening questionnaire for parents, teachers and educators that comprehensively assess children's musicality. Methods. We created an online questionnaire in German and English with 57 statements on child musical behavior. The participants rated these statements in relation to a child they know well on a 5-point Likert scale. The sample comprised 808 adults (293 English-speaking, 400 female) aged 18 to 81 years ($M = 32.90$, $SD = 10.43$). In order to explore the structure and select items for the final version, an iterative methodology was chosen in which the factors to be extracted were determined using parallel analysis and then extracted using an exploratory factor analysis. Confirmatory factor analyses with invariance tests were carried out for German vs. English language and younger vs. older children. Results. The final model consists of 9 items on 3 factors (motivation & enthusiasm, music perception, music production), which explain 61% of the cumulative variance. The relative and absolute fit indices for this model are in a good range (RMSAE = .048, SRMR = .033, CFI =.985, TLI = .977). Factor loadings range between .54 and .86 with $p <= .001$. Cronbach's α for the total scale is .86, with scale values of .82, .82 and .73. It achieves strict invariance across German and English and different age groups. Discussion and conclusion. The resulting short questionnaire is based on a broad understanding of musicality, is time-efficient, covers a wide age range, can be used by parents and teachers, and is available in German and English.

Functional brain coupling changes in the progression of Alzheimer's disease are associated with low cognitive reserve, social isolation and hearing impairment

Campo, Fulvia Francesca 1,2; Cabral, Joana 3; Nigro, Salvatore 4; Tafuri, Benedetta 4; Logroscino, Giancarlo 4,5; & Brattico, Elvira 1,2 , for the Alzheimer's Disease Neuroimaging Initiative*.
1 Department of Education, Psychology, Communication, University of Bari "Aldo Moro", Bari, Italy 2 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/ Aalborg, Aarhus, Denmark. 3 Life and Health Sciences Research Institute (ICVS), School of Medicine, University of Minho, Braga, Portugal 4 Center for Neurodegenerative Diseases and the Aging Brain, Department of Clinical Research in Neurology, University of Bari "Aldo Moro", "Pia Fondazione Cardinale G. Panico", Tricase, Lecce, Italy. 5 Department of Basic Medicine, Neuroscience, and Sense Organs, University of Bari "Aldo Moro", Bari, Italy

Subtheme G - Development and Aging

Latest research has evidenced crucial risk factors for the incidence and progression of Alzheimer's disease (AD), such as social isolation, low cognitive reserve, and not-corrected hearing loss. These factors are related to each other since low cognitive reserve indicates scarce involvement in complex leisurable activities whereas not -corrected hearing loss produces auditory deprivation and sparse options for social interaction. Music-based interventions address these factors effectively but the biological mechanisms and their impact on AD remain unclear. In this work, we analyzed a public repository of fMRI brain scans from elders at rest categorized as having early and late mild cognitive impairment, AD and healthy controls. We applied a method to detect functional coupling modes to the entire brain, including both cortical, subcortical, ventricular and cerebellar regions, and compare their occurrence across conditions. The functional coupling has then been correlated with social isolation (from marital and retirement status and depression questionnaire), cognitive reserve (years of education) and self-reported hypoacusis. Our results reveal a series of coupling modes in fMRI signals beyond gray matter and the 4th ventricle. While some modes overlap with known 'resting-state networks', the ones that most significantly changed with the progression of cognitive decline involved anti-phase coupling between signals from ventricular and global gray matter signal. Notably, these patterns were directly associated with social isolation and hearing impairment. Given that CSF flows into the brain parenchyma to clear toxic waste, these findings suggest that functional connectivity is associated with ultraslow and macroscopic coupling modes,

linked to cognition. Moreover, the impact of environmental risk factors on the functioning of these networks suggests strong interconnectedness between biological and environmental factors in AD. Hence, alongside investigating brain function at a biological level, action should also be taken at an environmental level, using proven tools for addressing social isolation, such as musical interventions.

Unveiling Rhythmic Ability in Children: A Comprehensive Review and Novel Assessment Approach

Francesca Cantoni1, Anna Fiveash2, Barbara Tillmann1. 1LEAD CNRS UMR5022, Université de Bourgogne-Franche Comté, Dijon, France; 2 The MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Sydney, Australia

Subtheme G - Development and Aging

Recent research has highlighted the importance of rhythm processing in both music and language domains. Although several tools have been developed for measuring rhythmic abilities, they are largely designed for adults, with fewer being tailored for children. Given the variation in rhythmic skills over development, and observations of atypical rhythmic processing in children with neurodevelopmental disorders, it becomes necessary to develop or adapt rhythm assessment tools for children. The adaptations should consider potential sub-processes and separable competencies involved, including rhythm production, beat-based rhythm perception, and sequence memory-based rhythm perception. The present study reviews existing tools, evaluating their strengths and weaknesses, and proposes potential extensions to current assessments of rhythmic skills in school-age children. Child-targeted tests could implement various strategies, incorporating: 1) more complex music-like materials integrating the task-relevant manipulation within the music stimuli and using expressive features; 2) adaptive threshold measurements, which should be more sensitive to individual differences in performance across development; 3) short duration, considering children’s restricted attention spans; and 4) engagement and interactivity. Emphasis is placed on beat and meter perception, which is less frequently assessed, in addition to rhythm perception, aiming to explore underlying cognitive processes and their developmental trajectory. A first implementation, in which participants judged whether musicians played well together, correlated with performance on a classical Beat Alignment Test, which involves determining whether an external metronome is aligned with the music. Building upon these findings, we are developing a second implementation incorporating more musical stimuli, including both beat and meter perception, and potentially extending to production. This work discusses the importance of recognizing developmental stages in evaluating rhythmic competencies, using more musical materials, and suggests directions for future research and applications in rehabilitation programs for children with language impairments.

The Plasticity Theory of Implicit Music Knowledge Acquisition (PTIMKA): Evidence from corpus analysis and short-term retention of six decades of popular music in younger and older participants

Annabel J. Cohen; Corey Collett
Department of Psychology, University of Prince Edward island, Charlottetown

Subtheme G - Development and Aging

Our Plasticity Theory of Implicit Knowledge Acquisition (PTIMKA) posits an adolescent/emerging adulthood sensitive period for acquisition of musical information, which follows the sensitive period for acquisition of first language. Evidence for PTIMKA comes from our research on short-term retention of popular music by 27 older (M = 65.7 years, SD = 6.7) and 19 younger (M = 20.3 years, SD = 2.3) adults. Participants heard short excerpts from 36 Billboard 100 songs, 3 from each half-decade between 1962 – 2021. Following an initial familiarity rating task of all songs, a surprise recognition task required choosing which of two excerpts had been previously presented. For each of 36 trials, target excerpts and foils represented the same era of popularity. Retention (d') and confidence in retention judgment were significantly stronger for songs of adolescence/emerging adulthood, despite the presentation of all 36 targets in the previous 15 minutes. The opposite trajectories of the two age groups for familiarity, retention and confidence reflected heightened musical knowledge during the adolescent/emerging adulthood period. To characterize the statistical properties of the presented music, we used The Billboard Melodic Music Dataset (BiMMuDa) of Madeline Hamilton and Marcus Pearce (2023) which quantifies properties of the melodies of the top 5 Billboard songs from 1950-2022. Their data show systematic changes with year of popularity in a variety of melodic features. As our selections were drawn primarily from top 2 Billboard songs, we conducted similar analyses and showed significant correlations with year of popularity (e.g., pitch SD $r = -.32$, $p < .001$). An explanation for our behavioral results thus may go beyond simply prior exposure to and memory for individual songs. Rather, results may reflect acquisition of implicit knowledge of regularities of musical styles to which one is during the adolescent/early adulthood period of heightened plasticity for musical information.

When metric cues conflict: Differences in oscillatory brain activity between older and younger adults

Cooke, Stephen (1), Prince, Jon (2), Vuvan, Dominique (3), Zendel, Benjamin Rich (1)
1. Faculty of Medicine, Memorial University of Newfoundland, St. John's, Canada 2. School of Psychology, Murdoch University, Perth, Australia 3. Psychology Department, Skidmore College, Saratoga Springs, USA

Subtheme G - Development and Aging

Metre is the subjective and hierarchical organisation of stronger and weaker beats in music. Although metric perception is subjective, it can be influenced by acoustic features. Interestingly, when metric cues are presented simultaneously, but conflict, pitch-based acoustic cues are preferred to time-based cues, even after equalising their ability to evoke the perception of a metre in baseline conditions. The timing of acoustic cues and subjective metric interpretation are observable in oscillatory brain activity, however, it remains unknown how oscillatory brain activity is impacted when simultaneous, but conflicting metric cues are present. Finally, there is growing evidence that unlike other aspects of auditory cognition, music perception seems to be relatively preserved in older adults. Accordingly, the goal of this study was to explore what age-related differences are present in perceiving conflicting metric cues and how they are represented in oscillatory brain activity. Participants were presented with a series of nine sequences containing pitch and/or duration cues for a triple (0.67 Hz) or duple (1Hz) metric interpretation, and asked to rate each sequence's metre. Consistent with previous work, participant ratings were more strongly influenced by pitch cues than time cues in younger adults' metric perception; this pattern replicated in older adults. Furthermore, for conflicting cues, oscillatory brain activity was consistent with frequency of the pitch cue, rather than frequency of the time cue, in both younger and older adults. The lack of differences found between younger and older adults provides neurophysiological support for the idea of pitch-dominance for the perception of metre, and highlights that age does not impact the perception and neural representation of conflicting metric cues.

Can individual differences in musical sophistication explain associations between executive functioning and musical perception?

Delmolin, G., Vanzella, P.
Graduate Program in Neuroscience and Cognition, Universidade Federal do ABC, São Bernardo do Campo, Brazil; Interdisciplinary Unit for Applied Neuroscience, Universidade Federal do ABC, São Bernardo do Campo, Brazil.

Subtheme G - Development and Aging

Executive functions (EF) encompass a set of cognitive abilities that enable us to plan, organize, focus attention, control impulses, and make decisions. Numerous studies have explored how musical training can foster the development of these functions during human development. Playing a musical instrument engages sub-skills associated with EF, such as sustained attention, goal-directed behavior, and cognitive flexibility in task-switching demands. However, much of this research has primarily focused on evaluating and comparing musically trained individuals with those having little or no musical training, often emphasizing Western musical experiences. Unfortunately, experimental tasks frequently lack ecological validity and fail to capture the entirety of the musical experience. Neuroimaging studies shed light on complex interactions between musical perception and cognition, but they do not fully elucidate how this relationship depends on individual cognitive dispositions and diverse musical experiences. Consequently, such an approach may yield results that are challenging to generalize and provide limited insights into how cognitive development and functioning can be influenced by musical training. Considering this, we propose that musicality should be regarded as a critical covariate in research. Musicality, inherent to the human species, exhibits remarkable diversity and can be productively studied from comparative, neural, developmental, and cognitive perspectives. Particularly from a developmental standpoint, musicality helps us comprehend how associations may arise between cognitive development and musical training. We hypothesize that, as a covariate measure, musicality can explain individual differences in musical perception, without this being exclusively linked to the cognitive profile of executive functions. To test this hypothesis, we will present a protocol to assess musical perception and executive functioning skills in healthy adults with different levels of musical sophistication.

Tempo Sensitivity Unveiled in Rhythmic Processing of Premature Infants

Mohammadreza Edalati1; Fabrice Wallois1; Ghida Ghostine1; Guy Kongolo1; Laurel J. Trainor2; Sahar Moghimi1 Institut National de la Santé et de la Recherche Médicale, Unité Mixte de Recherche 1105, Groupe de Recherches sur l'Analyse Multimodale de la Fonction Cérébrale (GRAMFC), Université de Picardie, Amiens, France; 2 Department of Psychology, Neuroscience, and Behaviour, McMaster University, Hamilton, Ontario, Canada

Subtheme G - Development and Aging

The capacity to perceive rhythmic structures is crucial for the development of language, music, and social communication. Our previous study in premature infants at 30 -34 wGA revealed selective enhancement of the neural response to grouping of two beats (duple meter) compared to single beats in a 6 beat ambiguous rhythm. A similar enhancement was absent in response to grouping of 3 beats (triple meter). In a more recent study, we showed that the neural response to the beat is present, even at the beginning of the third trimester of gestation, whereas the neural response to beat groupings develops gradually in this period with significant neural responses to single beats and groupings of beats near term. These results raised the question about the underlying factors, specifically whether it stemmed from the difficulty in processing slower tempi (long cycles) or a not yet developed neural coding of beat groupings. To address this question, we recorded electroencephalography in early premature newborns (<=32 wGA, currently in progress) in the incubator while exposed to the same auditory ambiguous rhythmic pattern at two tempi. The six-beat rhythmic sequence at the slow tempo has a beat frequency=3.33 Hz, duple meter frequency=1.66 Hz, and triple meter frequency=1.11 Hz, and the same rhythmic sequence at the fast tempo has a beat frequency=6.66 Hz, duple meter frequency=3.33 Hz, and triple meter frequency=2.22 Hz. We currently analyze the neural responses using frequency tagging, and stimulus-response synchronization measures. We compare the neural responses to the beat and the same metrical levels at the two different tempi. Our hypothesis is that the tempo (cycle duration) plays an important role in the neural coding of the rhythmic hierarchy and neural responses to beat groupings might arise at the fast tempo. We present our preliminary results at the two tempi to support our hypothesis.

Age- and intervention-related variability in network engagement during music listening

Sarah Faber1, Alex G. Belden2; Psyche Loui2; Randy McIntosh1
1 Simon Fraser University, Vancouver, BC; 2 Northeastern University, Boston, US;

Subtheme G - Development and Aging

Music is an enjoyable stimulus that is used therapeutically in numerous settings. Despite promising clinical reports, how music remains accessible to individuals with cognitive decline remains unknown. In the present study, older adults listened to a selection of music excerpts both familiar and novel while fMRI was recorded before and after an eight week music listening intervention. We used hidden Markov modelling (HMM, Vidaurre et al., 2016) and partial least squares (PLS; McIntosh et al., 1996) to identify patterns of network engagement and transition during music listening, and how these patterns differed before and after the intervention. We collected fMRI data from 15 cognitively healthy older adults (M = 62.67, SD = 15.35) during music listening. Excerpts included self-selected familiar, well-liked songs; and excerpts selected by experimenters. Participants provided liking and familiarity ratings following each excerpt. This protocol was completed twice: once before the intervention, and once following the intervention. We identified 4 brain states or functional networks. We calculated the fractional occupancy (time spent in each network) and transitional probability (the weighted, directed pairwise likelihood of transitioning between networks) for each excerpt, pre- and post-intervention. We averaged these values by stimulus category and modelled intervention effects using PLS. Results showed higher fractional occupancy in a bilateral temporal network pre-intervention, and higher fractional occupancy in a bilateral temporal mesolimbic network post-intervention. These networks are functionally analogous to the auditory network and auditory-reward network respectively. Transitional probability was higher for the temporal network pre-intervention, and higher for the temporal mesolimbic network post-intervention. These findings indicate that music listening may be able to change dynamic network activity patterns to prioritize musical reward. Increased reward stemming from increased music listening is one way music may be an effective therapeutic tool, and these findings raise many fascinating questions for future clinical work.

Exploring the Impact of Prematurity on the Perception of Infant-Directed Singing: A Multimodal Analysis of Visual Behaviour and Neural Responses

Betania Y. Georlette1, Mohammadreza Edalati1; Rafael Román-Caballero2; Laurel J. Trainor3,4; Barbara Tillmann5; Fabrice Wallois1; Sahar Moghimi1
1 Institut National de la Santé et de la Recherche Médicale (INSERM) U1105, GRAMFC, Université de Picardie Jules Verne, Amiens, France, Amiens; 2 Department of Experimental Psychology, and Mind, Brain and Behaviour Research Centre (CIMCYC), University of Granada, Granada, Spain; 3 Department of Psychology, Neuroscience, and Behaviour, McMaster University, Hamilton, Ontario L8S 3L8, Canada; McMaster Institute for Music and the Mind, McMaster University, Hamilton, Ontario L8S 3L8, Canada; 4 Rotman Research Institute, Baycrest Hospital, Toronto, Ontario M6A 2E1, Canada; 5 Laboratory for Research on Learning and Development, CNRS–UMR 5022, University of Burgundy, 21000 Dijon, France.

Subtheme G - Development and Aging

Prematurity constitutes a risk factor for neurodevelopmental disorders. Studying the behavioural, neuronal, and social developmental aspects of prematurely born children is crucial for detecting of early deficits, and therefore for better care of this vulnerable population. Infant-directed singing is a rich sensory experience that is known to enhance bonding and synchronises behaviour between the singer and the infant. In this study, we intend to understand (1) how preterm-born infants react to infant-directed singing compared to their term-born counterparts and (2) whether early musical interventions impact on the related neural/behavioural capacities. We measure the infants' behavioural and neural entrainment to auditory and visual rhythmic cues via eye-tracking and electroencephalography. Replicating the recent study from Lense et al. (2022) with French material, videos of women singing infant-directed songs in French are presented to infants born preterm and infants born at term at the age of 6 months. Our research strategy involves first assessing full-term infants to extract baseline data, followed by a comparative analysis with preterm infants. This approach will allow us to identify specific behavioural and neuronal biomarkers associated with prematurity through a coupled analysis of eye-tracking and EEG. We hypothesise that early premature birth could induce alterations in the perception of infant-directed singing, and that it would be reflected in distinctive gaze patterns and specific neuronal responses. This altered perception may indicate atypical neural pathways or connectivity in preterm-born infants that will potentially shape their

developmental trajectory. In the long-term, this could affect psychosocial, language, and musical abilities development. Early musical interventions could at least in part compensate early deprivations of rhythmic auditory stimulation, and therefore enhance both behavioural and neural responses to infant-directed singing.

Developmental trajectories of implicit and explicit rhythmic abilities in children

Antoine Guinamard1,2,3,4, Nicholas E.V. Foster1,2,3, Sylvain Clément4, Valentin Bégel5, Sonja A. Kotz6, Séverine Samson4,7, Simone Dalla Bella1,2,3*, Delphine Dellacherie4,8*.
1 International Laboratory for Brain, Music and Sound Research (BRAMS), Montreal, Canada. 2 Department of Psychology, University of Montreal, Montreal, Canada. 3 Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada. 4 Univ. Lille, ULR 4072 - PSITEC - Psychology : Interactions, Time, Emotions, Cognition, Lille, France. 5 Institut des Sciences du Sport Santé de Paris (I3SP), Paris Cité University, Paris, France. 6 Dept. of Neuropsychology & Psychopharmacology, University of Maastricht, Maastricht, the Netherlands. 7 Institut de l'Audition-Institut Pasteur, Paris, France . 8 CHU Lille, Centre de Référence Malformations et Maladies Congénitales du Cervelet, Lille, France. *Equal senior contribution

Subtheme G - Development and Aging

Processing rhythmic auditory information is part of many daily activities. The ability to extract the temporal structure of a sound sequence, such as speech or music, is linked to cognitive development. Poor temporal and rhythmic abilities are observed in many neurodevelopmental disorders (e.g. ADHD, Dyslexia). The timing of auditory events can be processed explicitly, when we assess the temporal properties of an auditory sequence, such as interval durations or sequence regularity, or implicitly when temporal information is processed incidentally to improve performance in non-rhythmic tasks. Implicit rhythmic abilities are well documented in adults. However, little is known about these abilities and their relationships with explicit rhythmic abilities and other cognitive functions in children. This limits our understanding of the role of rhythmic abilities in typical and atypical development. In this study, we tested 1) implicit rhythmic abilities with a new gamified task, 2) explicit rhythmic abilities with perceptual and motor tasks, and 3) attentional and executive functions in children aged 7-13 (n = 98). In the implicit task, participants had to react as quickly as possible to a pitch change following a 8-tone sequence. Children showed faster reaction times after a regular rhythmic sequence than

after an irregular one, suggesting that they can process temporal regularity implicitly. This facilitatory effect was independent of explicit rhythmic abilities but was modulated by individual differences in attention and executive functioning. Notably, performance in the implicit timing task was independent of age, while performance in the explicit timing tasks improved with age. In sum, the current results suggest that typically developing children between 7 and 13 years old implicitly process the rhythm of auditory events, and that implicit and explicit rhythmic abilities follow different developmental trajectories. These findings can inform new clinical or interventional perspectives for children with neurodevelopmental disorders associated with rhythm deficits.

Understanding Music and Aging through the lens of Bayesian Inference

Heng Jiamin Gladys [1*], Zhang Jiayi [2*], Leonardo Bonetti [3,4,5,6], Wilson Lim Peng Hian [7], Peter Vuust [3], Kat Agres [8,9^], S-H. Annabel Chen [7, 10, 11, 12^].
1 School of Computer Science and Engineering, Nanyang Technological University, Singapore; 2 Interdisciplinary Graduate Program, Nanyang Technological University, Singapore; 3 Center for Music in the Brain, Department of Clinical Medicine, Aarhus University & The Royal Academy of Music, Aarhus/ Aalborg, Denmark; 4 Centre for Eudaimonia and Human Flourishing, Linacre College, University of Oxford, UK; 5 Department of Psychiatry, University of Oxford, UK ; 6 Department of Psychology, University of Bologna, Italy; 7 School of Social Sciences, Nanyang Technological University, Singapore; 8 Centre for Music and Health, National University of Singapore, Singapore; 9 Yong Siew Toh Conservatory of Music, National University of Singapore, Singapore; 10 Centre for Research and Development in Learning, Nanyang Technological University, Singapore; 11 Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore; 12 National Institute of Education, Nanyang Technological University, Singapore;
* Heng Jiamin Gladys and Zhang Jiayi are equal contributors to this work and designated as co-first authors.;
^ Kat Agres and S-H. Annabel Chen are co-last authors.

Subtheme G - Development and Aging

Bayesian inference, supporting Bayesian predictive brain frameworks, has recently gained momentum in explaining music perception and aging. A fundamental mechanism underlying Bayesian inference is the notion of prediction, or the brain's ability to predict and interact with stimuli based on prior experiences. This framework could explain how predictions pertaining to musical (melodic, rhythmic, harmonic) structures give rise to action, emotion, and learning, expanding related concepts of music research, such as musical expectancies, groove, pleasure, and tension. Moreover, a Bayesian perspective of music perception may shed new insights on the beneficial effects of music on aging. Aging could indeed be framed as an optimization process of Bayesian inference. As predictive inferences refine over time, the reliance on consolidated priors increases, while the updating of prior models through Bayesian inference attenuates. This may affect the ability of older adults to estimate uncertainties in their environment, limiting their cognitive and behavioral repertoire. With Bayesian inference as an overarching framework, this review synthesizes the literature on predictive inferences in music and aging, and details how music could be a promising tool in preventive and rehabilitative interventions for older adults through the lens of Bayesian inference.

Rapid finger tapping performance of adults with autism spectrum disorder

Kazuaki Honda, Chihiro Ioti, Atsushi Takagi, and Makio Kashino.
NTT Communication Science Laboratories, Atsugi, Japan

Subtheme G - Development and Aging

Background: Autism Spectrum Disorder (ASD) is a term that includes a group of neurodevelopmental disorders defined by impairments in social communication and restricted and repetitive behavior. In addition to the above characteristics, most individuals with ASD have motor coordination deficits (Fournier et al, 2010). For these coordination deficits, the difference of cerebellum may be involved; histopathological and neuroimaging evidence has shown that the cerebellum of the person with ASD differs from that of typically developed controls. However, it is not clear the relationship between the complexity of the task and motor coordination deficits of ASD. Thus, we assessed the coordination deficits of ASD by the rapid finger tapping task as the simplest motor coordination task, which is a rhythmic movement task often used to assess the professional musicians which have skilled motor coordination (Aoki et al., 2005). Methods: Seventeen adults diagnosed with ASD and twenty-one age- and IQ-matched controls participated in this study. Sixteen participants with ASD and

twenty in controls were determined to be right-handed by the Edinburgh Handedness Inventory. They were asked to perform tapping as fast as possible for 12 seconds with index finger by flexion and extension at the metacarpophalangeal joint. There were four finger tapping tasks: two unimanual finger tapping tasks (i.e., the index finger of each limb), two bimanual-finger tapping tasks (i.e., anti-phase or in-phase tapping by index fingers of both limbs). The tasks were repeated three times each. The median inter-tap interval (ITI) and standard deviation of ITI were calculated for each trial. Results and discussion: As for the unimanual/bimanual-finger tapping task, there were no significant difference between the ASD and control groups in the median ITI and the SD of ITI. The results suggest that adults with ASD may not have problems with the simple single -joint movements such as finger tapping.

The amount of limb movements in three- to four-month-old infants differ with and without musical improvisation

Kenta Ueda1; Sotaro Kondoh1; Yuta Shinya2; Hirotaka Gima3; Hama Watanabe2; Gentaro Taga2; Shinya Fujii4
1 Graduate School of Media and Governance, Keio University, Japan; 2 Graduate School of Education, The University of Tokyo, Japan; 3 Faculty of Health Sciences, Tokyo Metropolitan University, Japan

Subtheme G - Development and Aging

Background. One of the most important elements of music is its improvisation. Previous studies have reported that infants' abilities to process music, such as moving rhythmically to music. However, the response of infants to musical improvisation is not fully understood. In this study, we aimed to investigate whether the amount of movement in infants changes with and without musical improvisation. Method. The four limb movements of 31 infants (103-117 3 2.95 days old) in the supine position were recorded using a motion capture system under three conditions; 1) an improvised jam session played by a professional drummer and bassist (session, the mean tempo of 99.6 beats per minute, or 1.66 Hz), 2) a looped drum beat (loop, the mean tempo of 132.6 beats per minute, or 2.21 Hz), and 3) in silence. The mean square sum of velocity was

calculated as a measure of movement amount for each condition. A Friedman test was performed to evaluate differences among the three conditions. Results. The amount of movement in silence was the largest ([8.7336.40]×10^4 [mm/sec]^2 ;mean 3 SD), followed by session ([7.68 34.57]×10^4 [mm/sec]^2) and loop ([4.9833.62]×10^4 [mm/sec]^2). There was a significant difference between the conditions ($\chi 2 = 7.22$; $p = 0.026$). We performed pairwise comparisons with Bonferroni correction. Although there was no significant difference between silence and session ($p = 0.938$), the amount of movement was larger in session than in loop ($p = 0.013$). We also found a significant difference between silence and loop ($p = 0.016$). Discussion. This study found that the amount of movement in three- to four-month-old infants varied depending on the presence or absence of musical improvisation. These results suggest that infants at this age are already primed to respond to the presence or absence of musical improvisation.

Temporal patterns in the complexity of child-directed song lyrics reflect their functions

Pierre Labendzki1; Louise Goupil2; Sam Wass1
1 Department of Psychology, University of East London, London, UK; 2 Université Grenoble Alpes, CNRS, LPNC, Grenoble, France.

Subtheme G - Development and Aging

When caregivers present content to a young audience, we structure that content, whether implicitly or explicitly, to optimise its learnability. Previous research has examined how temporally fine-grained changes in prosodic features might maximise the learnability of child-directed speech. However, no previous research has examined larger-scale changes in how information is structured over time in child-directed content. Here, we developed a novel technique based on Kolmogorov complexity to quantify the rate of change of textual information content over time across different corpora of 453 English -language open-access recordings of songs and stories. We compared child-directed songs (CDSo), adult-directed songs (ADSo), and child-directed stories (CDSt), along with comparison corpora in French (206) and Spanish (263).

First, we show that ADSo shows the expected inverted-U relationship between complexity and popularity (indexed as the normalised

number of YouTube views). For CDSo, in contrast, overall textual complexity is lower and lower complexity associates with higher popularity.
Second, we found that more novel information is presented at the beginnings and ends of songs in CDSo but not ADSo, which can provide benefits in terms of memory encoding because of the Serial Position Effect.
Third, we found that, whereas information was evenly allocated in CDSt, both CDSo and ADSo showed a periodic oscillatory pattern in the rate of change of information content, which was more predictable in CDSo. Our findings suggest that the optimal balance between predictability and expressivity in information content differs between child- and adult-directed content in a way that is compatible with the idea that child-directed songs are structured, whether implicitly or explicitly, to maximise learnability and foster early social bonding.

Emotion discrimination for music is related to individual rhythm and working memory abilities across the lifespan

Mariangela Lippolis1; Daniel Müllensiefen2; Klaus Frieler3; Benedetta Matarrelli1; Peter Vuust4; Elvira Brattico1,4
Department of Education, Psychology, Communication, University of Bari Aldo Moro, Bari, Italy; 2 Department of Psychology, University of London, London, UK; 3 Department of Methodology, Max Planck Institute for Empirical Aesthetics, Frankfurt, Germany; 4 Center for Music in the Brain (MIB), Department of Clinical Medicine, Aarhus University & The Royal Academy of Music Aarhus/Aalborg, Aarhus, Denmark.

Subtheme G - Development and Aging

Emotion discrimination, i.e., the ability to recognize emotions through perceptual cues, supports social interaction throughout life.
Specifically, emotional decoding in music consists in the processing of auditory features and is related to emotion recognition in speech and facial expressions. Among musical characteristics, rhythm is connected to emotions as its capacity to synchronize enables better emotional expression and interpretation.
In our study, positive and significant relationships were found between high levels of rhythmic ability (measured through the Rhythm Ability Test by MacGregor et al., 2024) and emotion discrimination

(measured through the Emotion Discrimination Test by MacGregor & Müllensiefen, 2019) in both a sample of 157 preadolescents (aged 10-14 years, 98 of them belonging to a music school curriculum and 59 to a standard curriculum) and a sample of 53 healthy elderlies (aged 65-86 years). For preadolescents, significant longitudinal relationships were found over 12 months (p = 0.028; = 0.5).
Causal mediation analyses conducted on the general sample showed the mediating role of working memory (WM) between musical emotion decoding and the independent variables of rhythmic ability (p <.001; = 0.1) and amount of music training (measured through the Concurrent Musical Activity Questionnaire, Müllensiefen et al., 2015) (p = 0.033; = 0.05). WM, enhanced by music training and linked to the prediction of regular rhythmic structures, allows comparisons with learned emotional schemas and maintains the affective musical information. For elderlies, the same association between rhythm and emotion discrimination was found in a preliminary analysis, still to be confirmed after data collection is completed. Here, cross-sectional analyses showed a trend for emotional discrimination ability to decrease with age for those with a lower level of rhythmic ability.
These results suggest that boosting musical skills promotes comprehensive development during pre-adolescence and may provide protection against cognitive and emotional decline in aging.

Music-driven emotion regulation depends on developmental timing of music exposure in the medial prefrontal cortex

Kelsie L. Lopez, Nick Kathios, Rebecca Hennessy, Rishi Kudaravalli, Juliet Davidow, Psyche Loui, Laurel J. Gabard-Durnam
Northeastern University, Boston, MA, USA;

Subtheme G - Development and Aging

Listening to music is a highly rewarding activity that effectively downregulates negative emotions in stressful contexts. Evidence from rodent models suggests that there is a sensitive period before puberty when acoustic stimuli, like music, shape medial prefrontal cortex (mPFC) responses that regulate affect in the context of acute stress in adulthood. The present study examines whether a similar sensitive period for the mPFC occurs during human childhood, such that music from this childhood time period would be more effective at downregulating stress into adulthood. In an fMRI paradigm, young adult participants (18-23 years old) are administered an acute lab stressor of 15 blocks of a speeded math test. Between stressor blocks, they are given rest periods during which they are exposed to music from the Billboard Year-End Hot 100 chart from either their preschool (4 to 6 years old), childhood (7 to 10 years old), or adolescent (15 to 18 years old) time periods, presented in randomized blocks. Participants report affect following both stressor and music blocks. We hypothesized that music from childhood would engage the mPFC after stress, more than music from preschool or adolescence. Data collection is ongoing, but preliminary results (n = 2) show dorsolateral prefrontal cortex activity during the stressor task, and superior temporal gyrus and mPFC activity during music listening. Importantly, increased mPFC activation is observed for childhood music relative to music from preschool or adolescence. Self-reported affect ratings preliminarily indicate that the stressor blocks are perceived as stressful, and that childhood music is more calming than adolescent music. These findings are consistent with the rodent literature, providing preliminary evidence for a sensitive period during human childhood by which music shapes mPFC responses to downregulate stress.

Acquisition of musical skills in older adults - results of 12 months of music training

Hannah Losch1; Eckart Altenmüller1; Damien Marie2; Edoardo Passarotto3; Clara R. Kretschmer4; Daniel Scholz5; Matthias Kliegel6; Tillmann H. Krüger7; Christopher Sinke7; Kristin Jünemann7; Clara James2; Florian Worschech1
1 Institute for Music Physiology and Musicians' Medicine, Hanover University of Music, Drama and Media, Hanover, Germany; 2 Geneva Musical Minds Lab, Geneva School of Health Sciences, University of Applied Sciences and Arts Western Switzerland HES-SO, Geneva, Switzerland; 3 Department of Neurosciences, University of Padova, Padova, Italy; 4 Department of Experimental Psychology, University of Oxford, Oxford, England; 5 Department of Musicians' Health, University of Music Lübeck, Lübeck, Germany; 6 Center for the Interdisciplinary Study of Gerontology and Vulnerability, University of Geneva, Geneva, Switzerland; 7 Division of Clinical Psychology and Sexual Medicine, Department of Psychiatry, Social Psychiatry and Psychotherapy, Hanover Medical School, Hanover, Germany),

Subtheme G - Development and Aging

Older adults demonstrate the ability to acquire new skills, potentially preserving cognitive abilities and flexibility. Learning to play an instrument emerges as a promising task for older individuals, impacting cognition, well-being, and brain plasticity. However, the development of musical skill in older adults remains insufficiently explored. This study aimed to assess the feasibility of older individuals acquiring musical skills, particularly focusing on piano-playing skills, examining the interconnectedness between different musical abilities, and identifying potential predictors influencing skill acquisition. 139 healthy older adults (age = 69.5 years 3 3.2), with no prior musical practice, participated in weekly lessons of piano practice (PP) or musical culture(MC) over one year. Musical aptitude tests, like the Beat Alignment Test, Melodic Discrimination Test and Midi Scale Analysis, were administered, and improvements were assessed through rating of recordings for the PP group and a music questionnaire for the MC group at three and twelve months. The interconnectedness of the various musical skills was explored through correlational analysis, and improvements were modeled using Bayes statistics. The PP group exhibited improvements in articulation (0.43, [0.18, 0.63] and dynamics (0.38, [0.08, 0.67]), as well as pitch (0.16, [-0.14, 0.46]) and expressivity (0.15, [-0.05, 0.34]), but not in rhythm (-0.01, [-0.16, 0.28]), and fluency (-0.09, CI [-0.32, 0.14]). Meanwhile, the MC group achieved higher scores in the music questionnaire throughout the intervention. Both groups exhibited small improvements in aptitude tests, with MSA showing more improvement in the PP group. The prediction of improvement varied, with no generalizable predictors of improvement in the tests. The development of the performance on all musical tests revealed no correlation. The results suggest an independent evolution of various musical domains and emphasizes the need for tailored approaches in music education for older learners. Genetic predispositions should also be considered as an explanatory factor in musical development.

Modeling the hierarchy of the brain network for the music effect on cognitive aging

Rui Ma1, Sijia Guo1, Jing Lu1;
1School of Life Science and Technology, University of Electronic Science and Technology of China, Chengdu, China

Subtheme G - Development and Aging

Modeling the directed and hierarchical architecture of the network under musical and aging interventions is crucial for examining the variations in brain network connectivity between musicians and non-musicians. Prior research found that functional connectivity within and between auditory and reward networks was modulated by music pleasurable. However, few studies have identified task-related distinctions in directed and hierarchical features between old musicians and other control groups across auditory, reward networks, and other regions. Our study enrolled 22 old controls, 16 old musicians, 22 young controls, and 20 young musicians' fMRI data during high/low award music stimulation missions. After the Specify activation 1st-level and stepwise multivariate Granger causality methods, we obtained some results on task-related activation ROIs and diverse between-ROIs pathways in four groups. It revealed various pathways from auditory regions to cognition regions and other sensory regions among groups, that old controls showed a different model against other three groups. Furthermore, musicians demonstrated more directed stepwise connectivity from auditory regions to the reward network and from the reward network to other sensory regions, particularly evident in old musicians, which indicated that distinct brain regions exhibit varying degrees of activation in response to music stimuli with different levels of pleasure. Moreover, we found that cognitive aging affects the quantity of directed pathways between the reward network and sensory areas, while musical training resulted in a tendency for both young and old musicians to have a higher number of pathways in this regard, which indicated that compared to non-musicians, musicians have a heightened demand for information processing in reward-related systems such as the basal ganglia.

Music Training and Lateralization of Arcuate Fasciculus

Sara Mendoza; Hanna Damasio; Priscilla Perez; Assal Habibi
Brain and Creativity Institute, University of Southern California, Los Angeles, USA

Subtheme G - Development and Aging

The arcuate fasciculus (AF) is shown to have a greater volume of fibers in the left hemisphere due to the left-lateralization of language-related processes. Given that music training engages circuits in the right hemisphere, we hypothesize that undergoing music training may lessen the asymmetry between the left and right AF. The present study aims to explore the difference in fractional anisotropy and mean diffusivity of the left and right AF in musically trained and untrained children, in order to explore the relationship between music training and its impact on neural development. School-aged children (n=50) self-selected to enroll either in a structured music program, sports program, or to not participate in a structured after-school activity. Over the course of 7 years, participants received up to 4 structural- and diffusion -weighted MRI scans: one baseline scan, followed by scans every ~2 years. Using Brainsuite, we first delineated regions of interest on both left and right hemisphere as the inferior frontal gyrus (IFG) and a temporal region (TR) consisting of the middle and superior temporal gyri. We modeled the

AF as the white matter tracts that have endpoints in both the IFG and the TR of each hemisphere using DSI Studio. We then calculated Fractional Anisotropy (FA) and Mean Diffusivity (MD) in the AF. To evaluate the broad maturation patterns of the brain throughout developmental stages, we also computed the average FA and MD across the entire left and right hemispheres at each time point. Subsequently, we will normalize the FA values of the arcuate fasciculus relative to the overall FA and use a growth model to determine if there is a distinctly faster maturation rate in the right hemisphere of the musically trained group. The analysis is currently underway, and we anticipate presenting the full findings in the presentation.

Differential effects of ageing on the neural processing of speech and singing production

Nella Moisseinen [1], Teppo Särkämö [1], Jaakko Kauramäki [1], Boris Kleber [2], Aleksi J. Sihvonen [1,3,4], Noelia Martínez-Molina [1,5].
[1] Cognitive Brain Research Unit, Department of Psychology and Logopedics, Faculty of Medicine, Centre of Excellence in Music, Mind, Body and the Brain, University of Helsinki, Helsinki, Finland. [2] Centre for Music in the Brain, Department of Clinical Medicine, Faculty of Health, Aarhus University, Aarhus, Denmark. [3] School of Health and Rehabilitation Sciences, Centre for Clinical Research, University of Queensland, Brisbane, QLD, Australia. [4] Department of Neurology, Helsinki University Hospital, Helsinki, Finland. [5] Department of Information and Communication Technologies, Centre for Brain and Cognition, University Pompeu Fabra, Barcelona, Spain.

Subtheme G - Development and Aging

Understanding healthy brain ageing has become vital as populations are ageing rapidly and age-related brain diseases are becoming more common. In normal brain ageing, speech processing undergoes functional reorganisation involving reductions of hemispheric asymmetry and overactivation in the prefrontal regions. However, little is known about how these changes generalise to other vocal production, such as singing, and how they are affected by associated cognitive demands. The present cross-sectional fMRI study systematically maps the neural correlates of vocal production across adulthood (N=100, age 21–88 years) using a balanced 2x3 design where tasks varied in modality (speech: proverbs / singing: song phrases) and cognitive demand (repetition / completion from memory / improvisation). In speech production, ageing was associated with decreased left pre- and postcentral activation across tasks and increased bilateral angular and right inferior temporal and fusiform activation in the improvisation task. In singing production, ageing was associated with increased activation in medial and bilateral prefrontal and parietal regions in the completion task, whereas other tasks showed no ageing effects. Direct comparisons between the modalities showed larger age-related activation changes in speech than singing across tasks, including a larger left-to-right shift in lateral prefrontal regions in the improvisation task. The present results suggest that the brains' singing network undergoes differential functional reorganisation in normal ageing compared to the speech network, particularly during a task with high executive demand. These findings are relevant for understanding the effects of ageing on vocal production as well as how singing can support communication in healthy ageing and neurological rehabilitation.

Development of neural encoding and spontaneous movements to music over the first year of life.

Trinh Nguyen1,2; Felix Bigand1; Susanne Reisner2; Atesh Koul1; Roberta Bianco1; Gabriela Markova2,3; Stefanie Hoehl2; Giacomo Novembre1
1 Neuroscience of Perception and Action Lab, Italian Institute of Technology, Rome, Italy; 2 Institute for Developmental and Educational Psychology, University of Vienna, Vienna, Austria; 3 Institute for Early Life Care, Paracelsus Medical University, Salzburg, Austria);

Subtheme G - Development and Aging

Human adults spontaneously synchronize to music. Influential theories suggest that this capacity is a core component of human musicality and is universally shared across distinct cultures. However, the developmental trajectory of this capacity, and its underlying neural mechanisms, are poorly understood. We recorded neural activity (EEG) and spontaneous movements from 79 infants (aged 3, 6, and 12 m.) listening to music. Neural (event-related) responses matured over the different ages, as revealed by increasingly sharper peaks and shorter latencies. Notably, infants of all ages showed enhanced neural encoding of music as opposed to shuffled control stimuli. Spontaneous body movements were extracted from video recordings using markerless pose estimation methods. We were able to extract 10 principal movements that infants exhibited across all ages, explaining 80% of the kinematic variance. Preliminary results suggest that 12-month-old infants moved more to music than to the shuffled control stimuli. Further analyses are meant to explore the rhythmic properties of infants' spontaneous body movements. Taken together, the results indicate independent developmental trajectories of musical encoding and spontaneous movements to music. While music is readily encoded in the 3-month-old infant brain, the capacity for spontaneous body movements to music appears to emerge at 12 months of age and likely develops further to become as precise as in adults. These preliminary findings might inform theories on the origins of musicality and its underlying neural mechanisms.

The ageing brain and experience of playing a musical instrument: evidence from the Lothian Birth Cohort 1936

Judith A. Okely1; Susana Muñoz Maniega2; Maria C. Valdés Hernández2; Mark E. Bastin2; Joanna M. Wardlaw2; Simon R. Cox3; Ian J. Deary3; Michelle Luciano3; Katie Overy4
1 Department of Psychology, Napier University, Edinburgh, UK; 2 Centre for Clinical Brain Sciences (CCBS), University of Edinburgh, Edinburgh, UK; 3 Department of Psychology, University of Edinburgh, Edinburgh, UK; 4 Reid School of Music & Edinburgh Neuroscience, University of Edinburgh, Edinburgh, UK

Subtheme G - Development and Aging

There is increasing interest in the potential of musical training to 'protect' the ageing brain, with evidence to date suggesting that cognitive skills may be positively impacted. Here we tested whether experience playing a musical instrument was associated with a) global and regional MRI brain volumetric measures at age 73 and b) decline in these measures between ages 73 and 82. Participants (n=420) from the Lothian Birth Cohort 1936 completed MRI assessments at ages 73, 76, 79 and 82, and the Edinburgh Lifetime Musical Experience Questionnaire (ELMEQ) at age 82. Demographic and health data were also recorded. We tested for associations between instrumental experience and level and/or change in 1) global MRI volumes (total brain, grey matter, normal appearing white matter, and white matter hyperintensity) and 2) the volume of 34 cortical and 7 subcortical regions. Analyses were preregistered on the Open Science Framework (OSF). 167 participants had played a musical instrument at some point in their life, mostly to beginner/intermediate level and during childhood. Greater instrumental musical experience was not significantly associated with any of the global MRI measures. Before but not after correction for multiple comparisons, greater instrumental musical experience was associated with greater grey matter volume at age 73 and steeper volumetric declines in several regions of the temporal and parietal cortices (all effect sizes were small/ moderate). Only one result survived correction for multiple comparisons: a positive association between experience of playing a musical instrument and change in the volume of the caudate (suggesting less age-related decline, β=0.170, FDR p = 0.028). This association did not survive further correction for potentially confounding variables of childhood cognitive ability, years of education, socio

-economic status, health behaviours, and disease history (β=0.118, p = 0.105). These results point to regions of interest for exploration in future studies of musicianship and ageing.

The Reciprocal Relationship between Maternal Infant-directed Singing and Infant Behaviour

Susanne Reisner (1), Trinh Nguyen (1,2), Pierre Labendzki (3), Stefanie Hoehl (1), Gabriela Markova (1,4).
(1) Faculty of Psychology, University of Vienna, Vienna, Austria; (2) Neuroscience of Perception and Action Lab, Italian Institute of Technology (IIT), Rome, Italy; (3) Department of Psychological Sciences, University of East London, London, UK; (4) Institute for Early Life Care, Paracelsus Medical University, Salzburg, Austria

Subtheme G - Development and Aging

Infant-directed (ID) singing has traditionally been divided into playsongs and lullabies (Trainor, 1996). Their distinct acoustic features are argued to have specific functions - to arouse and soothe, respectively (Cirelli et al., 2020). Previous studies have investigated the acoustic qualities of ID singing and infant reactions to it separately. However, it remains unclear how caregivers adjust to infant attention acoustically. Our study is the first to explore the reciprocal relationship between fine-grained acoustic variability of live, naturalistic maternal ID singing and infant attention. Seventy-three mothers sang a playsong and a lullaby to their 7-month-old infants while we recorded infant attention via social gaze. Maternal ID singing was characterised by spectral flux, measuring the variability of the acoustic signal via frequency and amplitude changes (Müller, 2015). We calculated the spectral flux of maternal singing over the whole song and time-locked to three beats before and after infant social gaze onsets. Results showed more frequent infant social gaze during playsongs ($p < .01$). Spectral flux was higher in playsongs than in lullabies ($p = .019$). Cluster-based permutation tests (1000 permutations) showed that in playsongs, spectral flux was significantly above-threshold ~2.5 beats before and ~1 and ~2 beats after infant social gaze onset ($p < .0167$). There were no significant above-threshold infant-social-gaze-related spectral flux changes in lullabies. These findings suggest that infants and caregivers show mutual adjustment to each other, modulated by song function. In playsongs, infants react to changes in maternal singing by shifting their attention to their caregiver, and caregivers scaffold salient events after infant social gaze to maintain infant engagement. Lullabies are kept stable and do not elicit the same amount of infant attention. The communicative character of ID singing may thus be vital for the effects of ID songs and an

important developmental step towards verbal communication.

Differences in attention and vigilance associated with musical training across the lifespan

Rafael Román-Caballero (1, 2, 3, 4), Laura Trujillo (1, 2), Paulina del Carmen Martín-Sánchez (1, 2), Elisa Martín-Arévalo (1, 2) & Juan Lupiáñez (1, 2)
1 Department of Experimental Psychology, University of Granada, Granada, Spain; 2 Mind, Brain and Behavior Research Center (CIMCYC), University of Granada, Granada, Spain; 3 Department of Psychology, Neuroscience, and Behaviour, McMaster University, Hamilton, Canada; 4 McMaster Institute for Music and the Mind, McMaster University, Hamilton, Canada

Subtheme G - Development and Aging

Recent evidence suggests that musical practice could be a promising cognitive training activity that could promote attentional functioning. However, findings with adult samples have shown that musical training might have a specific impact only over some attentional processes (e.g., phasic alertness, sustained attention, and vigilance). On the other hand, compelling twin studies have shown that instrument engagement is highly heritable and is genetically correlated with early intelligence capacities. Therefore, there is selection bias, in which individuals with higher cognitive functioning and socio-economic status select more this activity. The current study aimed to investigate the differences in attention between individuals with and without musical training using a fine-grained and comprehensive measure of attention (ANTI-Vea). This task allows measuring the three Posner and Petersen's networks (alerting, orienting, and executive control) as well as two different components of vigilance (executive and arousal vigilance). Children and adolescents with musical training (8–17 years) and adult musicians (18–35 years) were compared to a matched group of participants with no musical experience (n = 280, 190 vs. 190). For matching, we used a multivariate propensity-score procedure with an extensive set of confounding variables: age, sex, parents' education level, lifelong tobacco consumption, physical exercise, bilingualism, second language use, involvement in cognitively stimulating activities, video game playing, and personality traits. Individuals with musical training showed advantages in processing speed, sustained attention, and in the two components of vigilance compared to non-musicians. Therefore, our results support the possibility of specific effects of musical training on attention, even when both samples had similar characteristics in confounding variables.

Beat perception across the lifespan : the effects of aging on neural representation of beat

Flora Rosenzweig1, Cedric Lenoir1, Tomas Lenc1, Caroline Huart1, Sylvie Nozaradan1
1Institute of Neuroscience (IONS), UCLouvain, Brussels, Belgium

Subtheme G - Development and Aging

Humans around the globe often show the capacity to spontaneously perceive and synchronize their movements to periodic beats in music. Increasing evidence suggests that this ability involves neural processes that selectively enhance beat-related periodicities, irrespective of the prominence of these periodicities in the input (i.e. even when the rhythmic input is weakly periodic). What is the impact of aging on these neural processes? The aging auditory pathway has been shown to respond with an overall degraded temporal precision, and to overrepresent sound onset over duration. Here, we hypothesized beat perception to be influenced by the integration of two key temporal features of the acoustic input, namely sound duration and sound onset pattern. Moreover, we postulated that with aging, the neural processes that support beat perception become increasingly invariant to sound duration, relying instead primarily on sound onset patterns for stable beat perception. These hypotheses were tested by recording separately neural responses with electroencephalogram (EEG) and behavioral tapping responses from 24 younger (55 years old) participants while listening to four identical weakly periodic rhythms, each composed of sounds of different durations (50ms, 100ms, 150ms and 200ms). Results showed that neural responses to beat-related periodicities were enhanced in both groups. However, in the young participants, these neural responses were linearly modulated by sound duration increase, in contrast with older participants, whose responses did not differ across conditions, and who also showed an overall lower stability in tapping the perceived beat across conditions. Together, these results indicate an increased dependence on sound onset patterns for stable beat perception in aging, to the detriment of sound duration. These findings thus further our understanding of the neural processes underlying music processing and how they are shaped across the lifespan.

Auditory rhythm encoding during the last trimester of human gestation: From tracking the basic beat to tracking hierarchical nested temporal structures

Bahar Saadatmehr1, Mohammadreza Edalati1, Fabrice Wallois1,2 , Ghida Ghostine1, Guy Kongolo1, Erica Flaten3, Barbara Tillmann4, Laurel Trainor3,5,6, and Sahar Moghimi1.
1 Inserm UMR1105, Groupe de Recherches sur l'Analyse Multimodale de la Fonction Cérébrale, CURS, Amiens Cedex, France; 2 Inserm UMR1105, EFSN Pédiatriques, CHU Amiens sud, Amiens Cedex, France; 3 Department of Psychology, Neuroscience and Behaviour, McMaster University, Hamilton, Ontario, Canada; 4 Laboratory for Research on Learning and Development, LEAD – CNRS UMR5022, Université de Bourgogne, Dijon, France;5 McMaster Institute for Music and the Mind, McMaster University, Hamilton, Ontario, Canada; 6 Rotman Research Institute, Baycrest Hospital, Toronto, Ontario, Canada

Subtheme G - Development and Aging

Rhythm perception and synchronization to periodicity hold fundamental neurodevelopmental importance for language acquisition, musical behavior, and social communication. Interestingly, rhythm is omnipresent in the fetal auditory world and newborns demonstrate sensitivity to auditory rhythmic cues. During the last trimester of gestation, the brain begins to respond to auditory stimulation and to code the auditory environment. When and how during this period do the neural capacities for rhythm processing develop? We conducted a cross-sectional study in 46 preterm neonates born between 27 and 35 weeks gestational age (wGA), measuring their neural responses to auditory rhythms with high-density electroencephalography during sleep. We developed measures to evaluate neural synchronization to nested rhythmic periodicities, including the fast isochronous beat and slower metrical (beat grouping) structures. We show that neural synchronization to beat and meter becomes stronger with increasing GA, converging on small phase differences between stimulus and neural responses near term, similar to those observed in adults. Dividing the cohort into subpopulations born before and after 33 wGA (median split) revealed that both younger and older groups showed neural synchronization to the fast periodicity related to the isochronous beat, whereas only the older group showed significant neural synchronization to the slower meter frequencies related to beat groupings, suggesting that encoding of nested periodicities arrives during late gestation. Together, our results shed light on the rapid evolution of neural coding of external hierarchical auditory rhythms during the third trimester of gestation, starting from the age of hearing

onset, when the thalamocortical axons establish the first synapses with the cortical plate.

Exploring music-evoked memories and autobiographical salience in healthy aging

Ilja Salakka1; Anni Pitkäniemi1; Emmi Pentikäinen1; Petri Toiviainen2; Teppo Särkämö1
1 Cognitive Brain Research Unit, Centre of Excellence in Music, Mind, Body and Brain, University of Helsinki, Helsinki, Finland; 2 Centre of Excellence in Music, Mind, Body and Brain, University of Jyväskylä, Jyväskylä, Finland,

Subtheme G - Development and Aging

Background: Music evokes vivid autobiographical memories in individuals across various age groups. Our research synthesizes findings using quantitative and qualitative data collected from healthy older adults through a music listening experiment and data extracted from audio files by Music Information Retrieval methods. We wanted to investigate musical factors connected to the autobiographical salience of music. In addition, we explored the content of music-evoked memories. Methods: We conducted an experiment in which healthy older adults (N = 113, age >= 60 years) listened to a total of 140 songs comprising folk songs and popular songs from the 1950s to the 1980s and rated them on five domains measuring subjective emotional (valence, arousal, emotional intensity) and memory (familiarity, autobiographical salience) experience of the songs. Musical features were extracted using MIRtoolbox and dimension reduction was done by principal component analysis. In addition, participants were given the voluntary opportunity to verbally describe personal memories evoked by each song. Results: Results demonstrate that specific musical components, such as pulse strength (representing salience of the musical pulse), brightness (indicating the relative strength of high harmonics) and fluctuation in lower middle frequencies (200-800 Hz), have a relationship with autobiographical salience of music in older adults. In addition, all emotional ratings of the songs correlated moderately or strongly with the autobiographical salience. Reminiscence bump (higher prevalence of memories from adolescence) was observed in both quantitative and qualitative data. The content analysis revealed frequent occurrence of music-related activities (e.g. singing, dancing, listening) and specific people or places in music-evoked memories. Conclusion: The findings suggest some musical factors and age dynamics influencing the autobiographical salience of music in older adults. The content of music-evoked memories was also analyzed, revealing some recurring themes, such as music-related activities.

Deficits in beat induction during sensorimotor synchronisation to music in patients with neurodegenerative disease

Andres von Schnehen (1,2), Nicholas Foster (2,3,4), François Puisieux (5), Dominique Huvent-Grelle (5), Simone Dalla Bella (2,3,4), Lise Hobeika (1,6,7), Séverine Samson (1,6,7,8),
(1) Univ. Lille, ULR 4072 – PSITEC – Psychologie : Interactions, Temps, Emotions, Cognition, FLille, France, (2) International Laboratory for Brain, Music, and Sound Research (BRAMS), Montreal, Canada, (3) Dept. of Psychology, University of Montreal, Montreal, Canada, (4) Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada, (5) Hôpital Gériatrique les Bateliers, Pôle de Gérontologie, CHU Lille, Lille, France, (6) Sorbonne Université, Institut du Cerveau - Paris Brain Institute - ICM, Inserm, CNRS, APHP, Paris, France, (7) Institut Pasteur, Université Paris Cité, Hearing Institute, Paris, France (8) Epilepsy Unit, AP-HP, GHU Pitié -Salpêtrière-Charles Foix, Paris, France

Subtheme G - Development and Aging

Research on the impact of cognitive disorders associated with neurodegenerative disease, such as Alzheimer’s disease, on rhythmic abilities, yielded mixed results. This study aimed to test the impact of neurocognitive disorders on two rhythmic skills previously untested in elderly populations. First, a task involving synchronisation to music was employed, to identify a specific deficit in beat induction, which involves actively deducting an underlying rhythm in music (Toiviainen et al., 2020), distinct from automatic beat maintenance. Second, we used a beat misalignment detection test to evaluate rhythm perception without production. To this end, 87 patients (mean age = 81) with cognitive disorders of varying severity (MMSE from 16 to 30) from a geriatric day hospital underwent a sensorimotor synchronisation task with three levels of beat saliency (BS; metronome; music with high BS; and music with low BS) and an evaluation of beat perception. Mixed-effects models revealed an interaction between beat saliency and MMSE on synchronisation consistency. As expected, the highest consistency was observed when tapping to a metronome, followed by high BS music, and the lowest with low BS music ($p < .001$). Additionally, consistency decreased with lower MMSE scores, but only with low BS music ($p < .001$).With regard to beat perception, as assessed by the Beat Alignment Test, MMSE was negatively related to the number of false alarms (incorrect reports of alignment; $p < .05$). Our findings suggest that during synchronisation to music, beat maintenance remains preserved in individuals with impaired cognitive functioning. In contrast, those individuals may experience difficulty with beat induction

and the perception of beat alignment. These results will be discussed in light of current theories of rhythm and their potential clinical implications.

Relationships between the perception of speech prosody and music-related abilities in people with neurodegenerative disorders: towards the development of a new research protocol for Greek-speaking populations

Kalliopi Vourou1; Maria Martzoukou2; Georgios Papadelis2; Sokratis G. Papageorgiou1
1 Medical School, National and Kapodistrian University, Athens, Greece; 2 Aristotle University, Thessaloniki, Greece,

Subtheme G - Development and Aging

Background: Neurodegenerative diseases, such as Alzheimer's Disease (AD), Parkinson's Disease (PD), Mild Cognitive Impairment (MCI), and Frontotemporal Dementia (FTD), show a range of symptoms affecting different areas such as memory, executive functions, and language. However, recent studies have shown that both prosody production and perception can serve as markers for the early detection of the above-mentioned impairments. Apart from prosody, impaired music perception has also been found in individuals with neurodegenerative diseases. However, it appears, that different features of prosody and music perception are affected, depending on the neurological disorder. The link between music perception and prosody lies in the shared physical properties of sound waves which play a crucial role in auditory perception, allowing individuals to distinguish between sounds, understand speech, and appreciate music. Common features, such as melodic contours and rhythmic patterns, seem to be affected in different ways across different diseases. Aim: The current study aims (1) to investigate whether and to what extent prosody and music perception are impaired in patients with AD, PD, MCI, or FTD, and (2) to determine the relationship between these two concepts. By exploring this connection, better interventions could be developed for each neurodegenerative disease. Methods: To this end, prosody and music perception were examined in 10 native Greek speakers with each of the four neurodegenerative diseases using various tasks. In particular, affective, syntactic, and pragmatic prosody were assessed, along with the perception of musical pitch, melodic contour, duration, tempo, rhythm, dynamics, and timbre. The participants' difficulties were identified, and the relationship between prosodic and musical cues was examined. Results and Conclusions: Initial results suggest that some prosodic and musical cues appear to be challenging for all patients. Differences, however, between diseases were also noted. Further analysis is needed to investigate these differences.

Finding the Self in Other's Music: Investigating Neural Substrates of Social Associations with Music in Younger Individuals

Nicholas Kathios*; Kelsie L. Lopez*; Rebecca Hennessy*; Rishitha Kudaravalli*; Juliet Y. Davidow*; Laurel Gabard-Durnam*; Psyche Loui*+
Northeastern University, Boston, MA, USA, *Department of Psychology, College of Science +Department of Music, College of Arts, Media, and Design

Subtheme G - Development and Aging

Sharing music with others is a source of musical reward across cultures. While many studies in the neuroscience of music have shown the reward value of music listening in adults (and related it to note-based prediction errors), less is known about how the association of music with social mechanisms and prosociality might drive the reward value of music. Here, we investigate this source of musical pleasure in listeners across the early lifespan (ages 5 -24 years). Participants listened to 10-second blocks of either self- or researcher-selected music during fMRI. Participants rated each clip on an adapted version of the Inclusion of Other in the Self (IOS) scale, in which responses indicated how closely each clip resembled their music or music of close friends, acquaintances, or strangers. Preliminary results (n=2) in young adults (ages 18-24 years) show an effect of music self-selection, with self-selected music eliciting greater activation in the default mode network (medial prefrontal cortex, posterior cingulate), auditory network (Heschl's gyrus, superior temporal gyrus). Importantly, music that was rated as resembling that of a close friend elicited activation in the medial prefrontal cortex (similar to the effect of self-selection) and salience network (anterior cingulate, anterior insula, and amygdala), whereas music of an acquaintance or stranger elicited activation in the Theory of Mind network (bilateral temporoparietal junction and precuneus). Data collection in children (ages 7-12 years), adolescents (ages 13-17 years), and young adults (ages 18-24 years) is ongoing. Consistent with past fMRI work using the IOS scale, these results provide preliminary evidence that music's social associations elicit a gradient of representations from other to the self as a function of the closeness of the associated relationship, further advancing theories of music for social bonding.

Music rhythm interventions; from perceiving rhythm to skill

J. Riikka Ahokas1; Suvi Saarikallio1; Tiina Parviainen1; Graham Welch2
1 University of Jyväskylä, Jyväskylä, Finland; 2 Department of Culture, Communication and Media, University College London, London, UK
Subtheme H - Interventions in Educational and Clinical Settings

This poster focuses on two sub studies of the first author's PhD thesis. Sub study one was conducted in a practical school setting (Ahokas et al., 2023) and sub study three was a large systematic review (Ahokas et al., 202x). The overall focus of the first author's dissertation is on rhythm-induced movement and its effects on cognitive function, particularly executive function. Here, the main focus of this presentation will be on rhythm interventions. It will first discuss the practical reality of rhythm perception and the training and learning of rhythmic skills, and then move on to the benefits of this knowledge for research. The benefits are discussed, for example, by looking at the results of our systematic review, which focused on previous studies of the effects of rhythm training on executive function. The review contributes to cognitive music science and cognition research, but also supports more practical and replicable science on the topic. From the initial outcome of a total of 15,677 identified records, 10 research reports met the eligibility criteria and were included in the final synthesis of the systematic review. Of the ten eligible articles in our review, seven were pure dance intervention papers. This may indicate several things, but one intriguing idea is that dance training may be one of the most effective ways to teach musical rhythm. Ahokas, J. R., Saarikallio, S., Welch, G., Goswami, U. & Parviainen, T. (Submitted to Music & Science in August 2023). The training of musical rhythm and executive functions: A systematic review. Ahokas, J. R., Saarikallio, S., Welch, G., Parviainen, T., & Louhivuori, J. (2023, November 14). Rhythm and Reading: Connecting the Training of Musical Rhythm to the Development of Literacy Skills.

The effect of a rhythm-based reading training combined with tDCS in young adults with dyslexia

Alice Cancer; Alessandro Antonietti
Department of Psychology, Università Cattolica del Sacro Cuore, Milan, Italy

Subtheme H - Interventions in Educational and Clinical Settings

Numerous studies have explored the potential of music and auditory-based interventions for addressing reading difficulties in children with dyslexia, as they tap into neural and cognitive connections that overlap between the domains of music and language. Experimental findings indeed demonstrated the effectiveness of auditory and musical interventions designed to improve phonological and reading skills. The primary aim of this study was to assess the efficacy of a rhythm-based reading intervention, which has already proven successful in children, in young adults with dyslexia. This intervention, called Rhythmic Reading Training (RRT), integrates verbal decoding tasks with auditory-based exercises. To enhance the impact of RRT, we combined the cognitive intervention with a neuromodulation technique, namely, transcranial direct current stimulation (tDCS), targeting the cortical regions associated with reading. Twenty undergraduate students diagnosed with dyslexia, aged 19-26, participated in a 10-day intervention program involving daily 30-minute sessions of RRT and tDCS. During the tDCS application, a constant current of 1.5mA was delivered to the left temporoparietal region for 20 minutes. Participants were pseudo-randomly assigned to either an active or sham tDCS condition, ensuring matching across gender, age, school grade, musical expertise, intellectual functioning level, and reading difficulties. Reading speed and accuracy were assessed before (t0), immediately after (t1), and 4 weeks after the intervention (t2). Significant improvements in reading speed were observed immediately after the 2-week training period in both active and sham groups. However, within-group comparisons revealed significantly higher reading improvements after 4 weeks in the active-tDCS group, compared to sham. In conclusion, a short and intensive RRT intervention is effective in improving reading speed of young adults with dyslexia. Furthermore, the combination of RRT and tDCS over the left temporoparietal region produces better medium -term outcomes through brain plasticity mechanisms.

The effects of opioids and oxytocin on music curiosity in autism spectrum disorder

Claudia Álvarez-Martín[1,2], Raimund Buehler[3], Gemma Cardona[1,2], Xim Cerda-Company[1,2,4,5], Antoni Rodriguez-Fornells[1,2,6,7], Giorgia Silani[3].
1. Cognition and Brain Plasticity Unit, Institut d'Investigació Biomèdica de Bellvitge (IDIBELL), L'Hospitalet del Llobregat, Spain. 2. Department of Cognition, Development, and Educational Psychology, Universitat de Barcelona, Barcelona, Spain. 3. Department of Clinical and Health Psychology, University of Vienna, Vienna, Austria. 4. Computer Science Department, Universitat Autonoma de Barcelona, Cerdanyola del Vallès, Spain. 5. Computer Vision Center, Cerdanyola del Valles, Spain. 6. Institut de Neurociències, Barcelona, Spain. 7. Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain

Subtheme H - Interventions in

Educational and Clinical Settings

Given the profound impact of music on affect and mood regulation and recent evidence regarding the efficacy of music therapy in treating autism spectrum disorder (ASD), it is fundamental to explore how individuals with ASD engage with information within the musical domain. In this study, we aimed to examine the paper of curiosity in adults with ASD when sampling music-related information. Our investigation incorporates a pharmacological approach to delve into the neurochemical underpinnings of music curiosity, focusing on the opioidergic and oxytocinergic systems, which have been proposed to modulate the hedonic component of music. We investigated music curiosity and exploratory behaviour in neurotypical participants (n=39) and participants with ASD (n=37) using a within-subject double-blind placebo controlled pharmacological design. We administered placebo, naltrexone (an opioid antagonist), oxytocin (a neuropeptide relevant to reward processing), or a combination of the two, in four different sessions. In each session, participants performed an exploration/exploitation trade-off paradigm assessing their willingness to pay (WTP) for listening to new, unfamiliar electronic music. Participants with ASD reported lower curiosity ratings for electronic music pieces than the neurotypical group, overall and under all treatments. Moreover, ASD participants showed a reduction in curiosity ratings in all treatments compared to placebo. Neurotypical participants' curiosity ratings did not vary among sessions. Treatment affected the relationship between curiosity and WTP differently for each group. In both, higher curiosity ratings were associated to higher WTP. ASD participants across all treatments increased the weight of curiosity in the decision of exploring new music compared to placebo. In the neurotypical group, naltrexone (alone and in combination with oxytocin) reduced the effect of high curiosity on WTP. Overall, the present study provides new evidence on the relationship between music curiosity, ASD and their modulation by the opioidergic and oxytocinergic neurotransmitter subsystems, with possible implication for future therapeutic approaches.

Temporal alignment in music and speech in individuals with ASD through the lens of predictive coding.

Maude Denis[1], David Da Fonseca[2,3], Daniele Schön[1].
[1]Aix Marseille University, Inserm, Institut de Neurosciences des Systèmes (INS), Marseille, France; [2]CNRS, UMR7289, institut de neurosciences de la Timone, Aix-Marseille University, Marseille, France; [3]Service de pédopsychiatrie, hôpital Salvator, AP–HM, Marseille, France

Subtheme H - Interventions in Educational and Clinical Settings

Autism Spectrum Disorder (ASD) is characterized by difficulties in communication and social interaction, and by the presence of restricted, repetitive and stereotyped behaviors and interests. Since the 20th century, several explanatory theories of autism have been developed. While some of these theories focus exclusively on social symptomatology (deficit in theory of mind, lack of social motivation, weak central coherence, slow processing hypothesis), others provide a broader approach to autistic symptomatology (executive functions, predictive coding theories). More specifically, Bayesian theories offer a wide range of possible links between autistic symptomatology and a potential deficit in predictive abilities. These theories also include in their theoretical framework the presence of sensory peculiarities as well as attention and motor disorders, which are common in ASD. Importantly, they open up a potential field of action on this symptomatology, particularly at the level of interaction and communication deficits, a significant source of suffering and handicap. Indeed, predictive coding, rhythmic abilities and social and communication skills seem to be intimately linked, with rhythmic predictability underpinning interpersonal synchronization. In this work, I will put together two fields that have travelled separately so far: musical rhythmic skills and multilevel alignment and convergence in conversation. More precisely, I will present preliminary results of a battery of tests assessing various levels of temporal alignment in both music and language in young ASD adults. The results will be analysed through the lens of Bayesian theories, in particular the hypervolatility of the environment and the slow update hypothesis. These findings provide an interesting interventional perspective into language interaction through music.

The role of motivation in music (therapy) interventions

T. Dimitriadis [1,2], W.L. Magee [3], A.W.M Evers [1,4,5], R.S. Schaefer [1,5,6]
1- Health, Medical, and Neuropsychology Unit, Institute of Psychology, Leiden University, Leiden, The Netherlands; 2 - Amstelring Rehabilitation Centre and Nursing homes, Saaftingestraat 8, 1069BW; 3 - Boyer College of Music and Dance, Temple University, Philadelphia, PA, USA; 4 - Medical Delta Healthy Society, Leiden University, Technical University Delft and Erasmus University Rotterdam; 5 - Leiden Institute for Brain and Cognition, Leiden University, The Netherlands; 6 - Academy of Creative and Performing Arts, Leiden University, The Netherlands

Subtheme H - Interventions in Educational and Clinical Settings

Motivation is thought to be important in learning and rehabilitation, often considered an important underlying mechanism of music therapy effectiveness. Specifically, music may increase motivation for specific learning tasks, e.g., in sports, therapy or education. To quantify this, we systematically reviewed literature from both laboratory and clinical settings. Considering the complexity of the term motivation, we included clinical studies and learning studies in non-clinical groups that measured motivation directly, or indirectly through related constructs; distinguishing measures of prospective motivation, quantifying the drive to perform tasks, and retrospective motivation, considering mood or liking a proxy for future motivation, and indirect measures such as therapy adherence. Of seventy-nine included studies, 85% showed increased motivation for a music-based, as compared to a non-music condition. Interestingly, no difference between motivation measure categories was found, potentially indicating construct equivalence at this level. Of those studies showing increased motivation, 90% showed favourable outcomes of using music for the clinical or learning outcome. Although directional relationships cannot be extracted, a theoretical model is formulated describing the hypothesised role of motivation. Here, music interventions, while directly affecting clinical outcomes, are thought to additionally improve clinical or task outcomes, mediated by increased motivation. Thus, the contribution of motivational processes would take place along dual routes, inherently increasing the effectiveness of music-based interventions. Following up on these results, a currently ongoing, within-subject study investigates 20 subacute-phase stroke survivors who receive periods of additional music therapy compared to care as usual only in a cross-over design. Several measures of self-reported mood and motivation are included, next to pre- and post-period assessments of upper limb function and cognition. The

outcomes of this study may further inform our understanding of the role of motivation related to Music Therapy in a group with high disease burden, and link these directly to clinical outcomes.

Assessing the Impact of Singing Fundamental Frequency (F0) on Premature Infants' Brain: A qEEG-Based Study in the Neonatal Intensive Care Unit (NICU)

Kyriakos Dimitropoulos1; Efthymios Papatzikis2; Kassandra Tataropoulou3; Elena Pasoudi1; Maria Kyrtsoudi4; Angeliki Nika3
1 Department of Music Science and Art, University of Macedonia, Greece; 2 Department of Early Childhood Education and Care, Oslo Metropolitan University, Norway; *Advanced Health Intelligence and Brain-Inspired Technologies (ADEPT) Research Group, OsloMet, Norway; 3 2nd Pediatric Department P. & A. Kyriakou Children's Hospital, Neonatal Intensive Care Unit, Athens, Greece; 4 Clinical Psychoacoustics Laboratory, 3rd Psychiatric Department, Neurosciences Sector, Medical School, Aristotle University of Thessaloniki

Subtheme H - Interventions in Educational and Clinical Settings

Background: Neonatal prematurity presents significant pediatric care challenges. While neonatal advancements have improved survival, the effects of environmental sounds, particularly music, on brain development in NICUs, requires further exploration. Research Gap-Aim: Existing neuroimaging research is insufficient to understand the impact of live sung music's fundamental frequency (F0; a key feature of music delivery) on premature newborns' brain activity in NICU settings. This study aims to address this gap, enhancing music medicine practices in neonatal care. Hypothesis: We hypothesize that when premature newborns are exposed to a musical intervention provided by their mother (high F0), compared to the father (low F0) or an unrelated male/female music therapist, will statistically show more visible short-term positive oscillatory differentiations. Methods: This exploratory randomized control trial at a Greek hospital involves seven infants (≤32 weeks gestation) so far, with plans to expand by the conference. Infants are divided into a musical intervention and a control group. Brain activity is measured using quantitative Electroencephalography (qEEG), focusing on detailed spectral power, coherence, and brain connectivity analysis. This approach enables a comprehensive study of infants' neurophysiological responses to the different conditions (sound, music, silence) of the protocol. The statistical analysis includes Repeated Measures ANOVA for comparing brain activity across intervention days, conditions, and facilitators, and Time-Frequency Analysis for specific

qEEG module examination.
Results: Preliminary observations indicate brain response tendencies towards the F0 of the parents with some preference for the father's F0. Continuing data collection anticipated to report more definitive insights, potentially guiding neonatal care advancements.

Music-based attention training therapy for executive attention functions in individuals with acquired brain injury and neurocognitive deficits

Engel, Annerose; Werner, Julia; Wenk, Taavi; Löser, Alina S.; Villringer, Arno; Obrig, Hellmuth
Affiliations for all authors:
(1) Clinic for Cognitive Neurology, University Hospital Leipzig, Leipzig Germany (2) Max Planck Institute for Human Cognitive and Brain Sciences, Department of Neurology, Leipzig, Germany

Subtheme H - Interventions in Educational and Clinical Settings

We developed a music-based attention training therapy for small groups (2-8 participants) based on the Musical Attention Control Training of Neurologic Music Therapy (Thaut & Hoemberg, 2014). Our music-based training therapy aims at improving specific executive attention functions (e.g., focusing, divided attention, flexibility in responses, inhibitory control). It includes a set of exercises that are applied within a fixed training structure: (1) rhythmic exercises to drumbeats, (2) melodic and rhythmic game tasks for executive attention functions, and (3) rhythmic exercises to the patient's favourite songs. We present two studies that evaluated this music-based training therapy in individuals with acquired brain injury. They all suffered from cognitive deficits and received a multidisciplinary therapy within a day clinic setting (4-8 weeks). In the first study (34 participants) half of the patients received the music-based attention training therapy additionally to the multidisciplinary therapy. In the second study (26 participants) we used a randomized controlled trial design and patients received either the music-based attention training therapy or an individualized computer-assisted cognitive training therapy. Results on neuropsychological tests in the first study revealed an enhancement of several attention functions and mood for all participants, but only the music training group significantly increased inhibitory control providing evidence for a specific training effect. In the second study, the results showed an improvement in inhibitory control and rhythmic skills (sensorimotor synchronization to a metronome and to music) independent of group allocation. Thus, the music-based attention training therapy proved to be as effective as the computer-based cognitive training therapy that is well established in neurologic rehabilitation. We discuss the results of the second study for responder and non-responder to the music-based attention training therapy and whether free choice of therapy conditions influences the outcome of the therapy.

Music therapy, neural processing, and craving reduction: A mixed methods feasibility RCT study in a Community Substance Misuse Treatment Service

Jörg Fachner1* , Clemens Maidhof1, Devon De Silva2, Filippo Pasqualitto1, Paul Fernie1, Francesca Panin3, Andrew Michell4, Leonardo Muller-Rodriguez1
1) Cambridge Institute for Music Therapy Research (CIMTR), Anglia Ruskin University (ARU), Cambridge, UK; 2) Innovation & Research Unit, VIA, London, UK. 3) School of Life Sciences, Faculty of Science and Engineering, Anglia Ruskin University, Cambridge, UK; 4) Clinical Neurophysiology, Addenbrooke's Hospital, Cambridge, UK *Presenter

Subtheme H - Interventions in Educational and Clinical Settings

Music therapy (MT) has been shown to be effective for multiple clinical endpoints associated with substance use disorder such as craving reduction, emotion regulation, depression, and anxiety, but there are a lack of studies investigating those effects in UK Community Substance Misuse Treatment Services (CSMTSs) (Ghetti etal. 2022).

Furthermore, there is a demand for identifying MT mechanisms of change and related brain processes for substance use disorder treatment. The present study aimed to evaluate the feasibility and acceptability of MT and a pre-test, post- test, and in-session measurement battery in a CSMTS (Fachner etal. 2023). Fifteen participants, from a community service based in London, took part in a mixed-methods non- blind randomized-controlled trial. Ten participants received six-weekly sessions of MT in addition to the standard treatment offered by the CSMTS—five of them received individual MT and five of them received group MT—while a further five participants acted as a control group receiving standard treatment only. Subjective and behavioral indexes were assessed before and after the interventions to explore the effects of MT on craving, substance use, symptoms of depression and anxiety, inhibitory control, and were correlated with associated neurophysiological signatures. In-session analysis of two individual MT sessions served to explore how music and emotion were processed in the brain within the therapy. Data analysis is finalising, results will be presented at the conference focussing on resulting EEG biomarker changes, psychometric data, ERP analysis and thematic analysis of the interviews. Fachner, J., et al. (2023). "Music therapy, neural processing, and craving reduction: An RCT protocol for a mixed methods feasibility study in a Community

Substance Misuse Treatment Service " Addiction Science and Clinical Practice 18(36). Ghetti, C., et al. (2022). "Music therapy for people with substance use disorders (Review)." Cochrane Database of Systematic Reviews (Issue 5. Art. No.: CD012576.)

Effects of music training on the speech processing abilities of children with reading difficulties

Ferenc Honbolygó1,2; Maria Ioanna Zavogianni2,3; Maja Kelic4
1 Institute of Psychology, ELTE Eötvös Loránd University, Budapest, Hungary; 2 HUN-REN Research Centre for Natural Sciences, Budapest, Hungary; 3 Faculty of Modern Philology and Social Sciences, Multilingualism Doctoral School, University of Pannonia, Veszprém, Hungary; 4 Speech and Language Pathology Studies, University of Rijeka, Rijeka, Croatia

Subtheme H - Interventions in Educational and Clinical Settings

Previous research demonstrated the positive impact of music training on various language related skills in children with reading difficulties (RD). However, many studies lack rigorous methodologies such as Randomized Control Trial (RCT) design and primarily focus on the behavioral outcomes of trainings. This study aimed to address these gaps by employing an RCT design to investigate the effects of a specific music training program, developed in our lab, on the neural mechanisms underlying speech perception in children with RD. Thirty-nine children (age=8-11 years) participated in either a six-week intensive music training or computer-based spelling training. We assessed various cognitive and neural measures, but here we focus only on the results of the speech perception task. To measure speech processing abilities, we created a multi-feature Mismatch Negativity (MMN) ERP paradigm in which the standard stimulus, a two-syllable long pseudoword, was contrasted with deviant stimuli differing from the standard in the vowels (deviation by place and mode of articulation), consonants (deviation by place and mode of articulation) and stress pattern. Results indicated that all speech contrasts elicited the MMN component. Furthermore, MMN responses to vowel and stress contrasts were influenced by the training, with the music group exhibiting larger amplitudes. This suggests that music training specifically enhanced prosodic and spectral sensitivity relevant to vowel perception. Overall, these findings highlight the beneficial effects of music training on specific speech processing abilities in children with RD, while also underscoring the sensitivity of the MMN ERP component in detecting subtle training effects.

The Soundtrack of Self: Personality and Music Listening in Emotion Regulation

Caitlin Fountain1; Laura A. Stambaugh2
1 Department of Psychology at Virginia Commonwealth University, Richmond, Virginia, USA; 2 Department of Music, Theatre & Dance, Rhode Island College, Providence, Rhode Island, USA

Subtheme H - Interventions in Educational and Clinical Settings

Music's impact on listener emotions is well-established, but its effects vary widely among individuals. Beyond surface features such as tempo, personal traits may play a pivotal role. This study explores how the Big Five personality traits influence listeners' emotions and stress levels after listening to self-selected music. The study included two phases using American undergraduate samples. Participants (N=795) completed the Five Factor Form (FFF) and created customized playlists during the screening phase. During the experimental phase, 52 students (Mage= 19.65 years, SD= 3.43) from the screening phase were randomly assigned to one of three interventions (Empowering Music Listening, Calming Music Listening, Control Group) following a writing-based stress -induction task. Measures of emotion and stress were administered three times during the experiment. Correlation and multiple regression analyses examined the links between music listening conditions and personality traits on stress, negative emotions, and positive emotions post-intervention. The multiple regression model for stress with all six predictors produced $R2 = .357$, $F(1,50) = 4.158$, $p = .002$. Condition accounted for 9.6% of the variance, and personality accounted for 27.1%, with Neuroticism reaching significance ($p = .004$). For negative emotions, the model with all six predictors produced $R2 = .257$, $F(1,50) = 2.60$, $p = .03$. Condition accounted for 17.8% of the variance, but no personality traits reached significance. For positive emotions, the model was $R2 = .456$, $F(1,50) = 6.279$, $p < .001$. Condition accounted for 7.8% of the variance, and personality accounted for 38.3%. Openness and Conscientiousness reached significance ($p = .002$, $p = .007$). Findings underscore the pivotal role of listener personality traits in guiding the design of music-listening interventions aimed at alleviating stress and enhancing positive emotional experiences.

Finger-bowing Skill in Violin Playing: A Pilot Motion-Analysis Study of a Novice and Expert Using a High-Speed Camera

Haruno Fukatsu; Sotaro Kondoh; Shinya Fujii
Graduate School of Media and Governance, Keio University, Japan

Subtheme H - Interventions in Educational and Clinical Settings

The "finger-bowing" technique, also known as "Detache" in French or "Yubi-Yumi" in Japanese, is a skill utilized in violin playing to maintain a smooth sound around the moment of bow direction change. Despite daily practice among violinists (Fischer, 2004), the kinematic difference between novice and expert players remains unexplored. This pilot study aimed to clarify the characteristics of motion of an expert violin player compared to a novice. An expert violinist, who has won several competitions, and a beginner, who has never played the violin, participated in this study. The violin performance was recorded at 10,000 Hz with a high-speed camera (FASTCAM Mini AX, Photron), and the motion of the violin body, strings, and bow were tracked using DeepLabCut software (Mathis et al., 2018; Nath et al., 2019). Motion analysis revealed that the expert player switches the direction of the violin body and increases the amplitude of the string just before the downward bow switching at the hold side of the bow. The direction of the violin body is switched immediately after the upward bow switching at the tip side of the bow. In contrast, the novice did not show such coordinating motions. These results suggest that the fine coordinating movements of the bow, violin body, and strings during finger-bowing are fundamental in producing a smooth violin sound.

Therapeutic Use of Music Listening for Individuals with Non-Oncologic Chronic Pain: A Systematic Review

Jennifer Grau-Sánchez1,2; MªTeresa Sáez1,2; Lorena Zapata3; María F. Porto4,5; Víctor Fernández-Dueñas5,6; Antoni Rodríguez-Fornells5,6; Jèssica Garrido-Pedrosa1,2
1 Research group on Complex Health Diagnoses and Interventions from Occupation and Care (OCCARE); Terrassa, Spain; 2 Escola Universitària d'Infermeria i Teràpia Ocupacional de Terrassa (EUIT), Barcelona, Spain; 3 Pharmacology Unit, Department of Pathology and Experimental Therapeutics, School of Medicine and Health Sciences, Institute of Neurosciences, Universitat de Barcelona, Barcelona, Spain; 4 Cognition and Brain Plasticity Unit, Department of Cognition, Development and Educational Psychology, Faculty of Psychology, University of Barcelona; 5 Bellvitge Institute for Biomedical Research (IDIBELL), Barcelona, Spain. Barcelona, Spain; 6 Catalan

Institution for Research and Advanced Studies (ICREA), Barcelona, Spain.

Subtheme H - Interventions in Educational and Clinical Settings

Background: Chronic pain is a challenging problem, predominantly affecting women, that can impact all areas of occupation, despite the availability of multiple treatments. In recent years, there has been an increase in the misuse of opioids among individuals with non-oncological chronic pain, leading to addiction and dependence. This highlights the need to explore new non-pharmacological intervention tools such as music listening. Objective: To evaluate the effectiveness of music listening in reducing pain and improving functionality, quality of life, and occupational performance in adults with non-oncological chronic pain. Methodology: Searches were conducted in the PubMed, Cochrane Library, CINAHL, and Web of Science databases during December 2022 and February 2023, respectively. Randomized controlled trials, controlled trials, and longitudinal studies on music listening interventions in adults with non-oncological chronic pain were included. Results: Seventeen trials with a total of 779 participants from developed countries with non-oncological chronic pain of moderate to severe intensity lasting more than 6 months were selected. The duration of the music listening interventions ranged from a minimum of 1 session to a maximum of 120 sessions, with durations between 20 and 60 minutes. Nine studies used music listening as the sole intervention, while the remaining 8 studies combined it with vibratory stimuli, meditation mantras, and group music listening and imagery. Among all the gathered data, a significant reduction in pain and medication use, as well as an increase in functionality, quality of life, and psychological well-being, were found. Conclusion: Listening to music, especially classical or self-selected music, with headphones for at least 20 minutes daily in a stimulus-free environment is effective in reducing pain, increasing quality of life, and improving functionality in adults with non-oncological chronic pain.

Indian Music Rhythm Based Intervention for Parkinson's Disease: A pilot study

Shantala Hegde1; Topoti Baruah1; Sujas Bhardwaj1; Nitish Kamble1; Jitender Saini1; Venkatasubramanian G.1; Mariamma Phillip1; Ravi Yadav1; Pramod K Pal1; Matcheri S Keshavan2
1 National Institute of Mental Health and Neurosciences (NIMHANS), Bengaluru, Karnataka, India; 2 Department of Psychiatry, Beth Israel Deaconess Medical Center, Harvard Medical School, Harvard University, Boston, MA, USA
Subtheme H - Interventions in Educational and Clinical Settings

Background: Parkinson's disease (PD) is the second most common degenerative disorder. Along with motor symptoms (MS), non-motor symptoms (NMS) like cognitive and deficits, depression, anxiety, contribute significantly to poor quality of life. Cognitive rehabilitation (CR) is emerging an evidenced based non-pharmacological method to treat cognitive deficits. There is a strong need for comprehensive method of cognitive rehabilitation method that can target both MS and NMS. In the past decade, benefits of music-based interventions are being explored in neurological conditions. Indian classical music (ICM) is one of the oldest and complex forms of music. Talas (rhythmic structure and meters) of ICM can lend itself as a rich base for developing structured CR program. Aim: This study aimed at developing an Indian-rhythm based music intervention program and carry out a pilot study to examine the feasibility and effectiveness of this program in PD. Methods: Patients with PD (n=12) aged average of 46 years, with 4733.45 years of duration of illness, having less than 2.0 Hoehn & Yahr stage of illness comprised the sample. Eight patients completed 48-sessions of the intervention program and four patients completed same duration of passive music listening sessions (active controlled group). Baseline and post intervention neuropsychological functions and quality of life was assessed. Feedback and experience of the patients with regard to the intervention program was noted. Results: The preliminary findings indicate improved focused attention (color trails 2), working memory index (Weschler's adult intelligence scale) scale and positive changes in quality of life (PDQoL-39) in the intervention group compared to the active controlled group. Details of the intervention program, the preliminary quantitative and qualitative data along with challenges of carrying out intervention programs in a tertiary center will be presented Conclusion: Rhythm-based intervention in PD shows promising results however systematic study on larger cohort is underscored.

Audiovisual pitch perception training in congenital amusia: behavioral and neurophysiological benefits

Caliani Hoarau (1,2), Agathe Pralus(1,2), Lesly Fornoni(1), Denis Schwartz(3), Sébastien Daligault(3), Pierre-Emmanuel Aguera(1), Nathalie Bedoin(1,4), Annie Moulin(1), Barbara Tillmann(1,5), Anne Caclin(1)
(1) Lyon Neuroscience Research Center, Claude Bernard Lyon 1 University, Inserm U1028, CNRS UMR 5292, Lyon, France; (2) Humans Matter, Lyon, France; (3) Cermep, Inserm, CNRS, HCL, Lyon 1 University, Lyon, France; (4) Lyon 2 Lumière University, Lyon, France; (5) Laboratory for Research on Learning and Development, Université de

Bourgogne, LEAD-CNRS UMR5022, Dijon, France

Subtheme H - Interventions in Educational and Clinical Settings

Congenital amusia is a neurodevelopmental disorder characterized by an impairment in pitch perception and memory. Individuals with amusia have difficulties with detecting pitch changes, processing pitch contours, and memorizing pitches. Our present study builds on previously reported benefits of multisensory integration of audiovisual (AV) cues on pitch processing and tested whether AV training could result in an enhancement of pitch processing in amusic (n=18) and control participants (n=19). The training consisted of three pitch -related tasks, performed twice per week over 15 weeks: a pitch change detection task (PCD), a pitch direction of change identification task (DCI), and a pitch short-term memory task (STM). Each session lasting about 15min. Half of the training trials were auditory only, and the other half audiovisual. Participants underwent testing sessions without visual cues before and after the training. During the testing sessions, participants performed the same three tasks as during the training and additional untrained tasks. In addition, we used magnetoencephalography (MEG) measures to assess the effect of the AV training on brain plasticity. We recorded brain responses during an active short-term memory task for pitch and a passive oddball paradigm with pitch deviants. Our results revealed a benefit of AV pitch training (compared to control visuo-spatial training) on amusics' behavioral performance, with higher accuracy for the three pitch-tasks (PCD, DCI, STM). The investigation of the training effect on auditory networks revealed a decrease of N100 component during active sound sequence encoding in amusics and an increase of MMN during passive sound sequence encoding after the AV training in amusics and controls. These results suggest that pitch perception can be improved thanks to pitch AV training and provide new perspectives to decrease pitch perception deficits in other conditions and pathologies, such as in cochlear implant users.

Effect of daily choral singing on cognitive development in young children

Cédric HUBERT 1,2,3 & Aline FREY 1,2
1-AMU - Aix Marseille Université (Aix-Marseille Université Jardins du Pharo - France) 198056 2-CRPN - Centre de Recherche en Psychologie et Neurosciences (Marseille - France) 1184065 3-PsyCLÉ - Centre de Recherche en Psychologie de la Connaissance, du Langage et de Aix-en-Provence Cedex 1, France - France) 10213

Subtheme H - Interventions in Educational and Clinical Settings

The literature on the effects of music training on children's cognitive skills, brain function and/or academic performance has grown considerably in recent years (Bigand & Tillmann, 2021 and Roman-Caballero et al., 2022). To our knowledge, very few studies have looked at the effects of singing alone. However, one hypothesis would be that the processing of spoken and sung words involves interactive processes and common brain regions, so singing training could improve language development, particularly *phonological awareness, as well as the general cognitive abilities involved in language (e.g., auditory working memory). Finally, an emerging literature is beginning to show the effects of choral singing on prosocial skills, since singing requires a high level of cooperation and* synchronization between individuals. However, most of these studies have used a cross-sectional approach, and correlation is not causation. We therefore set up a 3-year longitudinal study in which we compared the cognitive performance of children participating in daily choral singing activities, or daily creative writing workshops (active control group), or not participating in any specific activity (passive control group). The children were tested at the beginning and end of each year on a series of skills such as working memory, auditory and visual attention, motor skills, creativity, oral and written language. The results show that the progression between pre and post measures in several tests of language abilities is greater for the choral singing group. These results thus encourage the introduction of this type of vocal practice to support school learning, especially as singing is much less costly to set up than instrumental practice.

Validation of a gamified rhythm training on a tablet for children with autism

Kevin Jamey1,2,3, Hugo Laflamme1,2,3, Nick E. V. Foster1,2,3, Simon Rigoulot1,2,3,4, Krista L. Hyde1,2,3, Simone Dalla Bella1,2,3,
1 International Laboratory for Brain, Music and Sounds Research (BRAMS), Montreal, Canada, 2 Dept. of Psychology, University of Montreal, Montreal, Canada, 3 Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada, 4 University of Quebec at Trois-Rivières, Trois-Rivières, Canada

Subtheme H - Interventions in Educational and Clinical Settings

Children with autism display both sensorimotor and executive functioning difficulties (i.e., inhibition control, and cognitive flexibility), which may be linked to co-occurring timing impairments. The rhythmic training of sensorimotor abilities may therefore improve executive functioning in autism. To test this hypothesis, we adapted a tablet music game called “Rhythm Workers” (RW) that trains auditory-motor abilities via finger tapping. RW was initially developed for adult populations with movement disorders (i.e., Parkinson's), and has not yet been assessed in autism. We invited children with autism (7-13 years; n = 26) to an at-home longitudinal protocol with remote evaluations. They were randomly assigned to either a finger-tapping rhythmic game (RW) or a control game with similar auditory-motor demands without beat-synchronization (active control condition). Participants played the game for 300 minutes over 2 weeks. We collected data (self -reported and logged on the device) on several feasibility measures (enjoyment, perceived difficulty). Additionally, we tested children's rhythmic abilities with the BAASTA battery and executive functioning tasks (inhibition control, and cognitive flexibility). Preliminary findings show high compliance with the protocol using RW and the control game (the training duration target was met), and that participants enjoyed playing both games. The children who played RW improved their auditory-motor synchronization skills (i.e., in tapping to music) compared to the control game. Training duration was strongly related to improvement on the Beat Tracking Index from BAASTA, a composite score reflecting beat perception and synchronization capacities, only for children who played RW. Finally, children who played RW improved in accuracy compared to the control game in inhibition control (flanker). In sum, we provide initial evidence that both games are well-matched and that the rhythmic game can selectively improve sensorimotor and executive functioning in children with autism. These findings can pave the way for future clinical studies with a larger sample size.

Resting-state and functional connectivity of auditory and reward systems in apathetic Parkinson's disease

Miguel Jose1, Lara Boyd2, Psyche Loui3, Silke Appel-Cresswell1;
1 Pacific Parkinson's Research Centre, Djavad Mowafaghian Centre for Brain Health, University of British Columbia, Vancouver, BC, Canada; 2 Brain Behaviour Laboratory, UBC Hospital, University of British Columbia, Vancouver, BC, Canada; 3 Brain Behaviour Laboratory, UBC Hospital, University of British Columbia, Vancouver, BC, Canada.

Subtheme H - Interventions in Educational and Clinical Settings

Objective: The aim of this study is to examine underlying resting -state and task-based functional connectivity between auditory and reward networks in apathetic individuals with Parkinson's disease. Our objective is to evaluate underlying connectivity at rest and during a music-listening task toward targeting apathy. Background: Parkinson's disease (PD) is often accompanied by non-motor symptoms that make treatment more difficult. One such symptom is apathy (decreased goal-directed behaviour). There are currently no targeted treatments for apathy in PD; this remains a major unmet need. One potential intervention shown to reduce apathy in clinical populations is listening *to rewarding music. Recent* studies have examined both resting-state and task-based functional connectivity within and between auditory-reward networks that underlie the ability to evaluate reward in musical stimuli in healthy and clinical populations. These mechanisms, which are key to predicting how effective music-based interventions are toward targeting clinical outcomes like apathy, have not been explored in PD. Method: This protocol has been preregistered and approved through the U.S. National Library Clinical Trials database. Participants are completing two functional magnetic resonance imaging (fMRI) sessions before and after an 8-week intervention period. Seed-based connectivity and region-of-interest (ROI) analyses are currently being conducted on the scans collected. Testing is ongoing and data is being collected. Results: As the study is ongoing, we predict reduced baseline functional connectivity within and between auditory and reward networks in PD participants with apathy compared to those without apathy. We predict that these less active auditory-reward functional pathways will be recovered (increased co-activation) as found in studies conducted in older adults and other clinical populations. Conclusions: The results from this study provide a novel perspective on the link between underlying neurological mechanisms and clinical benefits of rewarding music. The implications of this research extend to concurrent aims exploring auditory-reward functional connectivity during music listening.

Perception, Experience and Musical capabilities: A case study of the developing musical ear in Musicology students

Gabrielle Kaufman1; Marta Dosaiguas Canal2
1 Departament d’Art i de Musicologia, Universitat Autònoma de Barcelona, Spain; 2 Departament de Didàctica de l'Expressió Musical, Plàstica i Corporal., Universitat Autònoma de Barcelona, Spain

Subtheme H - Interventions in Educational and Clinical Settings

The relationship between experience, practice and musical perception has been the subject of intense research for decades in the fields of Music Cognition, including on topics such as rhythm and tempo perception, memory, emotion, while the relationship with musical aural training has emerged more slowly, as Butler complained in 1997. Recently, however, there has been a number of studies that connect aural training with new perception research (Buonviri, 2021, Fournier et al., 2019, Ponsati et al, 2016 and others) and this paper presents a new case study on the topic, focusing on the development of musical perception in Spanish Musicology students. This study will analyse the relationship between the regular use of aural training apps (Earbeater, Pitchimprover, Cantus and Sight Sing etc.) and changes in the perception of certain musical elements (pitch, rhythm, texture, timbre, structure and harmony) in adult university students enrolled in Musicology (n=8). The perception data was collected through private interviews and diagnostic surveys before and after a 3 months musical aural training course, including auto-evaluation items. The students were also asked to report the amount of time they spent using certain aural training apps each week. The perception data was compared to basic data (previous experience, collected from the entire first-year Musicology student population (n=60). The findings from this study, which is still on-going, have the potential to further our understanding of how new technological tools impact the musical perception for certain adult student populations, as well as the impact of self-confidence and training habits on the development of the musical ear in young adults. This research has clear implications for music-educational settings, especially regarding college education, and for the field of music perception in general.

Intra- and inter-brain coupling and activity dynamics during improvisational music therapy with a person with dementia: an explorative EEG-hyperscanning single case study

Clemens Maidhof1; Viktor Müller2; Kat Agres3; Olivier Lartillot4; Jodie Bloska5; Rie Asano6
1 Cambridge Institute for Music Therapy Research, Anglia Ruskin University, Cambridge, UK & Josef Ressel Centre for Personalized Music Therapy, University of Applied Sciences IMC Krems, Krems an der Donau, Austria. 2 Center for Lifespan Psychology, Max Planck Institute for Human Development, Berlin, Germany. 3 Yong Siew Toh Conservatory of Music, National University of Singapore, Singapore, Singapore & Centre for Music and Health, National University of Singapore, Singapore, Singapore; 4 RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion, University of Oslo, Oslo, Norway. 5 Anglia Ruskin University, Cambridge, UK . 6 Institute of Musicology, University of Cologne, Cologne, Germany & Advanced Comprehensive Research Organization, Teikyo University, Tokyo, Japan

Subtheme H - Interventions in Educational and Clinical Settings

Research into the neural dynamics underlying improvisational music therapy is largely lacking. This single case study explored within-session

differences in musical features and in within- and between-brain coupling between a Person with Dementia (PwD) and a music therapist during a music therapy session. Dual-EEG from a music therapist and a PwD (male, 31 years) was recorded. From audio-visual *data, three features and their* time courses of the musical improvisation were extracted: Note density, pulse clarity and synchronicity. Based on the video recording, three music therapists identified moments of interest and no interest (MOI/ MONI) in two drum improvisations. The Integrative Coupling Index, an index reflecting time-lagged neural synchronization between two brains as well as within each individual brain, and musical features were compared between the MOI and MONI. Results showed that between-brain coupling of 2 Hz activity was increased during the MOI, showing anteriority of the therapist's neural activity. Within-brain coupling for the PwD was stronger from frontal and central areas during the MOI, but within-brain coupling for the therapist was stronger during MONI. Differences in musical features indicated that both acted musically more similar to one another during the MOI. These within-session differences in neural synchronization and musical features highlight the dynamic nature of music therapy. The findings may contribute to a better understanding of social and affective processes in the brain and (interactive) musical behaviors during specific moments in a real-life music therapy session. This may provide insights into the role of such moments for relational-therapeutic processes.

Music Therapy to support Wellbeing, Cognitive Function, and Physiological Ageing in Older Adults: An RCT

Anthony Mangiacotti1; Emma Ward1; Sophie Williams2; Clare Barone2; Ming Hung Hsu3; Martine Van Puyvelde4; Michele Biasutti5; Gianfranco Gabai6; Laura Dallart6; Fabia Franco7
1 Department of Psychology, Middlesex University, London, UK; 2 Music Therapy lead, MHA Methodist Home, London, UK; 3 CIMTR, Anglia Ruskin University, Cambridge, UK; 4 Brain, Body and Cognition, Department of Psychology, Vrije Universiteit, Brussel, Belgium; 5 FISPPA Department, University of Padua, Padova, Italy; 6 Department of Comparative Biomedicine and Food Science, University of Padua, Padova, Italy; 7 Department of Psychology, Middlesex University, London, UK

Subtheme H - Interventions in Educational and Clinical Settings

With a rapidly expanding older adult population, investigating health issues related to ageing is increasingly important, including neurocognitive decline and its association with neuropsychiatric symptoms, and risk factors linked to mortality. Observational studies have identified social activity as a protective factor. Music therapy (MT) is a non-pharmacological intervention that demonstrates potential in alleviating psychological stressors associated with ageing, making it suitable for social prescribing and offering social-psychophysiological benefits for older adults. *However, controlled studies* looking at the effectiveness of MT are limited. Here we share findings from the MusiCare project funded by Dunhill Medical Trust. We report two studies investigating the efficacy of MT interventions in healthy older adults and individuals with mild to moderate cognitive impairment living in care. Both studies employ a pre-post randomized controlled trial (RCT) design, examining effects on cognition, behaviour, and well-being, as well as physiological aspects (salivary cortisol/DHEA ratio and Respiratory Sinus Arrhythmia). Study 1 concentrates on UK community interventions with healthy older adults, utilizing a four-arm RCT comparing three types of 5-month weekly MT sessions: (i) one-to-one, (ii) small-group, (iii) community MT (CMT), versus a passive control group. Study 2, a three-arm RCT, compares three types of 5-month weekly MT sessions: (i) one-to-one, (ii) small-group, (iii) standard-CMT with older adults living in care homes experiencing mild and moderate cognitive impairment. The findings provide initial insights into the relationship between diverse MT approaches and their biopsychosocial-cognitive benefits for both healthy older adults and those with cognitive decline. Generally, one-to-one MT seems relevant for supporting both attentional and executive functions. Small group therapy appears effective in enhancing general cognitive functions, while CMT may contribute to improvements in executive functions. Results also elucidate the connection between various measures used to monitor the effectiveness of MT interventions in reducing the speed and magnitude of cognitive decline.

Sound and Symbol: The development of a music intervention to foster musical, language and emergent literacy skills in children in early years settings.

Kathryn Mason1; Alice Bowmer1; Prof. Graham Welch1; Dr Julian Knight2; Vanessa Stansall2
1 University College London, London, UK; 2 Creative Futures, London, UK;

Subtheme H - Interventions in Educational and Clinical Settings

Sound & Symbol (S&S) is an early years music intervention devised in collaboration with researchers, music practitioners, speech and language therapists and early years practitioners (EYPs). There were two key aims of the study. The first was to impact positively on speech and language development of children aged 3-4 years with potential language delay. The second was to work with and mentor EYPs to give them a wider range of music-based tools and understanding with which to support children's language and musical development. This poster explains the development, implementation and research findings of the S&S project which took place between 2015-2022 across twelve Early Years settings of marked socio-economic deprivation in London, UK. This music and language intervention evolved across three iterations. In each iteration, weekly planning and reflection sessions shaped the content and delivery of the intervention, allowing the team to respond to the individual needs of the children and EYPs. Music practitioners visited each nursery weekly to run a session in partnership with the EYPs who would then continue to practise this material throughout the following week between S&S sessions. The impact of this mentoring had a transformative effect on EYPs teaching confidence as they formed new perspectives on their way of working. The latest S&S project iteration was carried out in 2022 with two intervention and two inactive-control nurseries in areas of marked socio-economic deprivation, in London, UK. The intervention ran for 20 weeks and involved 80 children. Data collected at baseline and post intervention showed improvement in all groups, with the S&S group having a significantly larger increase in performance on tasks of receptive and productive language and emergent literacy. This is a good early indicator of the potential of the S&S programme, and upcoming iterations of S&S aim to expand on these findings.

Finding the Melody: Music Therapy and Suicide Data Across Europe

Gabriel McDerment
Gallatin School of Individualized Study, New York University, New York, USA; The Grieg Academy Music Therapy Research Centre, University of Bergen, Bergen, Norway

Subtheme H - Interventions in Educational and Clinical Settings

This study is designed to integrate publicly available data to explore suicide and music therapy geographically across Europe. This study works in frameworks of public health and Geographic Information Systems (GIS) mapping to explore how suicide, a negative outcome of mental illness, occurs in the same geographical spaces as music therapy, a novel therapy showing great promise. The study draws on public health, medicine, anthropology of medicine, and computer science to provide a closer look at how the two co-exist in different European contexts and how music therapy may be in a great position to provide equitable treatment and help fight the suicide epidemic across the city in a revolutionary way. The study uses GIS mapping to overlay public data and analyze how music therapy and suicide exist geographically across Europe. The literature review and additional pieces show great promise that music therapy can fight against suicide ideation and be implemented quickly and cheaply in a manner that can rectify health inequities across historically underrepresented areas in both community practice and national guidelines. The primary finding is that music therapies are becoming more accessible to populations across Europe, concentrated in cities and in certain marginalized groups. The GIS model shows hope and aids practical suggestions about where music therapy practices would survive and thrive, making the most difference against the suicide epidemic. This study provides visual geographic information that expands on the need for novel mental health therapies in communities historically underrepresented in a traditional psychiatric landscape. The study frames music therapy in its potential to help right this equity and provides practical guidelines for implementation across Europe based on these GIS models.

Neuroimaging the impact of the musical program Un Violon dans mon école.

Morfoisse Théo (1,2) Séverine Becuwe (1) Marie Palue (1) Cassandra Potier Watkins (2) Ghislaine Dehaene Lambertz (1) Stanislas Dehaene (1,2)
(1) Cognitive Neuroimaging Unit, CEA, INSERM, NeuroSpin Center, Université Paris-Saclay, Gif-sur-Yvette, France. (2) Collège de France, Université Paris Sciences Lettres (PSL), Paris, France.

Subtheme H - Interventions in Educational and Clinical Settings

Does playing music have a positive impact on the development of children's cognitive abilities? This question, still widely debated, is central to our collaborative research with the Vareille Foundation, founders of the program Un Violon dans mon école. This program provides violin lessons from preschool to 2nd grade to schools in disadvantaged neighborhoods in France. Our longitudinal research compares children in this program with peers from matched socio-economic backgrounds, but without violin instruction. We use behavioral and neuroimaging methods, including MEG and fMRI to measure the development of children's cognitive abilities and their supporting brain networks. In this presentation, I will detail the outcomes of our neuroimaging studies, conducted at two pivotal points in each child's development: at the end of kindergarten (5-6 years) and at the end of first grade (6-7 years), i.e., after 2 and 3 years of music education respectively. Initially, 53 children were recruited for the study (32 violin and 21 control). Of these, 46 successfully completed all the experiments. No significant difference was found between groups in behavioral measures at pretest. Our most definitive findings were observed in MEG experiments focused on children's inhibitory control on an adapted flanker task. After 2 and 3 years of intervention, violinists appeared to be better and faster than the controls on the incongruent trials, suggesting a positive impact of violin practice on inhibition skills. The fMRI studies, on the other hand, were designed to identify and quantify the development of neural networks associated with mathematical reasoning, musical cognition, and social knowledge. Despite the observation of these networks at a relatively under-explored age, no clear difference emerged between violinists and controls at either time point. These nuanced results suggest that music practice seems to enhance executive functions, but its impact on more distant domains, such as mathematics, remains uncertain.

Two Case Studies of Improved Communication Skills in Developmental Disorder Children through Makaton Songs

Odawara Junior College, Department of Early Childhood Care and Education, Japan.

Subtheme H - Interventions in Educational and Clinical Settings

This case study investigated the effects of training non-verbal children using Makaton sign language combined with familiar melodies and lyrics. To achieve rhythmic singing while signing, we created three songs (“School Song,” “Food Song,” and “Hospital Song”) collectively named “Makaton Songs.” These songs were composed of a total of 62 core vocabulary words (including individual words and phrases). The training was evaluated through regular sessions conducted by a music therapist and practice at home facilitated by mothers. Case 1: A male child with Down syndrome (trisomy of chromosome) received training between the ages of 6 and 9. We conducted a two-factor analysis of variance (ANOVA) considering word condition (pre and post-training) for each song’s core vocabulary. Results showed significant effects for both word condition and pre/post-training, demonstrating the effectiveness of training across all three songs. Case 2: A female child with autism spectrum disorder underwent training between the ages of 3 and 5. The two-factor ANOVA revealed an interaction effect between word condition and pre/post-training, with significant differences in the evaluation of the three songs. Both cases exhibited relatively lower acquisition of food-related vocabulary. We hypothesize that the fusion of visual information from daily activities and auditory input through rhythm-emphasized songs contributed to vocabulary acquisition. Future research should expand the dataset and investigate word acquisition in more detail, considering factors such as specific disabilities.

Comparing Melodic Intonation Therapy with a matched non-intonation Speech Therapy in patients with Chronic Nonfluent Aphasia

Andrea Norton[1] and Gottfried Schlaug[1, 2]
[1] Music, Neuroimaging, and Stroke Recovery Laboratories, Dept. of Neurosciences, University of Massachusetts Chan Medical School - Baystate, Springfield, MA, USA. [2] Institute of Applied Life Sciences and Department of Biomedical Engineering, UMass Amherst, Amherst, MA, USA

Subtheme H - Interventions in Educational and Clinical Settings

Clinical observations of patients' ability to sing words that they could no longer speak inspired the use of singing for recovery from nonfluent aphasia. Results from small case series of open-label treatment trials in patients with moderate to severe nonfluent aphasia have provided evidence that methods involving singing (i.e., intoned (sung) speech), specifically Melodic Intonation Therapy (MIT), can facilitate or enhance recovery of speech-motor function beyond either natural recovery alone or non-intonation-based speech therapy (e.g., SRT). Patients in this trial (NCT00903266) had large left-hemisphere lesions, moderate to severe nonfluent aphasia, and were at least 12 months post-onset of their first-ever stroke. All participants were randomly assigned to one of three groups. Patients in the MIT or SRT group underwent two baseline assessments (B1 and B2) prior to initiation of the experimental intervention (75 sessions of 1.5hrs each), one mid-treatment assessment (post40), and one assessment immediately post-treatment (post75). Participants in the No-Treatment Control (NTC) group had three assessments over a similar period of time. Our primary outcome was change in Correct Information Units (CIUs)/min (a measure of speech fluency) elicited during propositional speech tasks; our secondary outcome measure was a change in confrontation naming scores on the Boston Naming Test (BNT30). In our preliminary analyses, a repeated measures ANOVA revealed significant overall differences in both the primary speech-fluency outcome (CIUs/min) and the secondary (BNT30) outcome measure (both F values were above 8 with a $p<0.01$) across 4 timepoints (B1, B2, Post40, and Post75). Post-hoc pairwise comparisons showed no significant difference between the Baseline assessments (p=1.0) suggesting stability of the impairment prior to intervention, but significant differences were found between the first baseline assessment and the P40 and the P75 assessments (all p<0.01) with MIT significantly outperforming SRT at the end of the intervention period.

Training-induced neural enhancement of novel song learning in chronic aphasia

Emma Oksanen (1) Emmi Pentikäinen (1) Anni Pitkäniemi (1) Sini-Tuuli Siponkoski (1) Sari Laitinen (2) Essi-Reetta Särkämö (3) Tommi Makkonen (1) Teppo Särkämö (1)
(1) Cognitive Brain Research Unit, Department of Psychology and Logopedics & Centre of Excellence in Music, Mind, Body and Brain, University of Helsinki, Helsinki, Finland (2) Espoo Hospital, Espoo, Finland (3) Private choir conductor, Vantaa, Finland

Subtheme H - Interventions in Educational and Clinical Settings

Background. Aphasia, a language disorder affecting up to 40% of stroke survivors, is often connected with abnormalities in learning, short-term memory, and auditory processing. Rehabilitation, including singing-based interventions, can induce changes in the auditory processing in people with aphasia (PWA), potentially aiding language recovery. This electroencephalography (EEG) study set out to explore the effects of a multimodal choir-singing intervention on the implicit auditory processing of PWA, reflected by the mismatch negativity (MMN), and whether these effects are correlated with intervention-induced changes in communicational abilities and verbal learning. Methods. 34 PWA took part in a 16-week intervention comprising choir singing, group-based melodic intonation therapy, and home training. Participants trained one of two novel songs during the intervention. In pre-and post -intervention EEG measurements, participants listened to modulated versions of the songs using a passive oddball-design with pitch and phoneme deviations embedded to the songs. Communicational abilities and verbal learning were also assessed pre- and post-intervention. Linear mixed models were used to analyze the training-induced changes in the MMN response for both trained and untrained songs. Those changes were then correlated with changes in communication and verbal learning. Results and conclusions. In the left frontotemporal area, the amplitude of the MMN decreased for phoneme deviations in the trained song but increased for phoneme deviations in the untrained song. Notably, the attenuation of the MMN to the trained song was correlated with enhanced language performance. These

findings suggest that singing intervention can modify implicit auditory processing in PWA, and that changes in those processes can be accompanied by improved communication abilities.

A randomized control trial on the effectiveness of improvisational music therapy for autistic children aged 7 - 11

Irene Pallás1, Artur C Jaschke1, Claire Howlin4, Jonathan Pool2, David M Greenberg1, Anna Kovalova1, Eve Merriam1, Rebecca Atkinson2, Karen Hayden3, Carmel Moore3, Carrie Allison1, Helen Odell-Miller2, Simon Baron-Cohen1.
1 Autism Research Centre, Department of Psychiatry, University of Cambridge, UK;2 Cambridge Institute for Music Therapy Research, Anglia Ruskin University, UK; 3 Anglia Ruskin Clinical Trials Unit, Anglia Ruskin University, UK; 4 Trinity College Dublin, School of Psychology, Ireland.

Subtheme H - Interventions in Educational and Clinical Settings

Background. The Autism-CHIME (CHildren’s Improvisational Music Therapy Evaluation) trial tests whether improvisational music therapy can effectively support improvement in social and communication skills for autistic children, aged 7-11 years old. Music therapy is the clinical use of musical interventions to improve mental and physical health, including social communication and wellbeing. Autistic children, who have difficulties with social communication and anxiety, sometimes demonstrate a strong preference for music, which makes music therapy a promising medium for intervention. Methods Autism-CHIME is an assessor-blind, pragmatic Randomised-Controlled-Trial(RCT) comparing the impact of 12-weeks (24sessions) of Improvisational Music Therapy (IMT) with Support as Usual (SU) for 7-11-year-old autistic children in school-settings. 240 participants will be randomly-assigned to IMT or SU and stratified into 3 groups: Minimally-Verbal, Phrase-Speakers, or Fluent-Speakers, depending on their verbal skills. The primary outcome measure is the Brief Observation of Social Communication Change to identify changes in social-communication behaviours. The secondary outcome measures include: Children's Communication-Checklist-2; Strengths and Difficulties-Questionnaire; Young-Child-Outcome-Rating-Scale; Vineland-3 Adaptive-Behaviour-Scale; Music at Home-Questionnaire; Parent-Rated-Anxiety-Scale for Youth with Autism-Spectrum-Disorder; Assessment of the Quality of Relationship; Music-Therapy-Communication and Social-Interaction-Scale(or Music-Engagement-Scale). Data will be collected at: T0 prior to randomisation(eligibility and baseline); T1(13 weeks) and T2 (39 weeks) Additional data collection includes: Wechsler-Abbreviated Scale of

Intelligence(WASI-II); Autism-Spectrum-Quotient; Children's versions of Empathy-Quotient and Systemizing-Quotient; Demographic parameters, co-occurring conditions, and concomitant treatments. Discussion. Our study aims to establish the effectiveness of improvisational music therapy for autistic children, regardless of verbal ability, to provide evidence for clinical guidelines and policymakers. It is among the first RCTs to explore how music therapy impacts on autistic children's wellbeing and anxiety, in addition to their communication and social skills, while identifying factors that influence its effectiveness.
Funding Funded by grants from the Autism Centre of Excellence at Cambridge, the RosetreesTrust(PGL21/10149) and the StoneygateTrust and supported by University of Cambridge and Anglia Ruskin University.

Immediate effects of Mozart's music on normal subjects: evaluation of vital signs as indicators

Ana Claudia Puggina, Luisa Helena Mangile, Bruna Zapparoli Leão, Caroline Simioni Coelho, Maria Helena de Sousa
Faculdade de Medicina de Jundiaí, Jundiaí (SP), Brasil.

Subtheme H - Interventions in Educational and Clinical Settings

Objective: to compare vital signs and capillary blood glucose levels before and during musical stimulation (immediate response) in normal subjects without changes in the level of consciousness. Method: An intervention study was conducted, involving volunteers approached only once. Vital signs were collected during 24 minutes and 17 seconds of silence (prior to the musical application) and during an equal duration of musical intervention (Mozart's music). Each vital sign was collected six times with a 4-minute interval. Capillary blood glucose levels were assessed twice in each patient before and after the musical intervention. *Descriptive analysis, as well as comparative analysis using* statistical tests, were performed. The significance level adopted for the tests was set at $p \leq 0.05$, with a trend of significance considered at $p \leq 0.08$. Results: Thirty-four normal subjects participated, with a mean age of 35.9 (317.8) years, and 61.8% were female. A significant trend was observed in the overall mean of systolic and diastolic blood pressure during the entire evaluation period, both without music and with music (p=0.06). Considering equivalent time points, statistically significant differences were found in systolic pressure at 2 minutes (p=0.02), diastolic pressure at 2 minutes (p=0.01), diastolic pressure at 10 minutes (p=0.05), and heart rate at 10 minutes (p=0.04). Additionally, significance was observed at 14 minutes of oxygen saturation (p=0.01), with a trend of significance at 18 minutes of oxygen saturation (p=0.07). Glucose levels exhibited a significant tendency to decrease after listening to music (p=0.08). Conclusion: The immediate response to music was characterized by decreases in systolic and diastolic blood pressure, heart rate, and capillary blood glucose, as well as an increase in oxygen saturation during the application of Mozart's music. Among the vital signs evaluated, blood pressure, heart rate, and oxygen saturation demonstrated potential as indicators of the immediate effects of listening to Mozart's music.

Autism, Music, and Alexithymia: a musical intervention to enhance emotion recognition abilities for adolescents with Autism Spectrum Disorder.

Celia Redondo Pedregal; Prof. Pamela Heaton
Psychology Department, Goldsmiths, University of London- London, UK

Subtheme H - Interventions in Educational and Clinical Settings

Difficulties in identifying emotions from facial expressions, vocalisations, and body language are common in autistic children and adolescents. Existing literature explores emotion recognition abilities in facial expressions and vocalizations among autistic children. However, limited attention has been given to emotion recognition in body gestures. Importantly, autistic adults and children show typical patterns of physiological arousal to music and can accurately attribute verbal labels to musical emotions. Moreover, difficulties in identifying emotions have been linked to increased alexithymia and language abilities. This study *aims to develop a music-based intervention to enhance emotion recognition in dynamic and static facial expressions,* verbal and non-verbal vocalisations, and body gestures. 43 autistic adolescents completed 5 music sessions and pre- and post-testing sessions on emotion recognition, alexithymia, and receptive and structural language. The sessions consisted of an analysis of the emotions portrayed in a series of musical excerpts and a posterior discussion on how these emotions may be communicated. Results showed that at pre-test vocabulary was correlated with emotion recognition abilities but not alexithymia. After the intervention, all participants improved their emotion recognition abilities in all modalities, being statistically significant for all modalities except for gesture. Music-based interventions may be a powerful tool to enhance emotion recognition abilities for autistic adolescents.

Modulation of pain perception through identifying emotionally with music-feedback during physical exercise in patients with chronic pain

Lydia Schneider1, Alida Wulfson2, Jutta Geidel2, Michael Schenk2 and Thomas Hans Fritz1,3
1 Max-Planck-Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, 2 Zentrum für integrative Schmerzmedizin, Franziskus Krankenhaus Berlin, Germany, 3 Institute for Psychoacoustics and Electronic Music (IPEM), Ghent University, Ghent, Belgium

Subtheme H - Interventions in Educational and Clinical Settings

The current study investigated the effects of music-feedback during physical exercise on anxiety, motivation and pain in patients with chronic pain during an acute clinic stay. A cross-over design was used to test the effects of music-feedback during an ergometer training (active condition) vs. music listening during an ergometer training (passive condition) in 43 patients with different chronic pain conditions. Patients were recruited by clinical staff and randomly assigned to perform both trainings in different order. The music was selected from 4 genres and the same songs were used in both conditions. Results showed that the motivation to exercise is stronger during the active condition as compared to the passive condition as measured by active engagement during the training interval ($t(39)= 3.013$, $p = .006$; 95% CI: .0104; .0529); Cohen´s $d= .066$), which matches with patients individual ratings on motivation. Anxiety levels decreased significantly for both conditions as compared to baseline anxiety (active condition: $Z = -4.213$; $p < .001$; passive condition: $Z = -3.864$; $p < .001$). The pain levels did not differ between conditions ($Z=-.137$, $p = .45$). Interestingly, the reported match/congruency of current mood of patient and emotion expressed by the chosen music piece correlated with changes in pain perception ($r = -.438$, $p = .007$), and the match of one's own emotional state with the music was significantly higher during the active condition as compared to the passive condition (Z = -3.429; p < .001). No significant correlation between changes in pain intensity and changes in heart rate variability were observed (r = 0.15, p = .952). Conclusion: music-feedback during physical exercise might be beneficial in terms of increased motivation in patients with chronic pain. A stronger match of emotions expressed by music-feedback and one`s own emotional state seems to positively influence pain perception.

Enriched Music-supported Therapy for Individuals with Chronic Stroke: a Randomized Controlled Trial

Emma Segura1,2, Jennifer Grau-Sánchez1,3, Xim Cerda-Company1,2,4, María F. Porto1,2, Myriam De la Cruz-Puebla1,2; David Sanchez-Pinsach5, Jesus Cerquides5, Esther Duarte6,7, Anna Palumbo8,9; Alan Turry9, Preeti Raghavan10, Teppo Särkämö11, Thomas F. Münte12, Josep Lluis Arcos5, and Antoni Rodríguez-Fornells1,2,13;
1 Cognition and Brain Plasticity Unit, Bellvitge Biomedical Research Institute, L'Hospitalet de Llobregat, Barcelona, Spain; 2 Department of Cognition, Development and Educational Psychology, University of Barcelona, Barcelona, Spain; 3 Research group on Complex Health Diagnoses and Interventions from Occupation and Care (OCCARE), Escola Universitària d'Infermeria i Teràpia Ocupacional, Universitat Autònoma de Barcelona, Barcelona, Spain; 4 Computer Science Department, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Barcelona, Spain; 5 Artificial Intelligence Research Institute, Spanish National Research Council, Bellaterra, Barcelona, Spain; 6 Department of Physical and Rehabilitation Medicine, Hospital del Mar, Barcelona, Spain; 7 Institut Hospital del Mar d'Investigacions Mèdiques (IMIM), Barcelona, Spain; 8 *Rehabilitation Science Program, New York University, New York, USA; 9 Nordoff-Robbins Center* for Music Therapy, New York University, New York, USA; 10 Department of Physical Medicine and Rehabilitation, John Hopkins University, Baltimore, Maryland, USA; 11 Cognitive Brain Research Unit, Department of Psychology and Logopedics, Faculty of Medicine & Centre of Excellence in Music, Mind, Body and Brain, University of Helsinki, Helsinki, Finland; 12 Department of Neurology, University of Lübeck, Lübeck, Germany; 13 Institució Catalana de Recerca i Estudis Avançats, Barcelona, Spain.

Subtheme H - Interventions in Educational and Clinical Settings

Many stroke survivors still present with upper-limb paresis six months post-stroke, impacting their autonomy and quality of life (QoL). However, access to chronic stroke rehabilitation remains limited. Music-supported Therapy (MST) is an effective intervention to improve upper-limb functionality and QoL post-stroke. We designed an enriched MST version (eMST) for chronic stroke by adapting the program for home-use and introducing group music therapy sessions. The eMST aims to improve upper-limb motor function through musical training while promoting autonomy and reintegration into community, crucial elements in chronic rehabilitation. We developed a tablet-based app to conduct the sessions with a MIDI-piano and percussion instruments. A pragmatic two-arm parallel-group randomized controlled trial was conducted to evaluate the eMST's effectiveness and efficacy in improving functional abilities and QoL in chronic stroke survivors compared to a conventional motor program. Fifty-eight individuals with chronic stroke and mild-to-severe upper-limb paresis were recruited and randomly allocated to the eMST-group (n=26; 23.1% females; 64.2312.5 years old; 2.832.9 years post-stroke) or the control group (n=32; 25% females; 62.2312 years old; 1.836.2 years post-stroke). Both interventions consisted of a 10-week home-based program with 4 one-hour sessions per week. We evaluated participants' functional abilities, emotional well-being, QoL, self-regulation and self-efficacy behaviours before, after, and 3-months post -intervention. The eMST exhibited notably superior effects in reducing upper-limb motor impairment post-intervention compared to the control group in both intention-to-treat analysis (55% vs 21.6% of participants achieving a relevant improvement; p=.02) and per-protocol analysis (60% vs 20%; p=.02), which were sustained at follow-up. Importantly, participants undergoing eMST showed a decreased anger and increased positive emotion and community participation post-intervention. Additionally, the eMST-group reported having more fun during the sessions. The eMST is an effective and enjoyable intervention for chronic stroke survivors to enhance their physical and emotional states, which could have both a medical and social impact.

The Experiences of Families with Neurodivergent Children at an Inclusive Educational Classical Music Concert: A Qualitative Analysis

Cassiea Sim, M.A.,1 Mélanie Moura,2 Marie-Claude Codsi,2 & Eve-Marie Quintin, Ph.D.1, 1Department of Educational and Counselling psychology, McGill University, Montreal, Canada; 2Youth Programming and Mediation, Orchestre Symphonique de Montréal, Montreal, Canada

Subtheme H - Interventions in Educational and Clinical Settings

Background: Social models of disability promote the perspective of neurodivergent individuals' experiences in society. Evidence suggests that neurodivergent individuals

suffer from social exclusion in spite of their desires to be included and valued by their peers, and it suggests that this social exclusion negatively impacts well-being. Further, there exists research to support the premise that families with neurodivergent children are more likely to encounter stigma and judgement in public and community spaces, and that these negative experiences discourage families from participating in their communities, effectively isolating them. Taking the reality of neurodivergent children into account, Montreal Symphony Orchestra (OSM) designed an inclusive concert with the needs of autistic children as a guiding principle. Objective: The goal of the present study was to assess the experiences of neurodivergent children attending educational concerts with their family unit in either the traditional classical concert format or the new inclusive format. Methods: Data was collected from families who attended OSM's educational concerts (either traditional or inclusive) through online post-concert questionnaires designed to capture the experiences of neurodivergent children in attendance. Results and Conclusion: Among the various findings, 4% of families reported attending the traditional concerts with a neurodivergent child, while40% of families reported attending the inclusive concert with a neurodivergent child. A qualitative content analysis was performed on the written responses provided by families; five key themes emerged among respondents, namely feelings of freedom and social acceptance, feelings of being part of a shared community, appreciation for the educational aspects of the concert, appreciation for the tailored nature of the experience, and feelings of gratitude and hope. Thus, findings show that families with neurodivergent children greatly appreciate inclusive concerts, and that such endeavours respond to a community need for accessible public art. Key words: Autism Spectrum, Music, Social Inclusion, Neurodivergence, Education, Concert Experience

Test CRDL with children and youth with physical and mental impairment

Alessio Surian1; Fabio Palmitesta2; Francesco Marchesi2; Alberto Zanette2
1 University of Padova, Italy; 2 Sonora Music Therapy Centre and "G. Ferrari" Music Therapy School, Padova, Italy,

Subtheme H - Interventions in Educational and Clinical Settings

This study focuses on the use of midi devices that turn human touch into sound in rehabilitative music interventions. Since the 2014 Playtronica group offers a toolkit addressing enhanced sound interactivity in the everyday world by using the conductive properties of objects to sense touch interaction (i.e. electric

resistance) and turn it into sound through MIDI-controllers such as TouchMe. This principle has been used by architects Jack Chen and Dennis Schuivens to create CRDL, an interactive instrument (a wooden “rugby ball”), developed to stimulate communication between users through sound and touch. CRDL can identify and translate different touches (such tickle, holding, grabbing, fondling, kneading, and tapping) between people into sounds, as if people could “play each other” like an instrument once they touch each other and the CRDL producing a closed circuit. Initially, this interactive instrument has been used with encouraging results to support family members, friends, and caregivers to communicate with people with dementia (Teunissen et al 2017; Heuvel et al 2020). During 2022 the “G. Ferrari” Music Therapy School and the Sonora Music Therapy Centre – both based in Padova (Italy) – in collaboration with CRDL creators and Klankspoor (NL), designed a 3-month study to test CRDL with children and youth with physical and mental impairment and their family members and caregivers. The qualitative multiple case-study was implemented in Padova and Treviso (in January-April 2023) involving one psychologist and three music therapists, with data gathering through video recordings, observation checklists and therapists’ notes and semi-structured exit interviews.

The results focus on the patients’ a learning curve as well as improved social communication elicited by music reward mechanisms based on data analysis concerning 12 children aged 3-6, 3 children aged 8-10, 3 teenagers aged 14-19, and 5 young people aged 22-26 - for a total of 23 patients.

Studying the effects of digital music composition in social media usage and its brain and mental-health consequences in teenagers: the SMART project

Lucía Vaquero (1,2,3,4), Karleigh Groves (2,3,4), Eva Luna Muñoz -Vidal (2,3), Franziska Degé (5), Elisa García-Mingo (1,6), Catherine Hartley (2,4), and Pablo Ripollés (2,3,4):
1. Digital Culture & Social Movements Lab (Cibersomosaguas), Department of Sociology: Methodology & Theory, Complutense University of Madrid (Madrid, Spain) 2. Center for Language Music and Emotion (CLaME), Max Plank Institute for Empirical Aesthetics and New York University (New York, USA) 3. Music and Audio Research Lab (MARL), New York University (New York, USA) 4. Department of Psychology, Faculty of Arts and Sciences, New York University (New York, USA) 5. Musical Development Unit, Music Department, Max Plank Institute for Empirical Aesthetics (Frankfurt, Germany) 6. Centre for Transforming Sexuality and Gender (University of Brighton)

Subtheme H - Interventions in Educational and Clinical Settings

Social media (SM) has rapidly become ubiquitous, especially among younger generations. However, which SM activities are beneficial or detrimental for the developing brain of children and adolescents is still an open question. Previous research shows opposite findings: while some reports highlight the beneficial contributions of SM for learning, social interaction , and wellbeing, other investigations describe decreased attention, cognitive and emotional control, and an increase in mental-health related disorders (such as depression and anxiety) associated with the overuse of SM. Interestingly, the cognitive and emotional functions negatively affected by the intense use of SM, as well as some of its neural underpinnings, have been previously and consistently reported to benefit from music and art-based interventions. Our goal in the 'Social Media Artistic tRaining in Teenagers (SMART)' project is to use digital art-based trainings to teach adolescents how to use SM in a more goal-oriented and stimulating way, in the context of learning music composition or photography edition through specific software (i.e., Soundtrap, Photoshop). A first group of 16 participants (age: 14 -16 years) has recently been recruited and will complete a 3-month music composition intervention program, being evaluated before and after the intervention, and providing weekly measures on SM usage and mood. Evaluations will include cognitive (attention), mood, and mental-health (depression, stress, anxiety, self-esteem) measures, as well as functional and structural connectivity and morphological biomarkers obtained via MRI and MEG techniques. We expect to observe changes in the self-reported use and attitudes towards SM, and benefits in attention, mood states, and mental-health indices, as well as in the neural substrates supporting these processes. The extension of data collection planned over the next 2 years will confirm (or refute) those expectations, with great consequences for our understanding of brain and mental health effects linked to SM overuse, while offering potential counteracting measures.

Memory, Reward, and Default Networks during Self-Selected Music Listening in Healthy Aging and Mild Cognitive Impairment

Xiaotong (Eva) Wu[1], Corinna Parrish[1], Laine Koenig[1], Jakob Laats[1], Milena Quinci[1], Alex Belden[1], Ben Kubit[1], Edward Large[2], Psyche Loui[1],
1 Department of Music, College of Arts, Media and Design, Northeastern University, Boston, MA, USA; 2 Department of Psychological Sciences, University of Connecticut, Storrs, CT, USA

Subtheme H - Interventions in Educational and Clinical Settings

Music-based interventions for healthy aging rely on the idea that listening to pleasurable music engages auditory and reward systems; however, this result has not yet been compared between healthy and cognitively impaired older adults. Here we compare brain activity during music listening in older adults (aged 56-89; n=17), whose cognitive abilities were screened by the Clinical Dementia Rating (CDR). Participants with a CDR score of 0 ("unimpaired group") were compared against participants with subjective cognitive decline to mild or moderate cognitive impairment ("impaired group": CDR scores 0.5-2). All participants listened to self-selected and researcher-selected musical excerpts during fMRI. Results showed that for both groups, there was significantly more activity in auditory (anterior and posterior superior temporal gyrus (STG) and planum polare), memory (bilateral posterior parahippocampal gyri), and reward (amygdala, ventral tegmental area) networks as well as the default mode network (DMN) while listening to self-selected as compared to other-selected music. Contrasts between impaired and unimpaired groups showed significantly more activity in the impaired group in reward (nucleus accumbens, amygdala), memory (bilateral posterior parahippocampal gyrus, left hippocampus), and auditory networks (bilateral MTG, left planum temporale), as well as the DMN (medial prefrontal cortex (mPFC), bilateral posterior cingulate cortex (PCC), right precuneous) and bilateral angular gyrus, while listening to self-selected as compared to other-selected music. Results converge with previous work on the importance of agency in music selection for music-based interventions for dementia. Since disrupted activity in DMN and parahippocampal, and angular gyri are linked to cognitive decline, results from the present study further support that self-selected music is more effective at engaging the brain than other-selected music, and this is especially the case for cognitively impaired older adults.

Ictal humming due to right temporal lobe epilepsy: a case report

Matteo Zaccagnino, MD[1], Luciano Pellegrino, MD[1], Giovanni Zanotelli, MD[1], Alessandra Pes, MD[1], Dario Seppi, MD[1], Filippo Dainese, MD[1], 1 Unit of Neurology and Unit of Clinical Neurophysiology, Department of Neuroscience, University of Padua, Padua, Italy

Subtheme H - Interventions in Educational and Clinical Settings

Melodic production including humming and singing is a rare motor phenomenon of focal seizures. Underlying neural networks are still poorly understood from an anatomical and electrophysiological point of view. Previous studies reported the localization of the epileptogenic zone of such phenomena in different brain areas including left frontal lobe, left temporal lobe, right temporal lobe, and right frontal lobe [Mi Lee 2013]. Humming was reported to be specifically associated with synchronization of superior temporal gyrus and inferior frontal gyrus activity [Bartolomei 2007]. We present a case of a 17-year-old right-handed male with no previous musical training who began experiencing two different types of focal seizures at age 15. One was characterized mainly by motor manifestation while the other consisted of humming and melodic verbal production. A previously recorded interictal electroencephalogram showed right temporal slow spike activity. He was admitted to our clinic for video-EEG monitoring. Simultaneous video and EEG data recorded from scalp electrodes for four days demonstrated two events during sleep and three while awake. In all the latter the patient manifested non-stereotyped motor activity of the upper limbs and humming of unfamiliar melodies. Ictal EEG showed sharp waves starting in the right posterior temporal lobe diffusing to the left temporal lobe and bilateral frontal regions. Humming was observed shortly before interhemispheric diffusion. A brain MRI scan demonstrated several nodules of subependymal heterotopia in both temporal horns and other periventricular small nodules of cortical heterotopia in both frontal lobes. No FDG uptake decrease on FDG PET-MRI was observed. Our findings are consistent with the hypothesis that ictal humming and singing is the result of the recruitment of neural networks in frontal and temporal regions of both hemispheres rather than the activation of a specific cortical region, as suggested in previous studies [Mi Lee 2013].

Can Haydn, Mozart and Beethoven rehabilitate neglect? - A case report

Ryan Zeineldin1; Monica Toba1,2; Dragana Manasova1; Maryane Chea1; Eléonore Bayen1,3,4; Paolo Bartolomeo1

1 Sorbonne Université, Institut du Cerveau–Paris Brain Institute –ICM, Inserm, CNRS, APHP, Hôpital de la Pitié Salpêtrière, Paris, France; 2 Laboratory of Functional Neurosciences (UR UPJV 4559), University of Picardy Jules Verne, Amiens, France; 3 Service de Médecine Physique et de Réadaptation, APHP, Hôpital de la Pitié Salpêtrière, Paris, France; 4 Faculté de Médecine, Sorbonne Université, Paris, France,

Subtheme H - Interventions in Educational and Clinical Settings

Our recent work stressed the importance of inter-hemispheric communication for recovery from spatial neglect. Perhaps, by ”talking” to the damaged right hemisphere, the healthy left hemisphere may “learn” to compensate for neglect signs. Might audio-visual music experience, which synchronously engages both hemispheres, help restore connectivity after stroke Here we report the case of a patient with chronic spatial neglect after an extensive right-hemisphere stroke impacting the frontoparietal cortex and the insula. Starting 104 days post-stroke, the patient was exposed to two hours/day of audio-visual music by Haydn, Mozart and Beethoven for two weeks. During the subsequent two weeks, he listened to an audiobook and received standard rehabilitation. Evaluations included line bisection and cancellation tests, diffusion MRI and EEG. They were conducted at baseline (T1), post-music (T2) and post-audiobook (T3), except for diffusion MRI which was only obtained at T1 and T2. The results showed some improvement on line bisection performance (T1: 45% rightward deviation; T2 and T3: 26%) and line cancellation (attentional field [the larger the better], T1: 112mm, T2: 128mm, T3: 144mm). However, there were no changes in performance on letter and bell cancellation tasks. White matter tractography indicated an increase in Fractional Anisotropy (FA) in the callosal fibers (T1: 0.43; T2: 0.46) and the left-hemisphere Superior Longitudinal Fasciculus (SLF) II (T1: 0.37, T2: 0.42) and III (T1: 0.39, T2: 0.42). The right-hemisphere SLF was totally disconnected by the lesion. EEG analysis in the theta band did not show any connectivity improvements. Partial improvement on neuro-psychological performance and increased microstructural integrity of interhemispheric and left-hemisphere frontoparietal pathways suggest that audio-visual music experience helped neglect compensation through inter-hemispheric communication. The extensive lesion perhaps overshadowed possible EEG correlates of this phenomenon. These preliminary results warrant further investigation in a larger patient cohort.

FONDAZIONE
MARIANI

neuromusic®

FOLLOW US

www.neuromusic.org
www.fondazione-mariani.org

www.facebook.com/neuromusicfm