THE NEUROSCIENCES AND MUSIC - VII

Connecting with music across the lifespan

18-21 June 2021
Concert Hall
Aarhus, Denmark
+ Online

Fondazione con SGQ certificato

Fondazione
Pierfranco e Luisa Mariani
neurologia infantile

THE NEUROSCIENCES AND MUSIC – VII

Connecting with music across the lifespan

Aarhus, Denmark
Concert Hall
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In collaboration with

Center for Music in the Brain

In partnership with

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The Royal Academy of Music

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WORLDWIDE MUSIC CONFERENCE
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Volunteers
will be available for assistance during the conference period.

The Mariani Foundation for Paediatric Neurology announces The Neurosciences and Music - VII congress to be held in hybrid format, in Aarhus, Denmark, from 18 to 21 June, 2021 and online. The seventh edition of this established series again gathers the main experts from all over the world for the most important conference in the field.

The central theme will focus on "Connecting with music across the lifespan".

The program includes Workshops, Symposia, Poster sessions and the Keynote Lecture. Online participants will enjoy Symposia transmitted by video and audio in a professionally produced quality, with the option of interacting during discussions.

Poster sessions will be held in interactive format, both onsite and online in Gather.town.

The meeting will be of interest to neuroscientists, psychologists, clinicians and professionals in the medical field, therapists, educators, musicians, musicologists, and students in each of these fields.

The conference will be co-hosted by the Danish National Research Foundation's Center for Music In the Brain (MIB), an interdisciplinary center of excellence addressing the dual questions of how music is processed in the brain and how this can inform our understanding of fundamental principles behind brain processing in general.

The city of Aarhus, which features a beautiful and concentrated array of unique historical and cultural venues, will be involved in welcoming participants and in the social moments.

Alongside the scientific program, the Royal Academy of Music Aarhus/Aalborg (RAMA) opens its doors to the conference and offers dedicated musical opportunities within the diverse and exciting musical interludes. Jam sessions will be arranged with local musicians, inviting participants to join in and share their talents.

Even within the constraints which need to be taken into consideration, the feeling of "community" characteristic of the Neuromusic conferences will be preserved and cultivated in this new format, which will make specialized knowledge more widely accessible, bridging distances and generations in a celebration of the special connections between music and our productive, creative lives.

PROGRAM

DAY 1
Friday, 18 June 2021
LILLE SAL
Musikhuset Aarhus (The Concert Hall Aarhus)
Thomas Jensens Allé 2, 8000 Aarhus C

11.00-13.00
Registration

13.00-13.10
Opening of session

13.10-14.25
Workshop 1
RESEARCH ON MUSIC INTERVENTIONS IN COMMUNITY SETTINGS - TOWARD LEARNING AND WELLBEING ACROSS THE LIFESPAN
Organizers:
Assal Habibi
University of Southern California, USA
Mari Tervaniemi
University of Helsinki, Finland
(online)

Speakers:
Gunter Kreutz
Carl von Ossietzky Universität Oldenburg
Germany
Frank A. Russo
Department of Psychology, Ryerson University
Toronto, Canada
(online)

14.25-14.55
Discussion

14.55-15.15
Coffee break
Caféen (The Café)

15.15-17.00
Workshop 2
PUTTING MUSIC TO TRIAL: DESIGN AND PROGRESS OF ONGOING CLINICAL TRIALS ON MUSIC-BASED INTERVENTIONS IN NEUROLOGICAL REHABILITATION
Organizers:
Teppo Särkämö
University of Helsinki, Finland
Jennifer Grau-Sanchez
Cognition and Brain Plasticity Unit
University of Barcelona, Spain
Antoni Rodriguez-Fornells
Universitat de Barcelona and Institut
d'Investigació Biomèdica de Bellvitge (IDIBELL)
Spain
(online)

17.00-17.30
Discussion

18.00-19.30
WELCOME RECEPTION AT AARHUS RÅDHUS (AARHUS CITY HALL)
Rådhuspladsen 2, 8000 Aarhus

18.00-18.10
Welcome by the Municipality of Aarhus

18.10-18.30
Welcome by Mariani Foundation and Hosting Committee

18.40-19.00
Connecting with music 1
Assoc. Professor Lena Gregersen and Song Dance and Playing student group

DAY 2
Saturday, 19 June
LILLE SAL
Musikhuset Aarhus (The Concert Hall Aarhus)
Thomas Jensens Allé 2, 8000 Aarhus C

9.00-9.15
Official Welcome

09.15-10.30
Symposium 1
SENSORIMOTOR INTEGRATION IN MUSIC PRODUCTION ACROSS THE LIFESPAN
Chair: Maria Herrojo Ruiz
Speakers: Maria Herrojo Ruiz, Peter Pfordresher Giacomo Novembre, Shinichi Furuya

Body-brain interaction in music performance
Maria Herrojo Ruiz
Goldsmiths University of London, UK
(online)

Singing accuracy across the lifespan: Problems and predictors
Peter Pfordresher
University at Buffalo, USA
(online)

On the role of inter-brain synchronization in social interactive learning of music
Giacomo Novembre
Italian Institute of Technology, Rome, Italy
(online)

Somatosensory communication between the brain, body, and tool in pianists across the lifespan
Shinichi Furuya
SONY Computer Science Laboratory, Japan
(online)

10.30-12.00
POSTER SESSION 1
Area around Filuren

12.00-13.00
LUNCH
Caféen (The Café)

13.00-14.15
Symposium 2
TOWARDS A GENOMICS OF MUSICALITY
Chair: Henkjan Honing
Speakers: Isabelle Peretz, Sarah Wilson Fredrik Ullén, Reyna L. Gordon

Does the speech genetic variant FOXP2 contributes to the emergence of Congenital Amusia?
Isabelle Peretz
University of Montreal, Canada
(online)

Investigating the heritability of singing ability in twins
Sarah Wilson
University of Melbourne, Australia
(online)

Gene-environment interplay in musical expertise
Fredrik Ullén
Karolinska Institute, Sweden
(online)

Musical rhythm ability exhibits highly polygenic architecture: A genome-wide association study in 606,825 individuals
Reyna L. Gordon
Vanderbilt University Medical Center, USA
(online)

14.15-14.30
Connecting with music 2
Prof. Jim Daus Hjernoe in vocal interaction with audience

14.30-14.45
Coffee break
Caféen (The Café)

14.45-16.00
Symposium 3
UNIVERSALITY AND VARIABILITY OF MUSIC ACROSS THE LIFESPAN AND ACROSS CULTURES
Chair: Samuel Mehr
Speakers: Samuel Mehr, Laurel Trainor, Nori Jacoby, Josh McDermott

A natural history of song
Samuel Mehr
Harvard University, USA and Victoria University of Wellington, New Zealand
(online)

Universals, variability, evolution, and cultural creation in the context of musical development
Laurel Trainor
McMaster University, Canada
(online)

Universal constraints on rhythm revealed by large-scale cross-cultural comparisons of rhythm priors
Nori Jacoby
Max Planck Institute for Empirical Aesthetics, Germany
(online)

Cross-cultural insights into music perception
Josh McDermott
Massachusetts Institute of Technology, USA
(online)

16.00-16.15
Coffee break
Caféen (The Café)

16.15-17.45
Symposium 4
THE IMPACT OF LONG-TERM MUSIC INTERVENTIONS ON BEHAVIOR AND BRAIN PLASTICITY OVER THE LIFESPAN IN HEALTHY INDIVIDUALS AND IN INDIVIDUALS WITH ADHD OR AUTISM SPECTRUM DISORDER
Chair: Gottfried Schlaug
Speakers: Peter Schneider, Annemarie Seither–Preisler, Eckart Altenmüller/Clara James, Christian Gold/Karsten Specht, Gottfried Schlaug

Effects of musical experience on morphology and network plasticity of the auditory brain in children and adolescents
Peter Schneider
Department of Neuroradiology and Section of Biomagnetism, University of Heidelberg, Germany
Centre for Systematic Musicology
University of Graz, Austria
Jazeps Vitols Latvian Academy of Music, Riga Latvia
(on site)

Behavioral and neurological benefits of musical training on children and adolescents with AD(H)D and dyslexia
Annemarie Seither-Preisler
Centre for Systematic Musicology, University of Graz, Austria
(on site)

Is it never too late?
Effects of music interventions in healthy seniors on cognitive function, motor control, listening skills, and brain plasticity in gray and white matter
Eckart Altenmüller
University of Music, Drama, and Media, Hannover, Germany
(on site)
Clara James
School of Health Sciences Geneva, University of Applied Sciences and Arts, Western Switzerland HES-SO and Psychology Department, University of Geneva, Switzerland
(on site)

Discrepant results between small exploratory trials and a multinational pragmatic trial of music therapy for autism: Heterogeneity on all levels
Christian Gold
NORCE Norwegian Research Centre AS, Bergen, Norway, and University of Vienna, Austria
(online)
Karsten Specht
University of Bergen, Norway
(online)

Randomized clinical trial of an intonation-based spoken language treatment for minimally verbal children with Autism Spectrum Disorder
Gottfried Schlaug
University of Massachusetts Medical School-Baystate and Institute of Applied Life Sciences at University of Massachusetts Amherst, USA
(online)

17.45-18.00
Coffee break
Caféen (The Café)

18.00-18.30
Best posters in a flash 1

19.00-22.30
CONFERENCE DINNER AT "Centralværkstedet" (The Railway Repair Center)
Værkmestergade 9, 8000 Aarhus C

DAY 3
Sunday, 21 June
LILLE SAL
Musikhuset Aarhus (The Concert Hall Aarhus)
Thomas Jensens Allé 2, 8000 Aarhus C

9.00-9.10
Opening of session

09.10-10.25
Symposium 5
EXAMINING THE DEVELOPMENT AND NEURODYNAMICS OF COMPLEX MENTAL PROCESSING: WHAT CAN (AND CAN'T) WE LEARN FROM ENGAGEMENT WITH FULL-LENGTH PIECES OF MUSIC
Chairs: Matthew Sachs & Petri Toiviainen
Speakers: Petri Toiviainen, Alluri Vinoo, Matthew Sachs, Mor Regev

Using music to probe the neural mechanisms of emotions and their dynamics
Matthew Sachs
Center for Society and Neuroscience, Columbia University, USA
(online)

Content-specific neural patterns in auditory cortices during imagery of music
Mor Regev
Montreal Neurological Institute, McGill University, Montreal, Canada
(online)

Investigating neural effects of musical training using dynamic, model-free naturalistic paradigms
Vinoo Alluri
International Institute of Information Technology, Hyderabad, India
(online)

Functional dynamics of neural networks for beat processing
Petri Toiviainen
Finnish Centre for Interdisciplinary Music Research, University of Jyväskylä
(online)

10.25-10.40
Coffee break
Caféen (The Café)

10.40-11.10
Best posters in a flash 2

11.10-12.45
POSTER SESSION 2
Gather.town - online

12.45-13.30
LUNCH
Caféen (The Café)

13.30-14.00
Connecting with music 3
RAMA Big Band
conducted by Professor Jens Christian Jensen

14.00-14.15
Coffee break
Caféen (The Café)

14.15-15.00
KEYNOTE LECTURE
Predictive coding
Karl Friston
University College London, Institute of Neurology, UK
(online)

15.00-15.15
Coffee break
Caféen (The Café)

15.15-16.30
Symposium 6
BRAIN MECHANISMS UNDERLYING MUSICAL INTERACTION AND IMPROVISATION ACROSS THE LIFESPAN
Chair: Virginia Penhune
Speakers: Peter Vuust, Boris Kleber, Morten Kringelbach, Elvira Brattico

Brain dynamics of interpersonal tapping
Peter Vuust
Center for Music in the Brain (MIB), Aarhus University/The Royal Academy of Music, Aarhus/Aalborg, Denmark
(on site)

Connecting with music through singing
Boris Kleber
Center for Music in the Brain (MIB), Aarhus University/The Royal Academy of Music, Aarhus/Aalborg, Denmark
(on site)

Social interactions, pleasure of music and human flourishing
Morten Kringelbach
Center for Music in the Brain (MIB), Aarhus University/The Royal Academy of Music, Aarhus/Aalborg, Denmark & Oxford University, UK
(on site)

The pleasure to learn and predict
Elvira Brattico
Center for Music in the Brain (MIB), Aarhus University/The Royal Academy of Music, Aarhus/Aalborg, Denmark & University of Bari Aldo Moro, Italy
(on site)

16.30-16.45
Coffee break
Caféen (The Café)

16.45-17.00
Connecting with music 4
El Sistema inspired children's orchestra Musik-Sak led by Rebecca and Gabriella Fuglsig

17.00-18.15
Symposium 7
TOWARDS MUSIC-BASED AUDITORY REHABILITATION FOR OLDER ADULTS
Chair: Benjamin Zendel
Speakers: Claude Alain, Frank A. Russo, Benjamin Zendel, Gavin M. Bidelman

Promoting healthy aging through music training
Claude Alain
Rotman Research Institute, Baycrest Centre
Department of Psychology and University of Toronto, Canada
(online)

Brief choir participation mitigates auditory processing difficulties experienced by older adults living with hearing loss
Frank A. Russo
Department of Psychology, Ryerson University
Toronto, Canada
(online)

Self-directed piano training improves the ability to understand speech in noisy environments in older adults
Benjamin Zendel
Faculty of Medicine, Memorial University of Newfoundland, St. John's, Canada
(online)

The impact of musicianship on the neural processing of speech across the lifespan
Gavin M. Bidelman
University of Memphis, USA
(online)

20.00-23.00
JAM SESSION AT THE ROYAL ACADEMY OF MUSIC
Musikhuset Aarhus (The Concert Hall Aarhus)
Skovgaardsgade 2, 8000 Aarhus C

Jazz/Blues led by Mikkel Vuust (dms)
"Klubscenen" (room 226) which will be equipped with rhythm group instruments, microphones and percussion.
Rooms 222 and 224 are reserved for spontaneous sessions (vocal or other).
Both are equipped with a grand piano.

DAY 4
Monday, 22 June
LILLE SAL
Musikhuset Aarhus (The Concert Hall Aarhus)
Thomas Jensens Allé 2, 8000 Aarhus C

9.00-9.10
Opening of session

09.10-10.25
Symposium 8
THE ROLE OF MUSIC TRAINING ON EXECUTIVE FUNCTIONS IN CHILD AND ADOLESCENT DEVELOPMENT
Chair: Jennifer Bugos
Speakers: Minna Huotilainen, Jennifer Bugos, Franziska Degé, Daniel Müllensiefen

Music play school for every child – with language benefits: An ERP study
Minna Huotilainen
University of Helsinki, Finland
(online)

The effects of a multimodal music training program on children's working memory: Results of a randomized controlled trial
Jennifer Bugos
University of South Florida, USA
(on site)

The association between music lessons and specific cognitive abilities in 9- to 12-year-old children: The mediating role of executive functions
Franziska Degé
Max-Planck-Institute for Empirical Aesthetics, Frankfurt, Germany
(online)

Working memory, music perception skills and musical training: development during adolescence
Daniel Müllensiefen
Goldsmiths, University of London, UK
University of Hamburg
University of Music, Drama, and Media, Hannover, Germany
(on site)

10.25-10.45
Connecting with music 5
Triple bass concert, featuring Morten Ramsbøl, Bjørn Petersen, Mads Bærentzen & Peter Vuust

10.45-12.00
POSTER SESSION 3
Gather.town - online

12.00-12.45
LUNCH
Rytmisk Sal and Kammermusiksalen

12.45-14.00
Symposium 9
MUSIC INTERVENTIONS FOR NEUROLOGICAL AND NEURODEGENERATIVE DISORDERS
Chair: Stefan Koelsch
Speakers: Noelia Martínez-Molina, Simone Dalla Bella, Séverine Samson, Stefan Koelsch

Neurological music therapy in the cognitive and neural rehabilitation of traumatic brain injury
Noelia Martínez-Molina
Cognitive Brain Research Unit (CBRU), Department of Psychology and Logopedics, Faculty of Medicine, University of Helsinki, Helsinki, Finland
(online)

Rethinking rhythm training in Parkinson's disease: Beneficial effects of a serious game across motor domains
Simone Dalla Bella
International Laboratory for Brain, Music and Sound Research (BRAMS) and Department of Psychology, University of Montreal, Canada
(online)

Music synchronisation and social interaction in Alzheimer's disease
Séverine Samson
University of Lille and La Pitié-Salpêtrière Hospital, Paris, France
(on site)

Can a singing intervention slow down brain ageing in Alzheimer's disease?
Stefan Koelsch
Institute for Biological and Medical Psychology, University of Bergen, Bergen, Norway
(online)

14.00-14.15
Coffee break
Caféen (The Café)

14.15-15.30
Symposium 10
MUSICAL PLEASURE AS A TOOL TO IMPROVE MEMORY AND AFFECT
Chair: Robert Zatorre
Speakers: Ernest Mas-Herrero, Laura Ferreri, Pablo Ripollés, Neomi Singer

The neural mechanisms underlying music-induced pleasure: From correlational to causal evidence
Ernest Mas-Herrero
Montreal Neurological Institute, McGill University, Montreal, Canada
(online)

From pleasure to memory: The implications of music-related reward responses in episodic memory
Laura Ferreri
Laboratoire d'Étude de Mécanismes Cognitifs (EMC), Université Lumière Lyon 2, Lyon, France
(online)

Enhancing memory via music-evoked pleasure
Pablo Ripollés
Department of Psychology, Music and Auditory Research Laboratory, New York University, New York, USA
(online)

Reward circuit modulation via musical neurofeedback
Neomi Singer
Sagol Brain Institute, Imaging section, Tel-Aviv Sourasky Medical Center, Israel and Department of Neurology and Neurosurgery, Montreal Neurological Institute, McGill University, Canada
(online)

15.30-16.00
Connecting with music 6
A cappella choir Vocal Line led by Associate Professor Jens Johansen

16.00-16.15
Coffee break
Caféen (The Café)

16.15-17.15
Symposium 11
EMERGING APPROACHES TO LARGE-SCALE AND LONGITUDINAL STUDIES OF THE IMPACT OF MUSIC ON HUMAN DEVELOPMENT IN CHILDREN AND ADOLESCENTS
Chair: John Iversen
Speakers: Daniel Gustavson, John Iversen, Miriam Lense

Distinct genetic and environmental influences on musical instruments, singing, and dancing in early adolescence and associations with cognition 4 years later
Daniel Gustavson
Vanderbilt University Medical Center, Nashville TN, USA
(online)

Large-scale nested studies of the impact of music on brain and behavioral development
John R. Iversen
University of California San Diego, La Jolla, CA, USA
(online)

Musical activities support social engagement in young children with autism and their parents
Miriam Lense
Vanderbilt University, Nashville, TN, USA
(online)

17.15-17.30
Awards and announcement of the next Neuromusic conference

17.30-18.00
General discussion and conclusions

18.30-22.00
MUSIC, EXHIBITIONS AND LIGHT SUPPER AT "DEN GAMLE BY" (The Old City Museum)
Viborgvej 2, 8000 Aarhus C

19.30-22.00
1. **Jazz at Bent J jazz bar**, featuring Mikkel Vuust, Frederik Vuust and Peter Vuust
2. **Aarhus fortæller (The Aarhus Story)**
800 m2 underground museum on the history of Aarhus
3. **Remember the 1970's?**
Entire neighbourhood based on the year 1974 with apartments, shops, a jazz bar and much more.

ABSTRACTS

WORKSHOP 1

RESEARCH ON MUSIC INTERVENTIONS IN COMMUNITY SETTINGS - TOWARD LEARNING AND WELLBEING ACROSS THE LIFESPAN

Organizers: Assal Habibi, Mari Tervaniemi

Assal Habibi
University of Southern California, USA

Gunter Kreutz
Carl von Ossietzky University, Oldenburg, Germany

Frank Russo
Ryerson University, Toronto, Canada

Mari Tervaniemi
University of Helsinki, Finland

A growing body of work suggests that music training supports cognitive and social functions across the developmental lifespan (infants to elderly adults). Music-based interventions that are offered in the community setting are growing in number because they are accessible, low-cost, and can be tailored to culturally and socio-economically diverse groups of population. Over the last decade, a number of research programs have been established in parallel with these community music programs, such as El Sistema, Harmony Project, and DEMOS, with the aim of investigating the impact of such programs on brain, cognitive, and/or social and emotional development of their participants across the lifespan. Other investigators have implemented community-based music training, such as choir participation, as an intervention to assess its efficacy on a variety of cognitive and social skills including language development, executive function skills, prosocial behavior and general well-being. Although the use of community-based samples is an appropriate alternative to randomized controlled trials, the design, development and implementation of these studies is not without challenges. A range of factors to consider include recruitment difficulties from a diverse group of population, participant retention, access to measures that can easily be implemented in a community setting and lack of standardized batteries across studies.
The purpose of this workshop is to consider the available evidence from correlational, cross-sectional and longitudinal studies on community-based music programs (both in the context of a parallel research study or an intervention), discuss methodological and theoretical challenges and consider the limitations associated with this research area. We also aim to provide an educational opportunity to inform junior researchers about the current approaches for music intervention research in community settings in comparison to randomized controlled trials and identify promising directions for future investigations. Finally, we will discuss development and implementation of a comprehensive communications plan designed to disseminate findings of these research programs on community-based music interventions to educators as well as policy makers.

WORKSHOP 2

PUTTING MUSIC TO TRIAL: DESIGN AND PROGRESS OF ONGOING CLINICAL TRIALS ON MUSIC-BASED INTERVENTIONS IN NEUROLOGICAL REHABILITATION

Organizers: Teppo Särkämö, Jennifer Grau-Sanchez, Antoni Rodriguez-Fornells

Teppo Särkämö
University of Helsinki, Finland

Jennifer Grau-Sanchez
Cognition and Brain Plasticity Unit, University of Barcelona, Spain

Antoni Rodriguez-Fornells
Universitat de Barcelona and Institut d'Investigació Biomédica de Bellvitge (IDIBELL), Spain

During the last years, there have been major advances in mapping the neural basis of music processing and the neuroplasticity changes underlying musical training. Coupled with the rapidly growing prevalence of many neurological illnesses, this progress has fueled interest towards music-based neurological rehabilitation, among both researchers and clinicians. In the world of evidence-based medicine, randomized controlled trials (RCTs) are the gold standard for showing the efficacy of rehabilitation. While individual RCTs have showed positive emotional, motor, or cognitive effects of music interventions, the overall quality of evidence for the clinical efficacy of music-based rehabilitation is still low to moderate for most patient populations and outcomes.
Building consensus about the design and methodology of trials and fostering collaboration between the music therapy and neuroscience communities and across research laboratories in different countries for building larger multicentre trials is pivotal for the development of the music rehabilitation field and, ultimately, for the translation of music intervention methods from the laboratory to clinical practice.
This workshop will bring together researchers, therapists and clinicians working on music rehabilitation to discuss about the current state-of-the-art in the field, what challenges we need to overcome, and what we can do to move music rehabilitation forward in the clinical realm. The Workshop entails short presentations of planned and ongoing RCTs of music rehabilitation, focusing on their methodology and intervention designs, in neurodevelopmental disorders (autism, dyslexia) and ageing-related neurological disorders (stroke, Parkinson's disease, dementia), followed by general discussion about the methodological issues and challenges of implementing clinical trials, especially in the current COVID-19 era.

SYMPOSIUM 1

SENSORIMOTOR INTEGRATION IN MUSIC PRODUCTION ACROSS THE LIFESPAN

Chair: Maria Herrojo Ruiz
Speakers: Maria Herrojo Ruiz, Peter Pfordresher, Giacomo Novembre, Shinichi Furuya

Sensory-motor integration plays a key role in both control and learning of musical skills across the lifespan. In singing and playing a musical instrument, abundant sensory information is provided from our body, which includes proprioceptive, auditory, visual, and interoceptive signals. From infants to elderly, the afferent feedback from the body continues to tune and rewire our brain, which sophisticates skillful production of music and enables a rich interaction and communication between musicians and audience as well as between teachers and students. The symposium introduces biological and computational mechanisms underlying the skillful interaction between the brain, body, and musical instrument, as well as their plastic adaptation across the lifespan. The researchers will also introduce novel intervention techniques such as non-invasive brain stimulation and exo-skeleton robot and discuss their potential contribution to facilitating these sensorimotor processes.

Body-brain interaction in music performance

Maria Herrojo Ruiz
Goldsmiths University of London, UK
(online)

There is an increasing body of evidence showing visceral signals modulating a wide range of perceptual, affective and cognitive processes. During musical performance and singing, it is reasonable to assume that visceral information, such as cardiovascular or respiration signals, can modulate emotional experiences in the performers and this can be tested empirically. Here I will report recent work, in which we turned our attention to a very different problem: how bodily signals, such as the cardiac cycle, influence sensorimotor processing during performance.
More specifically, I will provide data on error-monitoring-related neural responses during early stages of error detection. The results showed that the phase of the cardiac cycle (systole or diastole) modulates adjustments in behaviour following performance errors. Moreover, cardiovascular information modulated the neural responses during an early stage of error processing, 40-100 ms after error commission, in brain regions implicated in human cardiac autonomic regulation. These results suggest that brain-body interactions have an important influence on motor control and sensorimotor processing during music performance, which could be useful to guide music learning across the lifespan.

Singing accuracy across the lifespan: Problems and predictors

Peter Pfordresher
University at Buffalo, SUNY, USA
(online)

Our engagement in singing leads to a paradox. On the one hand, singing is universal across cultures and nearly every child engages in regular singing. On the other hand, most adults in Western cultures consider themselves poor singers and often avoid singing. The main source of this unease is accuracy of matching pitch (singing accuracy) – an ability that is so poorly understood that instructors to date are ill-equipped to help train inaccurate singers. These facts may be taken to imply that singing abilities reflect an inherited talent rather than a learned motor skill. If so, we may further predict that singing ability is modular and is not related to other sensorimotor and cognitive functions. I report a series of studies designed to test these hypotheses which include a wide range of age groups (6 to 99 years old), experimental and observational methods, and behavioral as well as psychophysiological measures. Taken together, results from the studies suggest that singing accuracy results from the formation of sensorimotor associations acquired through experience, and are further supported by one's ability to form and sustain musical imagery in working memory. In addition, the role of musical self-image and motivation may play a critical role, providing insights for music educators who struggle to work with poor-pitch singers.

On the role of inter-brain synchronization in social interactive learning of music

Giacomo Novembre
Italian Institute of Technology, Rome, Italy
(online)

Much of music learning emerges as a result of interaction with others. What neurophysiological processes support efficient information transfer from a music teacher to a student? In a first fNIRS experiment, we show that brain activity recorded from the inferior frontal cortex (IFC) synchronizes across teachers and students engaged in a social interactive song-learning task. Furthermore, inter-brain synchronization predicted learning performance. In a second experiment, we exogenously stimulated IFC using transcranial alternating currents (tACS). Delivering 6 Hz currents, being in-phase between the teacher and the student, led to enhanced learning performance in the student.
These effects were both phase- and frequency-specific: 6 Hz anti-phase stimulation, or 10 Hz inphase stimulation, did not yield comparable results. Together, the two experiments provide correlational and causal evidence demonstrating that inter-brain synchronization of IFC supports social learning of music. Besides providing a neurophysiological characterization of social interactive learning, these results also hold relevance for widespread clinical and pedagogical practices.

Somatosensory communication between the brain, body, and tool in pianists across the lifespan
Shinichi Furuya
SONY Computer Science Laboratory, Japan
(online)

Most pianists start to play the piano in infancy and are capable of playing even during a period of aging. Mechanical interaction between the body and piano provides abundant auditory and somatosensory feedback to the brain, and thereby endows outstanding sensorimotor skills in pianists. Compared to auditory functions, it has not been well understood what roles both innate nature and neuroplastic adaptation of proprioceptive functions play in skillful piano performance. This talk introduces that a combination of haptic interface such as an exo-skeleton robot and neurophysiological techniques (e.g. TMS, EEG) can not only uncover various roles of somatosensation in production of dexterous finger movements of pianists with a wide range of age, expertise, and severity of disorder, but also augment acquisition of musical virtuosity. Specifically, a novel active-touch training system enhanced both somatosensory functions and fine motor control of expert pianists, whereas a training system using a hand exo-skeleton robot facilitates the finger dexterity of expert pianists.
This implicates potentials of robotic-based somatosensory training as means for exceeding limits of experts' musical skills.

SYMPOSIUM 2

TOWARDS A GENOMICS OF MUSICALITY
Chair: Henkjan Honing
University of Amsterdam, Netherlands
Speakers: Isabelle Peretz, Sarah Wilson, Fredrik Ullén, Reyna L. Gordon

While there is still quite some debate on the cultural and biological origins of music (Honing, 2018), there is a growing consensus that musicality has deep biological foundations, based on an accumulation of evidence for the involvement of genetic variation. Recent advances in molecular technologies provide an effective way of investigating these biological foundations (Gingras, Honing, Peretz, Trainor, & Fisher, 2015; Mosing, Peretz, & Ullén, 2018; Peretz, 2016). The current symposium will focus on the genetics of musicality, the heritability of individual differences, and on the biology of musical deficits (e.g. tone deafness and poor rhythm) using a variety of genetic techniques that allow for pinpointing to the relevant genes. In turn, these genes can be used as entry points into the neurobiological pathways critical for musicality and potentially complement other approaches to understanding our capacity for music. Four international experts will present their latest results and discuss recent advances using familial aggregation, twin modelling and high-powered genome-wide screens to be able to effectively analyse musical phenotypes across the lifespan.

Does the speech genetic variant FOXP2 contributes to the emergence of Congenital Amusia?
Isabelle Peretz
University of Montreal, Canada
(online)

Congenital amusia is a neurodevelopmental disorder of musical pitch processing that aggregates in families. The expression of the disorder is very similar to another well-known neurodevelopmental disorder of speech that has identified a mutation of Homo sapiens forkhead box P2 (FOXP2) as causal. The role of the FOXP2 protein in the brain is to promote neuronal growth, and thus its dysfunction could be relevant to a congenital condition. Moreover, its alteration in a music-relevant disorder would point to common origins of music and language. Here, we examined the contribution of FOXP2 variants in a cohort of 49 cases of congenital amusia. We found that some specific FOXP2 variants were more frequent in amusia, although no significant associations emerged.

Investigating the heritability of singing ability in twins
Sarah Wilson
University of Melbourne, Australia
(online)

Singing is the most universal means of music making and an ideal paradigm for investigating the genetic basis of music abilities. We have just completed an investigation of the heritability of singing using a twin study design. We have now tested >1200 monozygotic (MZ) and dizygotic (DZ) twins, measuring their pitch accuracy in singing using an innovative, web-based singing program purpose-built for the study. Our program successfully captured the complexity of singing ability using a range of tasks that, when combined, supported the heritability of singing. Moreover, estimation of the genetic component of pitch accuracy for singing a familiar song was high, and similar to that observed for perceptual pitch matching using a tone slider. This points to the likelihood of obtaining evidence for the molecular genetic basis of singing ability.

Gene-environment interplay in musical expertise
Fredrik Ullén
Karolinska Institute, Sweden
(online)

Musical expertise and achievement show a characteristic pattern of correlations with a broad range of variables, that include both environmental factors (e.g. a musically enriched childhood environment, musical training and education) and traits of the individual (e.g. musical aptitude, cognitive ability, personality, and motivation). Recent twin modelling research from our laboratory has shown that the causal mechanisms underlying these associations are complex and likely to involve both genetic pleiotropy and causal effects of practice. In my talk, I will present key findings from this work which highlight the importance of gene-environment interplay for musicality and related outcomes.

Musical rhythm ability exhibits highly polygenic architecture: A genome-wide association study in 606,825 individuals
Reyna L. Gordon
Vanderbilt University Medical Center, USA
(online)

The extraordinary human musical rhythm ability involves not only sensitivity to durational properties of a stimulus, but also the capacity to extract the beat from an auditory sequence and synchronize motor output to musical sequences at high levels of complexity. This large-sample genome-wide association study provides new insight into the genetic architecture of rhythm, using a self-reported beat synchronization ability phenotype in 606,825 individuals. Sixty-eight genomic loci were significantly ($p<5x10-8$) associated with our rhythm trait, indicating high polygenicity. Analyses conditioning on known genetic markers of IQ revealed significant heritability of rhythm beyond shared genetics between rhythm and IQ, aligning with prior findings from twin modelling. Genetic associations with rhythm were enriched for genes expressed in brain tissue. We also detected small but significant genetic correlations primarily with cognitive, neurological, and motor-related traits. These results pave the way for future research into the neurobiological pathways of musicality.

SYMPOSIUM 3

UNIVERSALITY AND VARIABILITY OF MUSIC ACROSS THE LIFESPAN AND ACROSS CULTURES

Chair: Samuel Mehr
Speakers: Samuel Mehr, Laurel Trainor, Nori Jacoby, Josh McDermott

It is an incredibly exciting time to be studying music across the lifespan and across cultures. The new availability of large, systematically built corpora describing musical forms and musical behaviors in many cultures has prompted a new subfield of data-driven music research. Experiments that examine cognitive phenomena and their relations to music, across all ages, are now being iterated in multi-site international collaborations, ensuring that lab-based results generalize to all humans, rather than only to those humans who happen to visit the lab. The longstanding body of music work in developmental psychology is gaining new traction across all the cognitive sciences, as researchers outside of music welcome the scientific study of music as another puzzle piece for a complete understanding of the human mind. This symposium brings together leading experts in the cognitive science of music, with a particular emphasis on research across cultures and across the lifespan, to present a synthesis of brand-new findings in the growing field. The research to be presented is interdisciplinary at unprecedented scale, with deep connections to cognitive science, anthropology, developmental psychology, engineering, audition, computer science, linguistics, and more.

A natural history of song

Samuel Mehr
Harvard University, USA and Victoria University of Wellington, New Zealand
(online)

What is universal about music across human societies, and what varies? We built a corpus of ethnographic text on musical behavior from a representative sample of the world's societies and a discography of audio recordings of the music itself (Mehr et al., forthcoming 2019, Science). The ethnographic corpus reveals that music appears in every society observed; that variation in musical behavior is well-characterized by three dimensions, which capture the formality, arousal, and religiosity of song events; that musical behavior varies more within societies than across societies on these dimensions; and that music is regularly associated with behavioral contexts such as infant care, healing, dance, and love. The discography, explored through four representations (machine summaries, listener ratings, expert annotations, expert transcriptions), revealed that identifiable acoustic features of songs predict their primary behavioral context worldwide (enabling listeners to detect the function of music from its forms alone, as in Mehr et al., 2018, Curr Bio); that musical forms vary along two dimensions, melodic and rhythmic complexity; that the frequency distributions of melodic and rhythmic bigrams follow power laws; and that tonality is widespread, perhaps universal across cultures. These analyses show how applying the tools of computational social science to rich bodies of humanistic data can reveal both universal features and patterns of variability in culture, addressing longstanding debates about each.

Universals, variability, evolution, and cultural creation in the context of musical development

Laurel Trainor
McMaster University, Canada
(online)

The question of universals and variability is closely tied to the question of whether different aspects of music are evolutionary adaptations or cultural creations. Musical universals are candidates for adaptations, whether the pressure was for music or another function exapted by music. Various aspects of music likely emerged through complex iterative interplays between adaptive pressures for auditory scene analysis, adaptive pressures for music, and cultural creation (Trainor, 2015, Phil Trans B). Aspects that emerge early in ontological development and are universal across cultures were more likely shaped by evolutionary pressures than those that diverge early in development. Aspects of music that are based on adaptations for auditory scene analysis, such as pitch perception (e.g., logarithmic scale; virtual pitch) and polyphonic perception (e.g., rules for stream segregation; high voice superiority for pitch) emerge early in development and are likely universal, although cross-cultural testing needs to be expanded. Aspects that are likely candidates for music-specific adaptations, such as social consequences of experiencing music with others, also emerge early in development. In contrast, aspects that depend on experience, and are not determined early in development, such as use of particular tonal systems and metrical structures, are more variable and dependent on learning and cultural creation.

Universal constraints on rhythm revealed by large-scale cross-cultural comparisons of rhythm priors

Nori Jacoby
Max Planck Institute for Empirical Aesthetics, Germany
(online)

Music is present in every known culture, implying some biological basis. Yet the nature and extent of biological constraints have remained unclear, in part because cross-cultural comparisons have been limited. We measured a signature of mental representations of rhythm in over 600 participants from 15 countries on four continents, spanning modern societies and traditional indigenous populations belonging to 30 subgroups with varied musical expertise, using a method previously used to investigate rhythm priors in US and native Amazonian individuals (Jacoby & McDermott, 2017, Curr Bio.) Listeners were asked to reproduce random "seed" rhythms; their reproductions were fed back as the stimulus (as in the game of "telephone"), such that their biases (the prior) could be estimated from the distribution of reproductions. Every tested group showed priors with peaks. These peaks always overlapped with integer ratio rhythms, supporting the idea that rhythm "categories" at integer ratios are universal. On the other hand, the relative importance of different integer ratios varied considerably across cultures. Rhythmic prototypes in many cases reflected rhythms prevalent in the musical systems of a participant group's culture. However, university students in non-Western countries tended to resemble Western participants, underrepresenting the variability evident across indigenous participant groups and highlighting the problematic overreliance on student participants in cognitive science. The results illustrate consistency in rhythm perception amid cultural variation, demonstrating biological constraints and their interaction with culture-specific traditions.

Cross-cultural insights into music perception

Josh McDermott
Massachusetts Institute of Technology, USA
(online)

Most of what we know about perception derives from experiments conducted on members of developed Western societies. Yet many additional insights can be gained by studying other cultures. Phenomena that are consistent across cultures likely reflect biological constraints on perception, whereas those that vary cross-culturally could represent effects of culture-specific experience. Over the past eight years we have developed a research program assessing aspects of music-related audition in remote populations in the Amazon rainforest. This talk will describe what we have learned, discussing both methodological challenges and insights along with empirical results. We have observed significant cross-cultural variation in aspects of perception that have often been presumed by scientists to be universal, such as the preference for canonically consonant pitch combinations (McDermott et al., 2016, Nature), or the perceptual equivalence of tones separated by octaves (Jacoby et al., forthcoming, Curr Bio). However, we also find strong consistencies in other music perceptual phenomena, such as the assumption of a logarithmic scale for pitch intervals, despite highly divergent musical experience among the studied cultures. The results provide a new perspective on universal features of perception and the role of culture in shaping how we hear and evaluate music.

SYMPOSIUM 4

THE IMPACT OF LONG-TERM MUSIC INTERVENTIONS ON BEHAVIOR AND BRAIN PLASTICITY OVER THE LIFESPAN IN HEALTHY INDIVIDUALS AND IN INDIVIDUALS WITH ADHD OR AUTISM SPECTRUM DISORDER

Chair: Gottfried Schlaug
Speakers: Peter Schneider, Annemarie Seither-Preisler, Eckart Altenmüller/Clara James, Christian Gold/Karsten Specht, Gottfried Schlaug

In this symposium we plan to report several ongoing studies on effects of musical training on behavior and brain plasticity across the live span in healthy subjects, in children with ADHD and in children with autism spectrum disorder. Since 2009, A. Seither-Preisler and P. Schneider have been conducting a long-term study with a time span extending from primary school age (7-8 years) into adulthood (18-19 years). While P. Schneider focusses on the relationship between musical training, morphology and network plasticity of the auditory brain, and individual hearing profiles in typically developing individuals (220 participants), A. Seither-Preisler studies perceptual, behavioral and neurological benefits in children and adolescents with the developmental disorders AD(H)D and dyslexia (113 participants).
Since February 2019, C. James and E. Altenmüller have been conducting a two site 18 months long-term study with musical interventions in 150 healthy seniors. The experimental group received piano-training, while the control group had listening and understanding-based music lessons. E. Altenmüller will report on behavioral results after one year of training, including changes in fine motor control, memory, executive functions and listening skills, while C. James will focus on the impact of music interventions on brain plasticity and its links to cognitive behavior and well-being.
C. Gold and K. Specht will present their multinational trial, which examined the effects of individual improvisational music therapy versus enhanced standard care on symptom severity in 364 children with autism spectrum disorder. no effects were found in the primary analysis, symptom improvement was more likely in music therapy.
G. Schlaug and his colleagues will present results of a randomized controlled clinical trial testing an intense course of auditory-motor mapping therapy (AMMT) versus a non-intonation speech-repetition therapy (SRT) in minimally verbal children with autism spectrum disorder. AMMT leads to better speech-motor outcomes than SRT. The symposium will present novel unpublished data collected in rigorously controlled longitudinal studies. The results suggest that music interventions are an excellent tool to promote motor, cognitive, and brain development in healthy individuals of all ages including healthy seniors as well as individuals with neurodevelopmental disorders with various auditory, cognitive, and sensorimotor impairments.

Effects of musical experience on morphology and network plasticity of the auditory brain in children and adolescents

Peter Schneider
Department of Neuroradiology and Section of Biomagnetism, University of Heidelberg, Germany
Centre for Systematic Musicology
University of Graz, Austria
Jazeps Vitols Latvian Academy of Music, Riga, Latvia
(on site)

The investigation of plastic changes of the musical brain from childhood into adulthood is a big challenge. Although the relationship between musicality and brain functions has been investigated in cross-sectional studies with different age groups, until now longitudinal studies from childhood to adulthood were completely lacking, due to enormous time and cost expenditures. However, such neuroscientific longitudinal observations are indispensable to disentangle the complex interplay between musical aptitude, the biological maturation of auditory functions and learning-induced plasticity. Since 2009, we have conducted an extensive longitudinal study with 220 children / adolescents and five follow-up measurements. This time span corresponds to a lifetime of 11 years from elementary school age (7-8 years) until adulthood (18-19 years). Data have been continuously analyzed to provide a deep understanding of the interplay between a priori dispositions, the natural development of auditory functions and its promotion through musical training both on the behavioral and neurological level.
The analysis of the longitudinal MRI data revealed a time-invariant stable marker of musicality in right auditory cortex (enlarged Heschl gyrus with characteristic gyrification patterns), which was present already at the outset of formal musical education. Musical training, however, had a substantial influence on the functional activation of the auditory brain, as measured by fMRI and MEG. The more the participants had practiced their instruments, the faster and more synchronized were their auditory responses across hemispheres. Longitudinal comparisons revealed that subjects with a large initial interhemispheric asynchrony, signifying an immature state of auditory processing, strongly benefited from musical training.

Behavioral and neurological benefits of musical training on children and adolescents with AD(H)D and dyslexia

Annemarie Seither-Preisler
Centre for Systematic Musicology, University of Graz, Austria
(on site)

Human auditory cortex is widely connected with temporal and parietal multisensory areas and attentional networks. It is therefore not surprising that difficulties in recognizing acoustic patterns that arise from dysfunction of the auditory system are often associated with attention, language, and literacy problems. We tested a large cohort of 113 children / adolescents with developmental disorders (DD), comprising the subgroups ADHD and ADD (attention deficit with/without hyperactivity) and dyslexia, in comparison to a typically developing (TD) control group.
All three DD subgroups showed a substantial latency prolongation of the P1/N1 complex and a slowed maturation of corresponding auditory functions compared to TD children. Furthermore, they showed a remarkable temporal asynchrony of 20-40 ms between the left and right P1 response, which was associated with a reduced ratio of grey matter volume of Heschl's gyrus versus Planum temporale in the left hemisphere. These neurological markers allowed an objective differentiation of the three DD subgroups with an excellent accuracy of >90%. Longitudinal comparisons revealed a continuous bi-hemispheric synchronization over time, which directly depended on the amount of intervening musical practice. Our data show that practicing an instrument for only one hour per week over four years may normalize auditory brain functions. These improvements are also reflected on the behavioral level, thus showing that musical training directly counteracts the developmental disorders ADHD, ADD, and dyslexia. These novel findings do not only shed light on the neural foundations of auditory dysfunctions, but also bear a considerable potential for hearing-therapeutic, diagnostic and music-pedagogical applications.

Is it never too late?
Effects of music interventions in healthy seniors on cognitive function, motor control, listening skills, and brain plasticity in gray and white matter

Eckart Altenmüller
University of Music, Drama, and Media, Hannover, Germany
(on site)
Clara James
School of Health Sciences Geneva, University of Applied Sciences and Arts, Western Switzerland HES-SO and Psychology Department, University of Geneva, Switzerland
(on site)

Since February 2019, C. James and E. Altenmüller have been conducting a two-site 18 months long-term study with musical interventions in 150 healthy seniors. The experimental group received piano training, while the control group had listening and understanding-based music lessons. E. Altenmüller will report on behavioral results after one year of training, including fine motor control, listening skills, and on white matter changes, while C. James will focus on the impact of music interventions on gray matter brain plasticity and its links to cognitive and motor behavior.

Discrepant results between small exploratory trials and a multinational pragmatic trial of music therapy for autism: Heterogeneity on all levels

Christian Gold
NORCE Norwegian Research Centre AS, Bergen, Norway, and University of Vienna, Austria (online)
Karsten Specht
University of Bergen, Norway (online)

Increasing evidence from small RCTs, summarised in a series of Cochrane reviews, suggests positive effects in a number of domains ranging from communicative skills to parent-child relationships. To confirm promising small-trial evidence, we designed the first multinational RCT of music therapy for children with ASD. Methods: In an assessor-blinded RCT, 364 children with ASD across 9 countries were randomised to five months of individual improvisational music therapy or enhanced standard care. The main outcomes were symptom severity as measured by the Autism Diagnostic Observation Schedule (ADOS) Social Affect score (primary outcome) and parent-rated symptom severity (Social Responsiveness Scale, SRS). We explored heterogeneity across a number of mediators and moderators. Results: No effects were found on the primary outcome and in most secondary outcomes. However, exploratory analyses suggested that the likelihood of improving on the ADOS was greater in music therapy (52%) than in enhanced standard care (42%; risk ratio [RR] 1.25; p = 0.047). Further, those with low cognitive functioning (RR 1.43); who were non-verbal (RR 1.45); or younger than 5 years (RR 1.43) also appeared to benefit from music therapy. An analysis of session videos suggested that the therapist's musical and emotional attunement to the child predicted improvements in SRS (B = -16.06, p = 0.049), but not in ADOS. Conclusions: Music therapy may be effective for some subgroups, with some therapists, in some settings, or even in some countries, but not in others; all in relation to various outcome domains. What drives this heterogeneity is at present unknown.

Randomized clinical trial of an intonation-based spoken language treatment for minimally verbal children with Autism Spectrum Disorder

Gottfried Schlaug
University of Massachusetts Medical School - Baystate and Institute of Applied Life Sciences at University of Massachusetts Amherst, USA (online)

We tested an intonation-based treatment (Auditory-Motor Mapping Training, AMMT) for spoken language in minimally verbal children with ASD against a non intonation based control therapy (Speech Repetition Therapy, SRT) (NCT03015272). AMMT is a novel form of spoken- language treatment that involves singing two-syllable target words or phrases rather than speaking them. In time with each syllable, therapist and child tap on electronic drums tuned to the same two pitches that are sung. This co-activates shared auditory and motor neural representations of manual and vocal actions and the connections between them, and mimics the "babbling and banging" stage of typical development. Fourteen children (three female), aged 5;0-10;8 with a mean Autism Diagnostic Observation Schedule-2 (ADOS-2) score of 22.9 (SD 2.5), and a mean Kaufman Speech Praxis Test (KSPT) score of 13.6 (SD 10.7) participated in this RCT. The main outcome measure was % Syllables Approximately Correct, on trained and untrained bi-syllabic stimuli.
After 25 therapy sessions, AMMT resulted in a mean improvement of +13.4 percentage points on trained stimuli, compared to 11.1 percentage points for SRT. Both groups showed similar improvement on untrained stimuli (AMMT +6.2; SRT +5.3). Results were similar four weeks post-treatment (AMMT +13.3 trained, +5.2 untrained; SRT -2.7 trained, +7.2 untrained). AMMT can produce more improvement in trained stimuli than SRT across the group of minimally verbal children with ASD. We hypothesize that employing intonation and simultaneous bimanual movements are the effective factors in AMMT while creating a joyful and interactive environment with music making for each child in a one-to-one setting.

SYMPOSIUM 5

EXAMINING THE DEVELOPMENT AND NEURODYNAMICS OF COMPLEX MENTAL PROCESSING: WHAT CAN (AND CAN'T) WE LEARN FROM ENGAGEMENT WITH FULL-LENGTH PIECES OF MUSIC

Chairs: Matthew Sachs & Petri Toiviainen
Speakers: Petri Toiviainen, Alluri Vinoo, Matthew Sachs, Mor Regev

In neuroimaging research, music has proven to be an effective tool for examining a variety of cognitive processes related to language, memory, affect and executive functioning. Recently, in an effort to enhance the ecological validity of neuroscientific findings, there has been a push to incorporate more realistic, dynamic, and complex stimuli in experimental designs that emulate real-life experiences, as a way of better understanding the functioning of the human brain and how it changes across the lifespan. In this symposium, we discuss recent endeavors that use musical stimuli as a "naturalistic paradigm" and provide an overview of how such studies can provide evidence for both neural integration and neural segregation. In particular, we will present data showing how time-varying patterns of neural activity in response to music, collected through a variety of neuroimaging techniques, is related to how the brain perceives incoming sensory information, retains and integrates this information over time, and represents subsequent emotions and feelings.
Throughout, we aim to highlight how individual differences related to musical training, as well as clinically-relevant symptoms and behaviors, modulate the neural and network patterns associated with changing features of the naturalistic stimulus. Finally, we will consider the advantages and disadvantages of using music, in comparison to more narrative-driven stimuli, such as films and stories particularly in terms of its potential to uncover age-related neural changes related to complex processing.

Functional dynamics of neural networks for beat processing

Petri Toiviainen
Finnish Centre for Interdisciplinary Music Research, University of Jyväskylä, Finland
(online)

Beat perception in auditory rhythms is based on interactions between the auditory and motor systems. Most of previous work on this topic has been based on controlled settings with impoverished stimuli, in which aspects of beat, such as salience and metric regularity, are artificially manipulated. Consequently, it is not clear how these functional networks operate during continuous listening of real music with hierarchical metric structure and dynamically changing beat characteristics. In a series of studies, we recorded fMRI responses of participants while they were listening to entire pieces of music. Subsequently, we identified functional networks using methods of blind source separation and graph theory, and compared the temporal dynamics of these networks with that of computationally extracted features representing musical beat to pinpoint networks associated with beat processing. We identified an auditory-motor functional network, whose time-course of activation was associated with musical beat salience. The dynamics of this network was more stimulus-driven in nonmusicians than in musicians. Moreover, we found partially dissociated functional networks belonging to the cerebello-thalamo-striatocortical motor pathway whose time-course of functional connectivity was modulated by beat salience. Continuous musical stimulation combined with computational feature extraction allows to disentangle networks associated with different aspects of beat processing, such as beat inference and maintenance. Non-musicians' internal model of pulse clarity seems to rely on the acoustical content to a greater extent than musicians', which may be explained by musicians improved predictive models of beat induction. The presentation will also discuss general challenges associated with utilizing the naturalistic paradigm.

Using music to probe the neural mechanisms of emotions and their dynamics

Matthew Sachs
Center for Science and Society, Columbia University, USA
(online)

Psychological theories of emotion highlight the dynamic quality of affective experiences, yet neuroimaging studies of affect traditionally rely on static stimuli that lack ecological validity. Consequently, the brain regions and networks that are involved in emotional responding and emotional dynamics remain unclear. Music is temporal by nature and can evoke a variety of emotional responses, making it a useful tool for studying the dynamics of affect. In this talk, I discuss some of my research that uses computational methods to try to capture spatial and temporal brain activation patterns associated with emotions and feelings in response to music. I'll focus mainly on my current fMRI project, in which I commissioned a musical piece to be used during fMRI to systematically move participants through different emotions, with the goal of testing if brain-states and their transitions, identified with Hidden Markov Modeling, reflect the dynamic, multifaceted nature of the emotional experience. I'll end my talk with a discussion on ways in which studying responses to both highly-controlled and less-controlled, more ecologically-valid musical stimuli can extend our current understanding of the neural mechanisms involved in affect, as well as the possible translational applications of this research.

Content-specific neural patterns in auditory cortices during imagery of music

Mor Regev
Montreal Neurological Institute, McGill University, Montreal, Canada
(online)

Musical imagery, the internal representation of sounds, has been mostly studied by looking for spatially overlapping neural responses while listening versus internally recalling sounds. However, that approach does not allow a distinction between general mechanisms of imagery as opposed to representation of specific imagined content. In the present work, we compared the unique response profile of heard and imagined music and explore the influence of rhythmic motion on internal musical replay. Participants memorized six distinct minute-long melodies to a high standard of accuracy, and then using fMRI, their neural responses were recorded in two conditions: 1) silently imagining each melody to the rhythm of a visual metronome, while either tapping to its beat or keeping motionless, and 2) passively listening to the original melodies. To assess the neural reinstatement of the melody when imagined, we directly compared the response time-courses across the imagery and perception conditions using inter-subject correlation. During imagery, melody-specific response patterns were reinstated in lateral areas of the right superior temporal gyrus (STG). These neural patterns were both similar among people and discriminable from each other. When imagery was accompanied by rhythmic tapping, the melody-specific patterns were extended into dorsal areas of the STG bilaterally. The results suggest a common neural organization for the representation of complex musical content, whether retrieved from memory or externally perceived. Furthermore, similar to perception, tapping could modulate the specific representation of music in the auditory cortex even when the sounds are completely imagined and not generated by the movement

Investigating neural effects of musical training using dynamic, model-free naturalistic paradigms

Vinoo Alluri
International Institute of Information Technology, Hyderabad, India
(online)

Listening to music is an active process that engages bottom-up and top-down neural mechanisms, thus making the dynamic, model-free naturalistic paradigm an attractive and more ecologically valid approach to studying music perception as opposed to the hitherto controlled paradigms. Furthermore, investigating the timecourse of interaction between brain regions via dynamic functional connectivity has been gaining popularity, and task-free music listening affords a rich setting to study it. An important factor affecting the perception of music is musical training. Musical training, in addition to causing structural changes in the brain, has been shown to be associated with functional differences in both brain activation and connectivity patterns. The aim of this presentation is to provide an overview of studies that have attempted to unearth musical expertise-modulated neural differences in the naturalistic paradigm wherein the participants are scanned using fMRI while listening to entire pieces of music. Continuous musical features were extracted and correlated with brain response to observe differences in activation patterns between musicians and non-musicians associated with auditory perception. Following this, static and dynamic functional connectivity analyses revealed musical expertise-modulated differences in functional network organization. The presentation will be organized so as to summarize results first in the context of a segregated approach to neural processing, described by activation patterns, followed by those of an integrated approach to neural processing, as described by functional connectivity analyses. Finally, ongoing and future work on the dynamic functional connectivity front will be presented.

SYMPOSIUM 6

BRAIN MECHANISMS UNDERLYING MUSICAL INTERACTION AND IMPROVISATION ACROSS THE LIFESPAN

Chair: Virginia Penhune
Speakers: Peter Vuust, Boris Kleber, Morten Kringelbach, Elvira Brattico

Music is a social phenomenon, in that we listen to, synchronize to, and make music together. This makes it a fine-tuned instance of coordinated human interaction that involves interpersonal synchronization, social entrainment, improvisation, memorization and musical communication, and may serve as model for social cognition in general. Importantly, music interaction is usually based on agreeing on predictive structures such as meter or tonality. These predictions underlie the experience of music in general and hence meaningful musical interaction in particular. This symposium will show four different aspects of how people connect with music to further our understanding of the dynamics and neural mechanisms of musical interactions across the lifespan. The researchers will first introduce the audience to the general framework of predictive coding by which the brain tries to minimize the error between top-down predictions and bottom-up processes, and how this relates to musical interaction and brain development. They will then: (a) show how predictive coding can be applied to understand the dynamics involved in interpersonal synchronization using a minimal tapping paradigm; b) use predictive coding and whole-brain computational modelling to understand the dynamics of interacting musically through singing; c) present neuroimaging whole-brain modelling methods and studies of music syncopation, jazz improvisation, and psychedelics with and without music to show specific harmonic and criticality signatures associated with the deep experiences of pleasure of music interaction; and d) use the predictive coding framework to elucidate how learning can change the way that children, adolescents and adults interact with music.

Brain dynamics of interpersonal tapping

Peter Vuust
Center for Music in the Brain (MIB), Aarhus University/The Royal Academy of Music, Aarhus/Aalborg
(on site)

Moving to music and playing together entails synchronizing in a way that resembles other human social behaviours, such as the tendency towards synchronized walking, chair rocking and bodily rhythms during joke telling. The precise timing necessary for musical interaction makes it an ideal candidate to elucidate behavioural and brain mechanisms of mutual synchronization. In this presentation, I will present a line of studies based on a minimalistic approach to studying synchronization in a dual-tapping paradigm. Here, two individuals are placed in separate rooms with headphones and EEG equipment and asked to tap together in different conditions. First, I will show that participants receiving oxytocin – a hormone proposed to promote social - bonding are more synchronized when finger-tapping together under certain conditions compared to participants receiving placebo. Second, I will show how musicians instructed with either matching or conflicting metric models (different musical meters) adapt differently to each other and show a pronounced difference in brain-to-brain dynamics as measured with dual-EEG, depending on their underlying internal predictive model and instrumental expertise. Third, I will show how different dyad tapping behaviour may be successfully modelled using a four-oscillator model, containing one internal and one external Kuramoto-oscillator per person, consistent with how predictive coding theories of brain processing describes bottom-up and top-down influences on neural processing. These studies shed light on the predictive brain mechanisms underlying human social cognition in general with implications for individuals with impaired social skills, and may be used for understanding musical interaction in differently organized musical ensembles in particular.

Connecting with music through singing

Boris Kleber
Center for Music in the Brain (MIB), Aarhus University/The Royal Academy of Music, Aarhus/Aalborg
(on site)

The ability to communicate through complex vocalization is arguably one of humanity's most distinctive characteristics. Recognized for its powerful impact on the listener, the voice can be regarded as our default signaling system to acoustically convey meaning, emotion, and intention by precisely timing respiratory, laryngeal, and articulatory movements. From childhood onwards, people use their voice as a comprehensive means to make music by singing for their own sake, by partaking in leisure activities, or by pursuing a professional career. This makes singing an ideal example to assess how we connect with music across the lifespan. In our previous work, we have pioneered the neuroimaging of song production with trained singers as a model population to identify the neural mechanisms underlying voice control in experts and non-experts. Expanding this framework, I will present a series of novel experiments that aim to delineate the effects of implicit and formal singing training on musical communication and sensorimotor control. Performing a line of vocal tasks in an fMRI scanner, we employed the concept of improvisation as a hallmark of creativity and communication, and applied the conceptual framework of embodied predictive coding to assess audiomotor interactions in classical singers, jazz/rock singers, and non-singers. Using standard and advanced neuroimaging whole-brain modelling, I will show a distinction between neural networks that respond to musical creativity and communication across the different levels of expertise, and demonstrate how sensorimotor skill can interact with the ability to express ourselves musically.

Social interactions, pleasure of music and human flourishing

Morten Kringelbach
Center for Music in the Brain (MIB), Aarhus University/The Royal Academy of Music, Aarhus/Aalborg & Oxford University, UK
(on site)

A meaningful human life is not only characterised by survival but also by thriving and flourishing, which is strongly driven by social interactions. Aristotle proposed that this can usefully be captured by the dual aspects of hedonia (pleasure) and eudaimonia (a live well-lived, embedded in meaningful values).
Over two decades, I have together with colleagues identified the underlying the brain regions necessary and sufficient for the hedonia system. Lesions of regions in this network can lead to anhedonia, the lack of pleasure, which is a major feature of neuropsychiatric disorders, and which precludes eudaimonia. Eudaimonia crucially depends on the hedonic network but this elusive state is difficult to reliably evoke in a brain scanner and even harder to characterise. Yet, the sweet anticipation of music, especially in musical interactions, could potentially be key to unlock this deep scientific problem. This was first demonstrated by the seminal studies of Zatorre and colleagues, whose findings include how highly meaningful musical chills induce activity in the hedonic system. Expanding this corpus, I will show advanced neuroimaging whole-brain modelling in studies of music syncopation and jazz improvisation to find metastable brain networks, including parts of the hedonia network, linked to these highly meaningful states.
Furthermore, I will show how connectome-harmonics can help to uncover the specific harmonic and criticality signatures associated with the deep eudaimonic experiences evoked by psychedelics with and without music. Overall, music and musical interactions offer the promise of being able to elucidate the elusive, yet highly desirable brain-state of eudaimonia.

The pleasure to learn and predict

Elvira Brattico
Center for Music in the Brain (MIB), Aarhus University/The Royal Academy of Music, Aarhus/Aalborg & University of Bari Aldo Moro, Italy
(on site)

We interact with music before we are born and throughout our life. This interaction with music and between people is constrained by the culture in which we are born and embedded. Musical cultures are different in the way in which features are combined and communicated including regularities in pitch and rhythm patterns. Across the lifespan, listeners acquire internal models of the statistical and structural regularities defined by their musical culture - a process which can be formalized through the predictive coding of music framework. Each model varies in precision, and depends on exposure and neuroarchitecture. When prediction errors are fed forward from lower levels to higher brain areas, they are weighted by precision. I here present studies of the predictive processes that occur during musical processing in childhood and adulthood, and when we learn to play a new tune. Using analyses of static and dynamic neural connectivity, I show that auditory memorization of a tune corresponds to high centrality of hippocampal and auditory regions, whereas audiomotor engrams of learned-to-play tunes are represented in a network encompassing also the orbitofrontal cortex. When learning is motivating in adults, several reward areas and frontoparietal action-observation areas are recruited. The pleasure to listen and interact with music is seen even in school-age children, with higher probability of a reward orbitofrontal network during music listening than rest. These positive musical interactions in childhood are mirrored in improved executive functions and reduced impulsivity, thus preparing them to the self-regulatory abilities that are needed across the lifespan.

KEYNOTE LECTURE

Predictive coding

Karl Friston
University College London, Institute of Neurology, UK
(online)

This overview of active inference offers an account of embodied exchange with the world that associates neuronal dynamics with inferring the causes of our sensations. We will first look at the fundaments of how any sentient system models its world. The ensuing self-organising, self-evidencing behaviour rests upon something called generalised synchrony. Using simulations of birdsong, I hope to illustrate how synchronisation underwrites the emergence of communicative and affiliative exchange – that may be particularly prescient for musical perception. I will close by asking how one can understand the allure of music in terms of active listening – and the imperatives to minimise uncertainty that render us curious creatures.

SYMPOSIUM 7

TOWARDS MUSIC-BASED AUDITORY REHABILITATION FOR OLDER ADULTS

Chair: Benjamin Zendel
Speakers: Claude Alain, Frank A. Russo, Benjamin Zendel, Gavin M. Bidelman

Age-related declines in hearing abilities are nearly universal and are one of the most commonly reported health issues in older adults. This decline is associated with changes to both the physical mechanisms of the cochlea, and the central auditory system. Cross-sectional studies have shown that older, lifelong musicians have better hearing abilities compared to older non-musicians, and these benefits are related to neurophysiological processing differences at both the level of the brainstem and cortex. One major caveat of these studies is that they are unable to draw a causal link between music training and improved hearing in older adults. That is, older musicians may have become musicians and continued to be a musician because of predispositions towards better hearing abilities. Emerging longitudinal studies have started to draw a causal link between music training and improved auditory abilities in older adults. In this symposium, Drs. Alain, Bideleman, Russo, and Zendel will present findings from a series of recently completed longitudinal studies conducted in different labs, with different music training interventions, and with different outcome measures. The main similarity between these studies was that older non-musicians were given music training and compared to control groups before and after the training. Common findings from each of these studies suggest that music training interventions can improve hearing abilities in older adults. These studies provide the first evidence of a causal link between music training and improved hearing abilities in older adults. More importantly, they provide a foundation from which music-based forms of auditory rehabilitation can be developed and the first clues about the neurophysiological mechanisms that support improved hearing in older adults after music training.

Promoting healthy aging through music training

Claude Alain
Rotman Research Institute, Baycrest Centre Department of Psychology and University of Toronto, Canada
(online)

Age-related declines in cognitive and hearing functions are well-documented in the laboratory and are also obvious in the real world, manifesting in older adults having difficulties understanding what someone is saying in the presence of other sounds (e.g., television, music, other people talking). Contributing factors likely include not only difficulty registering sound by the ear itself (i.e., hearing acuity or sensitivity), but a degradation of information when the auditory signal travels from the ear to the brain areas responsible for processing and remembering sounds. Recent advances in hearing aids are encouraging but 'turning up the volume' doesn't help older adults to understand speech in crowded cocktail parties, restaurants or social gatherings. Hence, scientific interest has shifted toward identifying modifiable behaviors that may affect/alter cognitive hearing.

I will present studies from my research group and others that have investigated the role of musical training as a means to mitigate age-related decline in auditory perception and cognition. Behavioral and neuroimaging studies in young adults provide converging evidence that musicians exhibit exceptional auditory skills that allow them to cope with age-related hearing loss better than non-musicians. I will describe evidence showing that short-term music training in older adults can yield neuroplastic changes and improvement in auditory cognition. This research shows that musical training can promote changes in central auditory processing, and this in turn can compensate for peripheral hearing loss. The benefit of musical training on the aging auditory brain is exciting because it opens new avenues for developing innovative remediation programs and improving current rehabilitation protocols aimed at enhancing older adults' verbal communication abilities/functioning in both quiet and noisy environments.

Brief choir participation mitigates auditory processing difficulties experienced by older adults living with hearing loss

Frank A. Russo
Department of Psychology, Ryerson University
Toronto, Canada
(online)

Cross-sectional studies have revealed superior auditory processing abilities in older adults who are lifelong musicians. These results support the use of music-based interventions to mitigate auditory processing difficulties in older adults. However, one of the challenges in this type of work is the time and motivation required to develop proficiency in a musical instrument. There are several reasons for expecting that choral singing may have potential to yield rapid benefits. Foremost amongst these is that non-musicians tend to have experience with choral singing. In addition, choral singing tends to be motivating because of its benefits to social wellbeing. This talk will present two studies in my lab that have investigated the efficacy of choir participation to improve aspects of auditory processing in older adults living with hearing loss. In the first study, older adults with age-related hearing loss participated in a choir singing class combined with individualized vocal pitch matching exercises or a do-nothing control group. All participants underwent pre- and post-testing over a ten-week period. Linear mixed effects modelling in a multilevel regression analysis showed that choir participants demonstrated improvements in speech-in-noise perception, pitch discrimination ability, and neural pitch strength. In the second study, which is currently underway as a randomized controlled trial, we are tracking these same measures in older adults with hearing loss who are currently using hearing aids. Participants are being recruited into three groups: a choir group (choral singing combined with individualized vocal-pitch matching), a music appreciation group, and a do-nothing control group. Results to date have revealed improvements in pitch discrimination with the music-appreciation group outperforming the do-nothing control and the choir group outperforming the music appreciation group.

Self-directed piano training improves the ability to understand speech in noisy environments in older adults

Benjamin Zendel
Faculty of Medicine, Memorial
University of Newfoundland, St. John's, Canada
(online)

The goal of this study was to examine if six months of self-directed piano lessons could improve the ability to understand speech-in-noise, and if so, what neurophysiological changes would support this improvement. Participants were randomly assigned to learn to play piano, to learn to play a 3D video game, or to a no-contact group. The ability to understand speech-in-noise was evaluated in two tasks. In one task, participants were asked to repeat a single word aloud in three levels of background noise while electrical brain activity was monitored using EEG. In the second task, participants were presented with short sentences in three levels of background noise and asked to select an image that best matched the sentence while the BOLD response was measured using fMRI. Participants in the music training group improved their ability to understand a word in loud background noise, and tended to improve their ability to understand a sentence in loud background noise compared to the other two groups. Electrophysiologically, this improvement was related to an increased positivity over left-frontal brain regions starting 200 ms after the onset of the target word. fMRI data revealed post-training increases in activity in the left middle frontal gyrus and suprmarginal gyrus, and these increases were correlated with improved abilities to understand speech. These neurophysiological changes are consistent with plasticity in the speech-motor system, suggesting that music training enhances connectivity between auditory and motor regions. Interestingly, research has shown that the speech production system is critical for understanding speech, particularly in noise. It is therefore likely that this enhanced auditory-motor connectivity facilitates speech understanding through the speech motor system.

The impact of musicianship on the neural processing of speech across the lifespan
Gavin M. Bidelman
University of Memphis, USA
(online)

Cross-sectional studies have revealed superior auditory processing abilities in older adults who are lifelong musicians. These results support the use of music-based interventions to mitigate auditory processing difficulties in older adults. However, one of the challenges in this type of work is the time and motivation required to develop proficiency in a musical instrument. There are several reasons for expecting that choral singing may have potential to yield rapid benefits. Foremost amongst these is that non-musicians tend to have experience with choral singing. In addition, choral singing tends to be motivating because of its benefits to social wellbeing. This talk will present two studies in my lab that have investigated the efficacy of choir participation to improve aspects of auditory processing in older adults living with hearing loss. In the first study, older adults with age-related hearing loss participated in a choir singing class combined with individualized vocalpitch matching exercises or a do-nothing control group. All participants underwent pre- and post-testing over a ten-week period. Linear mixed effects modelling in a multilevel regression analysis showed that choir participants demonstrated improvements in speech-in-noise perception, pitch discrimination ability, and neural pitch strength. In the second study, which is currently underway as a randomized controlled trial, we are tracking these same measures in older adults with hearing loss who are currently using hearing aids. Participants are being recruited into three groups: a choir group (choral singing combined with individualized vocal-pitch matching), a music appreciation group, and a do-nothing control group. Results to date have revealed improvements in pitch discrimination with the music-appreciation group outperforming the do-nothing control and the choir group outperforming the music appreciation group.

SYMPOSIUM 8

THE ROLE OF MUSIC TRAINING ON EXECUTIVE FUNCTIONS IN CHILD AND ADOLESCENT DEVELOPMENT

Chair: Jennifer Bugos
Speakers: Minna Huotilainen, Jennifer Bugos, Franziska Degé, Daniel Müllensiefen

Music education has been associated with enhancements in executive functions for young children and adolescents. This symposium will present research conducted with short-term and longitudinal music training programs on executive functions and will examine relationships between music training and areas of executive functions across development. The first presentations will examine executive functions in early childhood. Minna Huotilainen will discuss behavioural and neurological data examining the effects of a musical play program on linguistic processes and executive functions in early childhood. Jennifer Bugos will discuss the effects of a randomized controlled trial with multimodal music training on working memory in young children (4-6 years). Late childhood includes the development of different areas of executive functions which may be more prominent and effected differently with music training. Franziska Degé will discuss associations between music instruction and specific areas of executive functions in children (9-12 years). Finally, Daniel Müllensiefen will present longitudinal data investigating relationships between memory performance, musical skills and musical training across different age groups from childhood through adolescence (10-17 years). Research from this symposium will contribute to an understanding of the role of music training on executive functions from early childhood to adolescence. Recommendations for future research and implications for the development of music programs will be provided.

Music play school for every child – with language benefits: An ERP study
Minna Huotilainen
University of Helsinki, Finland
(online)

According to UN Convention on the Rights of the Child, a child's right is to participate in cultural and artistic life. All education should include the development of the child's personality, talents and abilities to their fullest potential. To be able to create an inclusive operational culture, participation, equality and equity have to be considered in relation to children's access to cultural services. Focus should be especially in the inequalities due to different social economic status, or minority language background. Especially musical training has been shown to be beneficial for children's development in many ways. Neuroscience has focused especially on the development of linguistic and other cognitive skills. In Finland, we had a community setting where weekly music playschool or dance lessons were provided to all children in those kindergartens that took part in the intervention. We studied the linguistic abilities of the children in the participating kindergartens as well as control kindergartens (N = 66) four times over two school-years. We tested Phoneme processing, Vocabulary, Perceptual reasoning skills and Inhibitory control, as well

as ERPs (N=75) to phonemes in a multi-feature paradigm. We found that music playschool significantly improved the development of children's phoneme processing and vocabulary skills, but not non-verbal reasoning or inhibition. We found developmental changes in the MMN and P3a responses, unrelated to the intervention. Our interpretation is that playful group music activities have a positive effect on children's linguistic skills in a community setting. We recommend regular music playschool lessons given by professional teachers in early childhood education.

The effects of a multimodal music training program on children's working memory: Results of a randomized controlled trial

Jennifer Bugos
University of South Florida, USA
(on site)

In the United States, music training programs for young children typically focus on vocal skills or instruction with one specific instrument. We hypothesized a multimodal music program that integrated vocal development, bimanual coordination, and creative improvisation, would enhance executive functions in 4- to 6-years-old children. A multimodal music program may engage children with shortened attention spans in a group setting, thus transferring to within domain skills (e.g., pitch accuracy), and over cognition (e.g., executive functions).
The purpose of this study was to assess the impact of a 10-week multimodal music training program in a randomized controlled design. Eighty-four children were randomly assigned to a multimodal music training program, active control Lego training program, or no treatment control condition. All participants completed standardized measures of music achievement and executive functions (i.e., EF Touch) pre- and post-training. Results revealed enhanced pitch accuracy and working memory for children in the music training as compared to the active and no treatment control conditions. Children enrolled in the Lego active control condition demonstrated significant enhancements in spatial working memory.
Contributions to the literature include the randomized controlled design, the group multimodal music program appropriate for 4-6 year-old children, and executive function measures sensitive to individual differences. Future research should include these key elements when evaluating the impact of arts-based interventions on children's cognitive development.

The association between music lessons and specific cognitive abilities in 9- to 12-year-old children: The mediating role of executive functions

Franziska Degé
Max-Planck-Institute for Empirical Aesthetics, Frankfurt, Germany
(online)

Studies show positive associations between music lessons and general as well as specific cognitive abilities. These findings raise questions about the processes by which music lessons and cognitive abilities are connected. Previous studies found that music lessons and IQ (general cognitive abilities) are mediated by executive functions. It is unclear to which extent associations between music lessons and specific cognitive abilities are mediated by executive functions. Therefore, our study investigates whether associations between music lessons and specific cognitive abilities (phonological awareness, mathematical abilities) and general cognitive abilities (IQ, academic achievement) are mediated by executive functions.
We tested 30 (16 girls) 9- to 12-year-old children (M = 10 years; 10 months, SD = 1 year; 1 month). We assessed socioeconomic status (control variable) and amount of music lessons (predictor). The executive functions inhibition, working memory, set shifting, planning, fluency, and selective attention were measured (mediator). Phonological awareness, mathematical abilities, IQ, and academic achievement were tested (criterion). It was demonstrated that set shifting mediated the association between music lessons and phonological awareness, the association between music lessons and IQ, as well as the association between music lessons and academic achievement. Working memory mediated the association between music lessons and phonological awareness as well as the association between music lessons and mathematical abilities.
Results suggest that executive functions (set shifting, working memory) have not only a mediating role for associations between music lessons and general cognitive abilities (IQ, academic achievement), but also for music lessons and specific cognitive abilities (phonological awareness, mathematical abilities).

Working memory, music perception skills and musical training: development during adolescence

Daniel Müllensiefen
Goldsmiths, University of London, UK
University of Hamburg
University of Music, Drama, and Media, Hannover, Germany
(on site)

Working memory is a fundamental resource that is underlying many cognitive processes and is closely connected to the development and the use of complex intellectual abilities (Basak & Zelinski, 2013), including musical listening skills and instrumental learning (Talamini, Altoè, Carretti, & Grassi, 2017). Undisputedly, musical training also contributes to the development of musical skills. However, it has recently been questioned whether intellectual abilities, such as working memory, are a pre-requisite or a consequence of musical training (Schellenberg, 2019).
On one hand, there is evidence suggesting that working memory capacity and executive functions increase in response to musical training (Jaschke et al. 2018) through music-induced brain plasticity (Seither-Preisler et al., 2014). On the other hand, working memory is described as a necessary component of the cognitive profile of successful musical learners that may be largely determined by genetics (Meinz & Hambrick, 2010). This study presents an analysis of the relationships between working memory capacity, musical skills and musical training across different age groups during the adolescent period (10-17 years). The data was gathered as part of the LongGold project, a longitudinal study of cognitive, psycho-social and musical development during the teenage years. Working memory was assessed through a visuo-spatial complex span task and musical skills were measured via six adaptive listening tasks targeting different musical skills. The pattern of correlations and partial correlations across different age groups give rise to new causal interpretations regarding the changing relationship between working memory, musical training and musical skills.

SYMPOSIUM 9

MUSIC INTERVENTIONS FOR NEUROLOGICAL AND NEURODEGENERATIVE DISORDERS

Chair: Stefan Koelsch
Speakers: Noelia Martínez-Molina, Simone Dalla Bella, Séverine Samson, Stefan Koelsch

The aim of the symposium is to present neuroscience and neurology studies investigating the effects of music interventions in patients with neurological or neurodegenerative disorders, with an emphasis on high-quality designs. We will present our most recent RCTs (SDB, SK, NMM), and a study related to an RCT (SS). Each talk will introduce the audience to the backgrounds of the respective fields, provide overviews of the state of the art of music interventions and music therapy research in the respective patient groups, and describe our methods as well as results in ways that they can be understood by audiences with different backgrounds. Moreover, we will also reflect critically on the beneficial effects of our music interventions, e.g. with regard to observed effect sizes or methodological limitations, and discuss implementations of our interventions in clinical, rehabilitative, preventive and care services. S. Dalla Bella will present an RCT on Parkinson's disease, S. Koelsch an RCT with patients with (or at risk for) Alzheimer's disease, S. Samson a case control study from a music intervention study in Alzheimer's disease, and N. Martinez-Molina an RCT on traumatic brain injury.
Except the trial by S. Koelsch, studies are finished, but currently not yet published.
In addition to neuropsychological and socioemotional assessments, the studies by S. Koelsch and N. Martinez-Molina also use magnetic resonance imaging methods.
Thus, using different neuropsychological and neuroscientific methods, we aim at presenting very recent studies and findings on very timely topics that we hope will be of great interest to the audience of the conference.

Neurological music therapy in the cognitive and neural rehabilitation of traumatic brain injury

Noelia Martínez-Molina
Cognitive Brain Research Unit (CBRU), Department of Psychology and Logopedics, Faculty of Medicine, University of Helsinki, Helsinki, Finland
(online)

Background: Traumatic brain injury (TBI) is a common disorder which impairs especially executive function (EF). Musical training is known to enhance cognitive functioning in healthy subjects, and neurological music therapy (NMT) holds great promise for TBI rehabilitation. However, as I shall review, evidence for this is limited by the lack of randomized control trials (RCT). This first RCT (Clinical Trials ID: NCT01956136) studied the cognitive and neural efficacy of MT in TBI.
Methods: Using a single-blind cross-over RCT design, 40 patients with moderate-severe TBI received a 12-week NMT intervention either during the first (AB group) or second (BA group) half of a 6-month trial. NMT comprised rhythmic and cognitive-motor training with drums and assisted music playing with piano. Outcome measures were cognitive testing and

MRI performed three times (baseline / 3-month / 6-month stages).
Results: EF [Frontal Assessment Battery (FAB) score] and set shifting [switching cost in NumberLetter Task] improved more in the AB than BA group from baseline to 3-month stage, and the effect on FAB was maintained in the 6-month follow-up. Pooling the data, set shifting improved in the intervention vs. control period. In voxel-based morphometry (VBM), this effect was coupled with increased grey matter volume especially in the right inferior frontal gyrus but also in other prefrontal, cingulate, insular, and cerebellar regions. Recent work has examined the resting-state functional connectivity underlying this cognitive recovery.
Conclusions: NMT is effective in TBI rehabilitation, especially for EF, and leads to structural neuroplasticity changes in prefrontal and limbic networks.

Rethinking rhythm training in Parkinson's disease: Beneficial effects of a serious game across motor domains

Simone Dalla Bella
International Laboratory for Brain, Music and Sound Research (BRAMS) and Department of Psychology, University of Montreal, Canada
(online)

Background: Parkinson's disease (PD) is characterized by rhythm disorders, which manifest across motor domains (orofacial, manual and gait), and in perceptual tasks. These disorders may stem from a general source (general dysrhythmia), linked to impaired central mechanisms underpinning rhythm processing. Rhythmic auditory cueing has been used in the past to improve motor symptoms, with a particular focus on gait, with variable effects. However, evidence is scant on the effects of training rhythmic abilities apart from gait, and their transfer to other domains. Here we report the results of a single-blind randomized clinical trial (Clinical Trials ID: NCT02855710) testing the effect of rhythm training, delivered via a tapping serious game on tablet, across motor domains.
Methods: Patients with PD played an at-home serious game training rhythmic skills (n = 10), a non-rhythmic video game (n = 11), or no game (n = 12, control group), for 6 weeks. We tested rhythmic abilities in orofacial, manual and gait motor domains, and rhythm perception before and after the training period.
Results: Only patients who received the rhythmic training improved their orofacial and manual performance (i.e., lowered motor variability). This beneficial effect was linked to an improvement of rhythm perception due to the rhythm training.
Conclusions: These findings provide evidence supporting the use of technology-driven interventions aiming at alleviating rhythm-related motor deficits in PD such as hypokinetic dysarthria or gait impairment in complement to more traditional therapeutic approaches.

Music synchronisation and social interaction in Alzheimer's disease

Séverine Samson
University of Lille and La Pitié-Salpêtrière Hospital, Paris, France
(on site)

Background: Our previous RCT (Clinical Trials ID: NCT02833870) suggests that musical interventions in patients with Alzheimer's disease (AD) positively affect wellbeing (emotional, cognitive, and behavioural) and reduce distress of caregivers. The mechanisms underlying these effects remain unclear. One likely candidate is the engagement in social functions such as movement coordination, which promotes positive feelings such as pleasure. Here we investigate if a social context can help patients to move with musical rhythms, and modulate patients' motor and socio-emotional engagement, both of which might contribute to the efficacy of music-based interventions.
Methods: In a case-control study, 48 patients with mild-moderate AD and 49 matched controls (MC) performed a joint rhythmic task with a musician, with two auditory sequences (metronome vs music) and in two social contexts (live vs pre-recorded partner). The outcome measures assessed hand rhythmic synchronisation, spontaneous rhythmic (whole body, head and lips) and socio-emotional (facial expression, gaze contact) behaviours, and cognitive abilities.
Results: Although synchronisation did not differ between AD and MC, we found a decrease of spontaneous body movements and emotional positive expressions in AD compared to MC. We also found an interaction between auditory and social contexts on synchronisation.
Conclusions: Rhythmic synchronization abilities are modulated by the social environment in both AD and MC, whereas other spontaneous motor and non-verbal behaviours can be affected in AD. These findings will be used to propose a method to measure rhythmic entrainment in the elderly that can be used in future research to assess the impact of interventions in pathological ageing.

Can a singing intervention slow down brain ageing in Alzheimer's disease?
Stefan Koelsch
Institute for Biological and Medical Psychology, University of Bergen, Bergen, Norway
(online)

Background: Patients with Alzheimer's disease (AD) have a remarkable ability to remember music, even learn new music, and music therapy is commonly applied in AD. Here we report the first RCT (Clinical Trials ID: NCT03444181) investigating effects of music therapy on brain ageing, cognitive function, and wellbeing of patients with (or at risk for) AD.
Methods: In this ongoing single-blind study, individuals with early AD, mild cognitive impairment (MCI) and subjective cognitive decline (SCD) are randomized to a singing intervention, physical exercise, or passive control. Participants undergo neuropsychological testing, and magnetic resonance imaging (MRI) before and after a one-year intervention (or passive control) period. Individuals in the singing group receive weekly singing lessons, practise daily using recorded CDs, and participate every other week in our Alzheimer-choir. Main outcome measures include brain ageing (brain age is estimated based on structural MRI), disease progression, and depression scores.
Results: At present, the first patients have finished their one-year intervention (43 participants have been randomised so far). I will present data from those participants who will have finished the study by June 2020, and examine whether the music intervention can (a) decelerate the increased brain ageing in individuals with, or at risk for, AD, (b) delay cognitive decline, and (c) reduce depressive symptoms.
Conclusions: If successful, our trial will show that the negative brain age gap of individuals with, or at risk for AD (whose brains are significantly older than their actual age), will not increase, or even decrease, as compared to control individuals.

SYMPOSIUM 10

MUSICAL PLEASURE AS A TOOL TO IMPROVE MEMORY AND AFFECT

Chair: Robert Zatorre
Speakers Ernest Mas-Herrero, Laura Ferreri, Pablo Ripollés, Neomi Singer

Mood disorders and memory loss are frequent in our society and their prevalence is increasing with population aging. Because of their severe consequences in every-day life, identifying and developing therapeutic and prevention strategies have become fundamental goals to improve life quality across the lifespan.
Present since the dawn of humanity, in every culture, and from the very first steps of human development, music represents one of the most pleasurable stimuli throughout our lives. Recent research has shown that musical pleasurable responses rely on the activity of the mesolimbic system (Mas-Herrero et al., 2017), with a main role played by dopaminergic transmission (Ferreri et al., 2019). The knowledge gained from basic science research about music and the reward system is now beginning to be applied to questions of memory and mood enhancement that can eventually lead to exciting new avenues for clinical research.
Based on behavioral, neuroimaging, neurofeedback and neuropharmacological studies, this symposium aims to explore and discuss the intriguing hypothesis that musical reward might drive improvements in both affective responses and higher cognitive functions, such as learning and memory (Ferreri & Rodriguez-Fornells, 2017; Ripollés et al., 2018). By connecting young researchers from different research centres, and introduced by the main expert of the field, Dr. Robert Zatorre, this symposium will propose challenging perspectives on music-reward, human processing, and its implications for musical clinical interventions across the lifespan.

The neural mechanisms underlying musicinduced pleasure: From correlational to causal evidence
Ernest Mas-Herrero
Montreal Neurological Institute, McGill University, Montreal, Canada
(online)

Music's ability to induce feelings of pleasure has been the subject of intense neuroscientific research lately. Prior neuroimaging studies have shown that music-induced pleasure engages both cortical circuits involved in auditory perception and predictive coding, and striatal circuits related to the anticipation and receipt of biologically relevant rewards/ incentives. However, neuroimaging methods are correlational in nature, and thus, while they may reflect true causal mechanisms, correlational activities may not distinguish between brain regions directly involved in the hedonic experience from those that are only modulated by this experience. To establish a direct causal relationship between the engagement of corticostriatal circuits and music-induced pleasure is crucial to actively manipulate brain function. Starting from correlational findings to causal evidence using pharmacological and noninvasive brain stimulation techniques, this talk will explore the key role of corticostriatal circuits to experience rewarding feeling from

music. Specifically, I will present a meta-analysis of fMRI studies investigating music-induced reward, and results from a multimodal TMS-fMRI study showing that cortico-striatal connectivity may be the mechanism underlying music's rewarding power. Understanding the neural mechanism underlying music-induced reward is critical to develop and identify music-based interventions to improve both affective responses and higher cognitive functions.

From pleasure to memory: The implications of music-related reward responses in episodic memory

Laura Ferreri
Laboratoire d'Étude de Mécanismes Cognitifs (EMC), Université Lumière Lyon 2, Lyon, France
(online)

Based on the hypothesis that stimuli triggering dopamine release can result in long-term memory improvements (Lisman et al., 2011), the aim of this talk is to show how variations in music-related reward responses modulate episodic memory.
In a first study, we manipulated dopaminergic transmission via a within-subjects pharmacological intervention (oral administration of dopamine precursor, antagonist, or placebo) in healthy adults. Results showed a crucial role played by dopamine in both musical reward and memory: musical excerpts were rated as more pleasurable and better remembered with increased dopaminergic transmission. On the contrary, decreased reward subjective ratings and memory performance were found when dopaminergic transmission was inhibited. In a second study, we behaviorally explored the effect of musical reward on memory for non-musical material, and considered the implications of interindividual differences in musical reward sensitivity. We showed that pleasant, but not unpleasant or neutral music during verbal encoding enhanced memory performance 24 hours later, and specifically in subjects with higher musical hedonia scores. Findings will be discussed considering musical reward as an underlying mechanism of music-driven memory benefits, and interindividual differences in musical reward sensitivity as a key feature to take into account for musical interventions aiming at stimulating memory (e.g., in normal and pathological aging).

Enhancing memory via music-evoked pleasure

Pablo Ripollés
Department of Psychology, Music and Auditory Research Laboratory, New York University, New York, USA
(online)

The Behavioral Tagging Hypothesis (BTH; Moncada et al., 2007), widely explored in rodents, posits that weakly memorized events can be strengthened by an independent rewarding or novel stimulus that induces the generation of plasticity-related proteins (PRPs), if the latter occurs within a particular time following or preceding the weakly encoded episode (within 1 hour prior to 2 hours after learning). However, whether the BTH can be extended—and more importantly, how can it be extended to humans, is vigorously debated. Here, we used music as the PRP-eliciting stimulus that induces memory benefits within the BTH: a stimulus easy to administer (allowing for behavioral testing at different times); that evokes strong emotions; elicits physiological responses such as changes in skin conductance; and mediates the release of several neurotransmitters well-known to aid the creation of stable long-term memories, such as dopamine (a candidate for PRP; Moncada et al., 2015; Salimpoor et al., 2011; Ferreri et al., 2019). In a first study, we show a benefit in memory recognition for new words learned after listening to rewarding, but not neutral, music. We hypothesize music-induced activity within dopaminergic regions to be the neural correlate for the memory benefits. These results have clinical and educational implications, as they could help to develop new educational strategies aimed at boosting learning via music in both young and elderly populations.

Reward circuit modulation via musical neurofeedback

Neomi Singer
Sagol Brain Institute, Imaging section, Tel-Aviv Sourasky Medical Center, Israel and Department of Neurology and Neurosurgery, Montreal Neurological Institute, McGill University, Canada (online)

As music has been shown to modulate the ascending mesolimbic pathway, and particularly the ventral striatum (VS), an intriguing idea is to harness music's power to determine if it is possible to train individuals to regulate their mesolimbic activity using neurofeedback. Neurofeedback is a training approach in which people learn to regulate their brain activity by using auditory/visual feedback.
In this talk, I will present a series of studies designed to develop and test an accessible and target-specific neurofeedback approach for training individuals to up-regulate their mesolimbic activity using pleasurable music as feedback. The first study will describe our work to develop and validate an fMRI-based EEG model of mesolimbic activity centered on the VS (termed electrical fingerprint) using simultaneous EEG/fMRI data and machine learning. The second study will describe our work to develop an approach to utilize individually-tailored pleasurable music as a feedback signal, such that it is modulated systematically to alter its reward value reliably. Finally, I will present preliminary results from a study that measured the feasibility and the neurobehavioral outcomes of repeated neurofeedback sessions using this novel approach. The discussion will focus on how this method will contribute both to the scientific understanding of the link between volitional mesolimbic modulation and reward processing elements and serve as a platform to train individuals who suffer from reward deficits such as apathy in Parkinson's disease and anhedonia in major depression.

SYMPOSIUM 11

EMERGING APPROACHES TO LARGESCALE AND LONGITUDINAL STUDIES OF THE IMPACT OF MUSIC ON HUMAN DEVELOPMENT IN CHILDREN AND ADOLESCENTS

Chair: John Iversen
Speakers: Daniel Gustavson, John Iversen, Miriam Lense

There is continually accumulating scientific evidence for the interaction of music engagement with developing sensorimotor, cognitive, and social/emotional functions, health and academic achievement in children and adolescents in general. Yet, the existence of persistent disparities in individual outcomes in our education system is a reminder that such effects play out in the context of great individual differences. How can we best optimize the experiences we give children to optimize their development? As development is a deeply complex interplay of biology and experience, challenging questions remain before the impact of music can ultimately be understood within a comprehensive model of individual differences. We are at a moment of great opportunity, with increasing support for in-school neurodevelopment interventional studies, and the creation of open large-scale neuro-geneticcognitive longitudinal development datasets.
This symposium highlights recent longitudinal studies using complementary approaches of targeted in-school intervention and mining largescale, longitudinal, and highly multi-modal datasets with the goal of understanding interactions between music, genetics, brain structure, and behavior. Symposium speakers will discuss their results, but also consider the motivations and practicalities of such studies as well as considerations for how to best integrate disparate forms of evidence. The symposium will close with presentation and open discussion of a recent conceptual model of the integration of genetic and neuroimaging data as a guide to future studies. Beyond catching up with recent results, attendees of the symposium will also gain understanding of the opportunities and pitfalls of this type of research, and be better positioned to themselves engage with large-scale and open datasets to answer questions about music and development.

Distinct genetic and environmental influences on musical instruments, singing, and dancing in early adolescence and associations with cognition 4 years later

Daniel Gustavson
Vanderbilt University Medical Center, USA (online)

Studies of the genetic/environmental underpinnings of musicality typically focus on adults and have not yet considered diversity in musical engagement (e.g., playing instruments vs. singing). Moreover, the etiology of links between musicality and cognition are unclear, especially in adolescence when cognition is still changing. Parents of 758 twins from the Colorado Longitudinal Twin Study reported on their adolescent children's engagement with musical instruments, singing, and dancing (mean age 12.4 years, SD=0.37), including items related to interest, lessons, and skills. Twins also completed

an intelligence (IQ) test at age 12 and multiple vocabulary and executive function tests ~5 years later.
Structure equation models revealed that instrument engagement was only weakly correlated with singing (r=.22) and dancing (r=.25), which were more strongly correlated with each another (r=.56). At age 12, IQ was associated with instrument engagement (r=.29), but not singing or dancing. Instrument engagement was also correlated with later vocabulary (r=.20) and executive function (r=.30), but only the association with executive function remained significant controlling for age 12 IQ (ß=.19). Instrument engagement was moderately heritable (a2=.50), but its association with IQ appeared to be driven by a mix of genetic and shared environmental influences. Together, these findings suggest that adolescent instrument engagement is quite distinct from singing and dancing. Instrument engagement was associated with later cognition, but there was little to no evidence for direct causal effects (at least within this 5-year interval). Further use of longitudinal genetic data will help inform how musiccognition associations emerge and change.

Large-scale nested studies of the impact of music on brain and behavioral development
John Iversen
University of California San Diego,
La Jolla, CA, USA
(online)

We are leveraging several existing large-scale neurodevelopmental studies by adding music phenotype descriptions in order to quantitatively assess the impact of music on brain and cognitive development. A first study followed elementary school aged children, some of whom were engaged in learning to play a musical instrument, for five years. Initial findings indicate that children learning music have improved phonological processing of language sounds (CELF test), that is additionally explained by rhythmic performance accuracy. Separately, individual differences in rhythmic accuracy are predicted by motor and premotor cortex area. Second, we have begun analyzing data from the beginnings of a longitudinal study of a very large sample of adolescents (Adolescent Brain and Cognitive Development) within which music training is highly represented (43% of participants reported some level of music training). Together these studies span ages 5 to 20, covering the transition to school, through adolescence and into adulthood, tracking ~200 and ~11,000 children for five and ten years, respectively. Both studies combine in-depth, longitudinal observation of neural and behavioral developmental trajectories, and assessment of the impact of music interventions on these trajectories. While this work is in its infancy, the prospects and practicalities for such studies will be discussed. More broadly, this work fits in a larger context of ongoing largescale scientific efforts to describe the 'growth curves' of the brain, as a way to define the complex interactions by which individual differences in brain development relate to individual differences in cognitive development and achievement.

Musical activities support social engagement in young children with autism and their parents
Miriam Lense
Vanderbilt University, USA
(online)

Beyond their role in typical development, musical activities may be affiliation impactful for children with Autism spectrum disorder (ASD), a common neurodevelopmental disorder characterized by impairments in social interaction and communication. Musical activities align with key elements of evidence-based approaches for supporting social engagement in ASD as musical games incorporate predictability, reinforcement, emotion regulation, shared attention, and a social play context. In a series of studies, we demonstrate how musical activities may scaffold both child and parent behavior, including eye gaze and social movement, to support social development in ASD. In Study 1, parents and preschoolers with ASD participated in a book sharing activity. Compared to picture books, song book sharing was associated with children's increased attention to the task and parents' increased gaze toward their child. In Study 2, parents and preschoolers with ASD completed a free play activity. During musical vs. non-musical play, parents showed increased physical responsiveness to their child's play (e.g., imitating child). In Study 3, parents and preschoolers with ASD participated in a 12-week parent-child music program that provided parent training through musical activities.
Over the program, children with ASD increased their active engagement in musical activities (e.g., completing song-associated movements). Additionally, compared to families in a waitlist group, children in the music program had greater increases in non-musical motor imitation skills and parents reported increased parenting efficacy. These studies suggest that musical activities may support both children with ASD and their parents by creating a context conducive to the delivery and receipt of social information.

POSTER SESSION 1
On site

All on site posters are also included in session 2 and 3 in Gather.town

POSTER SESSION 2
Online in Gather.town

Poster rooms 1-6
11.10-12.00: Posters 1-14
12.00-12.45: Posters 15-28

Rediscovering the musician's brain: a systematic review and meta-analysis

Criscuolo, A.1,2, Pando-Naude, V.2, Bonetti, L.2, Vuust, P.2, Brattico, E.2
Maastricht University and MIB Aarhus

Gather.town: Room 1 Code 1

Subtheme A - Nature vs Nurture in Music

The acquisition of complex and specialized skills required by musical expertise has been proposed as a perfect scenario to investigate the neuroplasticity mechanisms underlying continuous neuro-anatomical and -functional adaptations. Decades of research in cognitive neuroscience have provided a plethora of variegated findings, which ultimately fail to converge into a unified picture of the neuroanatomy of musical expertise. Thus, here we performed a systematic review and meta-analysis of publications investigating brain functional and structural differences between musicians and non-musicians. Coordinate-based meta-analyses were conducted using the anatomic/activation likelihood estimation (ALE) method implemented in GingerALE, with a total of 675 foci, 79 experiments and 2780 participants. Results revealed widespread and bilaterally distributed networks, revealing for the first time a consistent and controversies-free picture of the neuroanatomy of musical expertise.

It's in your genes? Family history and the course of musician's dystonia

Doll-Lee, J., Haslinger, B. , Altenmüller, E., Lee, A.
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Gather.town: Room 1 Code 2

Subtheme A - Nature vs Nurture in Music

Objective: Musician's dystonia (MD) leads to involuntary cramping of the affected limb and severely impairs playing ability. Risk factors include genetic predisposition and workload/practice time. Hypotheses: We hypothesized that with a genetic predisposition, 1) less practice time is needed to elicit dystonia and 2) onset of MD is at younger age 3) outcome of dystonia is worse 4) gender differences exist Methods: We sent a questionnaire to 663 patients with MD treated at our outpatient clinic, of which 369 answered, and assessed age of onset, dystonia progression, practice time and family history. For normally distributed data we applied t-tests, otherwise we applied a Wilcoxon rank sum test and chi-square tests. Level of significance was α=0.05. Results: We showed that patients with a positive family history developed MD after less practice time, had an earlier onset of symptoms and more often reported that their dystonia worsened over time, confirming our first 3 hypotheses. Generally male musicians were more commonly affected with MD (79% men,21% women). However, we found in the group of patients with a family history of MD the relative proportion of women larger than in the group with a negative family history. Discussion: Genetic predisposition has a negative impact on age of onset, susceptibility and prognosis of dystonia, which has implications for the medical advice given to patients based on their family history. The higher proportion of women in the "genetic group" might indirectly hint towards behavioral differences between male and female musicians, with men being more prone to excessive practice (i.e. workload) and thus higher risk of MD. Future studies are needed to evaluate differences in practice habits between men and women.

The Effects of Musical Improvisation Instruction on Visual and Auditory Statistical Learning

Norgaard, M., Deocampo, J., Garber, L., Emerson, S., Conway, C.,
Georgia State University, USA, Boys Town National Research Hospital, USA

Gather.town: Room 1 Code 4

Subtheme D - Music and Development

It is currently unknown whether music improvisation instruction results in far-transfer effects to other aspects of cognition. Our previous research showed enhanced performance in executive function after 2 months of improvisation instruction. Here we probe if these enhancements may be related to underlying changes in statistical learning (SL). SL is the ability to implicitly extract the statistical regularities embedded within sequences of stimuli. As improvisers create new sequences of notes, they must follow syntactic rules, also a central element of statistical learning that thus may enhance abilities in other domains where sequences are created in real time. Students participating in a university sponsored jazz instruction after-school program for adolescents (N=11) participated in the study. Electroencephalography (EEG) data were collected during four computerized SL tasks assessing the learning of both adjacent and nonadjacent dependencies in visual and auditory input streams; learning was assessed both pre and post four months of jazz improvisation training. Participants also completed a music improvisation assessment at both time points. Pre scores show a strong correlation between visual SL measures and improvisation achievement. Initial analyses of post scores show a correlation between improvements over time in visual SL measures and improvisation achievement. Analysis of the auditory SL data will be available by the time of the proposed poster presentation.

Deliberate Practice in Music: Development and Psychometric Validation of a Standardized Measurement Instrument

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2 Universität Trier, Germany

Gather.town: Room 1 Code 5

Subtheme D - Music and Development

Practice is the process through which musicians improve their performance abilities and increase their level of expertise. Deliberate Practice (DP) is a theory of expertise conceptualized by Anders Ericsson (1993) that aims at representing activities having positive effects on performance quality: despite its popularity, subsequent studies have demonstrated several critical issues in Ericsson's DP concept, due to its vagueness in definitions, arbitrary measurements of expertise and inability to account for the possible role of genes. The present project aimed at creating a new questionnaire, capable of measuring practice quality in terms of deliberate practice for the music domain, regardless of the instrument and musical genre played, at any level of expertise. On the basis of data from a sample of 1558 musicians, ranging from amateurs to world-renowned soloists, the Deliberate Practice in Music Inventory (DPMI) was created, a self-report questionnaire and measurement instrument for practice quality consisting of a main DP scale and four subscales: Process improvement, Practice competences, Mindless practice (inverted scale) and Task decomposition. Results indicated that musicians who implement effective practice habits are focused on solving problems related to music playing and often refine their practice routines to increase their effectiveness. In addition, musicians who usually exhibit high amounts of DP behavior often decompose complex tasks into simpler elements, aiming to master them more easily. The DPMI instrument shows good convergent validity with measures related to expertise in music as well as good predictive validity for performance improvement. The DPMI generates new perspectives for the field of musical expertise research.

Train the brain with music – Can one year of musical intervention lead to structural connectivity changes in healthy elderly?

Jünemann, K.1,2, Sinke, C.1, Worschech, F.2,3, Marie, D.4,5,6, Kliegel, M.5, James, C.4,5,6, Altenmüller, E.2,3, Krüger, T.1,2
1 Hannover Medical School, Hannover, Germany,2 Center for Systems Neuroscience Hannover, Hannover, Germany 3 Hannover University of Music Drama and Media, Hannover, Germany, 4 University of Applied Sciences and Arts Western Switzerland HES-SO, School of Health Sciences, Geneva, 5 University of Geneva, Switzerland, 6 Geneva Musical Minds lab, School of Health Sciences, Geneva, Switzerland

Gather.town: Room 1 Code 6

Subtheme H - Music and Aging

Healthy and active ageing is becoming more and more important as the global number of elderly people is increasing. Ageing naturally not only leads to cognitive decline but also to a loss of white matter integrity. Recent data however suggests that music making might prevent or at least slow down these processes. Fixel-based analysis (FBA) is a novel analysis technique to investigate white matter changes providing different biologically relevant metrics. These include fibre density, showing microstructural changes and fibre bundle cross-section, showing macrostructural changes. In this study, we use FBA to investigate whether different musical training procedures can improve white matter integrity in an elderly population and therefore counteract naturally occurring white matter fibre loss. We acquired diffusion weighted images (65 diffusion gradient directions, b = 1500 s/mm2) in 120 healthy, retired, initially musically naïve participants (mean age = 69.43, 69 female) at three time points: at baseline, after 6 and 12 months of weekly musical training, provided by professional musicians. Participants learned to play the piano (PP, 64 participants) or received musical culture lessons (MC, 56 participants) during this time. FBA was used to examine group differences in five tracts of interest over time: corpus callosum, left/ right corticospinal tract and left/ right arcuate fasciculus. Final results will be presented at the conference.

Measuring beat perception abilities in the general population

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Gather.town: Room 1 Code 7

Subtheme A - Nature vs Nurture in Music

Musicality – the ability to perceive and process music – has been suggested to consist of several key components, including beat perception: the ability to perceive a regular beat in a time-varying rhythm. The vast majority of humans is capable of perceiving a beat, with considerable individual differences that do not depend on musical training per se. To understand musicality, and to be able to relate beat perception (phenotype) with its underlying biology (genotype), it is important to be able to index this variability. Several tests have been developed to test beat perception abilities in the general population, but it is unclear how these tests relate to each other. Moreover, whether all these tests validly measure beat perception, and not some other aspect of rhythmic capabilities, is not known. Here, we tested beat perception in 121 healthy participants. We included tests specifically targeting beat perception (Beat Alignment Test, anisochrony detection, H-BAT), but also tests indexing related but differential abilities (duration discrimination, working memory). We show that beat perception tests correlate with each other, but also with duration discrimination tests, as such questioning their specificity. Also, factor analysis did not reveal a clear separation between tests measuring beat perception and related abilities, further highlighting the need to improve the design of beat perception tests, to be able to index an important aspect of human musicality

Improved decoding of vocal emotions in individuals with naturally higher music skills

Correia, A.I.1, Castro, S.L.2 , MacGregor, C.3, Müllensiefen, D.3, Schellenberg, E.G.4., Lima, C.F.5
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Gather.town: Room 1 Code 8

Subtheme A - Nature vs Nurture in Music

Music training has been associated with improvements in nonmusical abilities, including attention, speech perception, and emotion recognition. Evidence for this association comes mostly from studies comparing musicians and nonmusicians. However, it remains unclear whether training itself is the only factor explaining the musician advantages, or whether factors such as informal musical experience and predispositions could produce similar effects. We addressed this issue by examining the association between music and vocal emotion recognition. The sample (N = 169) included trained musicians and listeners with minimal or no training, who varied in their music skills. Self-report and performance-based measures evaluated music skills, and emotion recognition tasks assessed listeners' ability to categorize emotions in prosody and vocalizations (e.g., laughter). We found a small positive association between music training and vocal emotion recognition. A robust association between music skills and emotion recognition in the entire sample was also found, even when music training was held constant. In fact, untrained participants with higher music skills were as good as trained participants at recognizing emotions. Furthermore, the effect of music training on vocal emotions was fully mediated by music skills. These findings emphasize the need to consider the role of predispositions and informal musical experience when studying associations between music and nonmusical domains.

Influence of musical abstractions on the perception of low-level acoustic stimuli

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Gather.town: Room 1 Code 9

Subtheme A - Nature vs Nurture in Music

Research on music psychology suggests that the manipulation of complex musical regularities can be linked to distinct hemodynamic responses, Event-Related Potentials, as well as to distinct patterns of behavioral responses. In the present work, we support the idea that abstract musical regularities can influence the perception of low-level acoustic stimuli. We hypothesized that the ability to differentiate between two frequency ratios (i.e. harmonic major and minor third) would be affected by the presence of high-level musical regularities. In an oddball task, participants (professional musicians = 112, amateurs = 145, and naive = 111) were asked to ignore Major Thirds (80%) and to press the spacebar whenever they heard a Minor Third (20%). These intervals were arranged in a way that they could either suggest a tonal context (i.e. experimental condition) or an atonal one (i.e. control condition). Performance was significantly better within the control condition, indicating that context (i.e. Tonal/Atonal) influenced the participant's ability to differentiate between frequency ratios. In line with our hypothesis, the acoustic difference between Major and Minor Thirds lost its perceptual saliency within a tonally structured environment, and we interpret this finding as evidence that knowledge of musical regularities might affect the processing of low-level acoustic features.

The social nature of consonant sounds. Insights from chicks

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Gather.town: Room 1 Code 10

Subtheme A - Nature vs Nurture in Music

Do we like consonant sounds before any exposure to music? One hypothesis is that consonant sounds represent biological determinants in agents' identification: consonant ratios are predominant in human vocalizations and, when in agreement, people produce consonant utterances in dyadic conversations. Consonance seems also a cue we are predisposed to attend to: human newborns readily show neural circuits to encode consonance as different from dissonance. However, only data from completely naïve organisms could disentangle whether consonant sounds have an innate biological value. In a previous study, the young of the domestic fowl (Gallus gallus) showed to prefer consonant sounds. Here, with the aim at investigating the reason for such preference, we analyzed the ratio of fundamental frequencies between specific points in the spectrogram of four different types of positive/negative valenced calls and we quantified the frequency of consonant/dissonant intervals. Consonant ratios prevailed in chicks' calls and this was true also for fear thrills, thus fueling the idea that consonant sounds are biologically relevant, likely facilitating the detection of an organism. In sum, there would be a highly social component in consonant organization of sounds that has nothing to do with experience.

Is there a sensitive period for musical skill acquisition during development? A genetically informative study

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Gather.town: Room 1 Code 11

Subtheme A - Nature vs Nurture in Music

Experts in domains such as music, dance, or sports, which require advanced sensorimotor skills, often start training early in life. It has been suggested that this may reflect a sensitive period

in childhood for skill acquisition, during which the nervous system is particularly sensitive to environmental stimulation. However, it also appears likely that familial factors (e.g., genetics) contribute to such associations. For example, children who show more interest or talent during early childhood in a specific domain of expertise may be more likely to be encouraged to begin training early. Here, we examine the effect of age of onset of musical training on musical aptitude and achievement in a sample of Swedish professional musicians (N=310) and a large sample of Swedish twins (N=7,786). In both samples, an earlier age of onset was associated with higher musical aptitude and achievement. However, when adjusting for lifetime practice hours, an earlier age of onset was only associated with higher musical aptitude ($p<.001$), but not with musical achievement ($p=.14$). Furthermore, twin analyses showed that the association between age of onset and aptitude was fully explained by familial factors. In conclusion, the findings indicate that familial factors may have important contributions to associations between early training and adult performance and therefore should be taken into account in studies of sensitive periods.

Cognitive processing of culturally familiar and unfamiliar music examined through a sorting task among Turkish listeners

Morrison, S., Demorest, S., Pearce, M.
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Gather.town: Room 1 Code 12

Subtheme I - Cross-cultural Studies

Processing of culturally unfamiliar music may be mediated by the degree to which that music differs in statistical patterns of pitch and rhythm. Previous data using U.S. participants listening to Western and Turkish music suggested this to be a viable construct in interpreting listener responses. The aim of the present study was to replicate this design using Turkish participants. We identified 10 Western chorales and 10 Turkish makamlar and extracted two phrases from each. We analyzed excerpts for within-culture distinctiveness to calculate strength of classification (SoC) data for combined parameters of pitch and inter-onset interval. SoC scores reflected the degree to which an excerpt was representative of its corresponding music type and different from the contrasting type. Texture (single-line melody) and timbre (piano) were held constant. Adult Turkish participants (N=88) were asked to freely place randomly-ordered icons representing each excerpt along a horizontal axis. Similar to prior results with Western participants, Turkish participants tended to segregate melodic excerpts by music type with 78.1% of Western excerpts and 74.0% of Turkish excerpts placed to one side of the midpoint, consistent with findings from Western listeners (68.2% Turkish, 71.8% Western). Placement along the axis demonstrated correlation with SoC scores of $r = .28$ for Turkish excerpts and $r = .27$ for Western excerpts, similar to those of U.S. participants (.33 Turkish, .25 Western).

Statistical learning in the developing brain

Daikoku, T.1,2, Jentschke, S.3, Tsogli, B. 3, Lachmann, T.4,5, Koelsch, S.3
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Gather.town: Room 1 Code 14

Subtheme D - Music and Development

The brain is a learning system that adapts to multiple external phenomena existing in its living environment, including various types of input such as auditory, visual, and somatosensory stimuli, and various learning domains such as music and language. A body of research suggests that the brain also possesses a domain-general learning system, called statistical learning (SL), that is partially shared by music and language. The SL is a process by which the brain automatically calculates transitional probabilities of sequential information. SL doesn't require any intention to learn and occur without awareness of what has been learned. Previous evidence suggests that children suffering from Developmental Language Disorder have deficiencies with using statistical-learning mechanisms. In a series of studies we evaluated the neural correlates of auditory statistical learning using event-related potentials (ERP). An ERP component, the statistical mismatch negativity (sMMN), reflected differences in brain activity to stimuli with lower and higher transitional probability. It had a negative polarity peaking at 150–250 ms after the onset of the stimuli. The aims of our studies are to establish experimental paradigms to investigate SL in children and to determine whether these could be indicative of differences between typical and delayed language development. This could open a perspective for better insight in mechanisms underlying the disorder and for applications in early detection

An investigation of rhythm and meter perception in infancy using electroencephalography

Flaten, E., Trainor, LJ.,
McMaster University, Canada

Gather.town: Room 1 Code 15

Subtheme D - Music and Development

Adults primed to hear ambiguous rhythms with different metrical interpretations show steady-state responses (SSR) in their electroencephalography (EEG) with more energy at the primed meter than unprimed meters. Previously, we presented 7-month-olds with an ambiguous 6-beat rhythm and found SSRs with peaks at the beat, duple (groups of 2 beats), and triple (groups of 3 beats) meter frequencies. We can also measure meter perception via the mismatch negativity (MMN), an automatic brain response to occasional (pitch in our case) deviants in a repeating pattern, and the following P3a response. Half of our 6-month-olds were primed to hear the rhythm in duple meter and half in triple meter by adding accents to every second or every third beat, respectively. Following priming, test trials consisted of 16 repetitions of the ambiguous

unaccented pattern. Rare pitch deviants occurred on either beat 4 (strong beat in triple meter) or beat 5 (strong beat in duple meter) of the unaccented pattern. Data collection is ongoing (N=18 to date), but preliminary SSR results show peaks at all frequencies present in the unaccented pattern. We also found significant MMN and P3a responses. We are continuing data collection in order to analyze interactions involving beat (4 or 5) and priming condition (duple, triple). This research will help us understand development of the metrical interpretation skills needed for early language and music learning.

Are poor language skills associated with narrow entrainment region?

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Gather.town: Room 1 Code 16

Subtheme D - Music and Development

Children with Developmental Language Disorder (DLD) show impairments primarily in language, but research suggests that rhythm problems can also occur. The source of language impairments is unknown. In the current study, we investigated the hypotheses that entrainment region, the range of tempi that affords efficient attentional entrainment (McAuley et al., 2006), is 1) narrower in children with DLD than with typical development (TD) and 2) associated with rhythm and language skills. We measured entrainment region (calculated from spontaneous motor tempo, fastest and slowest tapping rate following McAuley et al., 2006), rhythm discrimination and expressive grammar together with nonverbal IQ, musical experience and socio-economic status in 5-8-year-old children with DLD (N = 18) and TD (N = 120). Children with DLD showed a significantly narrower entrainment region than children with TD. However, introducing musical experience scores as a covariate eliminated the difference. Overall, children with broader entrainment region showed better rhythm discrimination and expressive grammar performance, even after controlling for age, socio-economic status and musical experience, although musical experience also had a significant effect. These results indicate that the size of entrainment region plays an important role both in rhythm and language development, and are consistent with the possibility that a narrow entrainment region may account for weak language and rhythm skills in DLD.

What is the most appropriate outcome measure to detect the effects of music therapy for dementia?

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Gather.town: Room 1 Code 18

Subtheme H - Music and Aging

Music therapy for patients with dementia has been reported to be effective for behavioral and psychological symptoms of dementia (BPSD), but it has not been still determined which scales are appropriate to show the effectiveness. We investigated the scales used in literatures of music therapy for patients with dementia and the most appropriate scales to detect its effectiveness. We searched the articles in pubmed and psychoinfo and found 94 studies detected by 'dementia & music therapy' search terms (in January 20, 2020). Systematic reviews, reviews, and case reports were excluded. As the results, 83 outcome measures were detected. Among them, Mini-Mental State Examination (MMSE/ 31%), Neuro Psychiatric Inventory (NPI/ 22%), Cohen-Mansfield Agitation Inventory (CMAI/ 14%), Barthel Index (3%) and The Raven's Coloured Progressive Matrices (RCPM) (1%) in our study were used. Of theese 83 outcome measures, 45 showed statistically significant: NPI (17%), CMAI (9%), MMSE (5%) Quality of life for Alzheimer's disease (5%) and RCPM (1%) in our study. There are too many outcome measures used in music therapy for patients with dementia, which makes it difficult to verify the effectiveness of the intervention. In our studies including the intervention using music for community-dwelling healthy people and patients with dementia, the results of RCPM were consistently significant even in the cases of other scales were insignificant. The RCPM measures general intelligence and psychomotor speed, and can be carried out within 10 minutes. Based on the results mentioned above, we can reasonably conclude that the RCPM is the most appropriate scale for the assessment of the effects of music therapy for patients with dementia.

Effect of age on behavioral and neural correlates of temporal predictability

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Gather.town: Room 1 Code 19

Subtheme H - Music and Aging

Grasping the temporal structure of auditory rhythms is essential to predict future events (e.g., the next beat in music). Timing abilities vary during aging. To assess perceptual and sensorimotor timing abilities and its variability, the Battery for the Assessment of Auditory Sensorimotor and Timing Abilities (BAASTA) has been developed. The goal of the present study was to investigate EEG signatures of temporal predictability as a function of age. We tested young (n = 22, Mage = 22.8y) and older adults (n = 21, Mage = 68.5y) on perception and sensorimotor timing tasks from BAASTA. EEG activity was studied via an

auditory oddball task, consisting of isochronous and random sound sequences to manipulate temporal predictability. Results showed that EEG is more sensitive in detecting age effects when compared with behavioral timing perception and production tasks. We found associations between enhanced tapping consistency and increased N100 amplitudes for isochronous sequences in young, and with increased P300 amplitudes in old adults. P50 amplitude and N100 latency values served as potential markers distinguishing between isochronous and random temporal structures in young, but not in older adults. These results suggest less efficient sensory gating in older adults across isochronous and random auditory sequences. In the young participants, the P50 results support this component as marker of temporal predictability, confirming sensitive gating of temporally regular structures

Singing lessons: A path to well-being in later life

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Gather.town: Room 1 Code 20

Subtheme H - Music and Aging

Seventy-two persons who had taken voice lessons for at least a year, beginning after the age of 40 years, were invited to complete an on-line questionnaire that focused on the singers' experience, motivation, goals, impact on health and well-being, repertoire achievements, practice, lifestyle, and demographic information. Forty-eight respondents (33 females; mean age 60.94 years, range 48.83-82.08, SD= 6.99) completed the questionnaire which included both open-ended and closed questions. The majority of the participants indicated that personal enjoyment and personal growth motivated taking lessons. Over 90% commented on the benefits of singing to their physical health (e.g., proper breathing) and to their mental health (e.g., mood, less depressive episodes). Despite the association of singing lessons with individual activity, 67% reported positive changes in social relations since taking singing lessons. Benefits to professional relations were also reported (e.g., confidence, listening to others, giving and taking). Repertoire level was in generally high, suggestive of rapid learning. Although the voice is a "free" instrument, the cost of time and lessons may account for the generally high socioeconomic status of respondents. Given that the singing voice is a musical instrument available to almost everyone, results of the present study might motivate older adults to consider taking voice lessons and health care professionals to consider voice-lessons as an intervention.

Understanding and measuring the benefits of community group singing for people with dementia

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Gather.town: Room 1 Code 21

Subtheme H - Music and Aging

Background: Creative social interventions can support people with dementia and their carers to live well with the condition, improving quality of life and reducing burden on health and care systems. Community-based group singing has received attention for its potential to enhance the lives of people with dementia and their carers, but its benefits have not been conclusively demonstrated through research. This poster reports the findings of a doctoral study which used a mixed-methods approach to evaluate the impact of attending a singing group upon people with dementia and their supporters. Methods: People with dementia and their supporters attended a singing group for 10 weeks. Data was collected using measures of mood, quality of life, and musical engagement, as well as interviews and focus groups. Findings: Data analysis found that the benefits of group singing which the participants reported qualitatively were not reflected in the quantitative measures of mood and quality of life. The social benefits of the group were a prominent theme; participants appreciated the chance for peer support and resource sharing with those in a similar position. Conclusion: Group singing has many supportive attributes for people with dementia and their carers but capturing these quantitatively is a challenge. Further research is needed into the complex dynamics at play in the group singing experience in order to develop methods for meaningfully measuring its benefits.

Group singing, but not group yoga, fosters social connectedness and concomitant increases in oxytocin in older adults living with Parkinson's Disease

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Gather.town: Room 1 Code 22

Subtheme H - Music and Aging

Many older adults face formidable challenges to social and psychological wellbeing, especially those diagnosed with an age-related disease such as Parkinson's Disease (PD). Recent research by our group and others has demonstrated that group singing may be an effective way to ameliorate some of these challenges faced by older adults. In particular, group singing appears to positively impact wellbeing by elevating mood, reducing stress, and increasing social connectedness. In the current study, we tested older adults living with PD in group singing and group yoga conditions to determine the extent to which social benefits are attributable to singing rather than group activity. The study also sought to provide some preliminary evidence for two potential sociobiological underpinnings of these effects, namely cortisol and oxytocin. Several novel findings were obtained: the singing group exhibited

higher levels of social connectedness than the yoga group. Importantly, although both singing and yoga led to decreases in cortisol, only group singing led to increases in oxytocin. While group singing and yoga conditions both involve movement, cardiovascular engagement, and deep breathing, singing seems to have an advantage with regard to social connectedness. We presume that this advantage is owed to the synchronized movements that occur in group singing.

Cognitive, emotional, and social well-being of older adult choir-singers compared to demographically matched older adults

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Gather.town: Room 1 Code 23

Subtheme H - Music and Aging

The effects of musical practice on cognition are well established yet rarely compared with other types of artistic expertise, such as theater. Both of these activities require many hours of individual or collective training in order to reach an advanced level. These practices require the interaction between higher-order cognitive functions and several sensory modalities (auditory, verbal, visual and motor), as well as the regular learning of new multimodal information. The objective was to determine whether expertise in these practices had different effects on cognitive performance. In this study, 50 musicians, 46 actors, and 50 healthy controls, matched for sex, age (18 to 84 years old) and education were included and underwent a neuropsychological battery targeting processing speed, executive functioning, working memory, long-term memories, and non-verbal reasoning abilities. Results showed that music and theater artistic expertise were strongly associated with cognitive benefits. Musical expertise mainly improved executive functioning, working memory and non-verbal reasoning, whereas theater expertise mostly influenced verbal long-term memory. Thus, these results may indicate a positive effect of expertise over cognition, although each activity had different benefits of its own. As artistic expertise appears to influence cognition at any age, future studies should focus on its potential to preserve healthy cognition throughout aging. Choir singing is associated with reduced depression and anxiety and enhanced quality of life (QOL) in healthy older adults, but its potential cognitive benefits are still largely unknown. Here, we report a cross-sectional questionnaire study comparing elderly (age 60+) choir singers (CS, N=106) and matched controls (N=56) using self-report measures of cognition and memory, mood, social activity, QOL and role of music in daily life. 74 subjects (39 CS, 35 controls) were also assessed with an extensive neuropsychological testing battery. For the self-report measures, CS with longer singing experience (>10 years, N = 48) had higher scores on the Social Integration scale of the SPS than controls and CS with shorter singing experience (≤10 years, N = 58). In contrast, CS with shorter singing experience reported higher satisfaction with health on the WHOQOL-BREF than controls and choir singers with longer singing experience. Both CS groups had higher MusEQ scores compared to controls. CS performed better than controls on verbal fluency, but there were no other significant effects on cognitive tests. In conclusion, long-standing participation in choir singing is associated with self-reported benefits in social engagement whereas choir singing which started in late middle age is associated with better satisfaction with health. Cognitively, senior choir singing is linked to better executive function, particularly in cognitive flexibility.

Atypical Functional Connectivity during Unfamiliar Music Listening in Children with Autism Spectrum Disorder

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Gather.town: Room 1 Code 25

Subtheme D - Music and Development

Children with autism spectrum disorder (ASD) present repetitive behaviors and interests. This insistence on sameness behaviors seems to indicate a preference for the familiar and aversion to novelty in ASD. In addition, music is an auditory stimulus that interests and motivates individuals with ASD and a useful tool to study cognitive functions. We investigated the familiarity effect using music stimuli (familiar and unfamiliar songs) in typically developing (TD) and ASD children, using magnetoencephalography (MEG). This technique enabled us to study brain connectivity and characterize the networks and frequency bands involved. 24 ASD (mean age 9.96 ± 1.5) and 24 TD (mean age 10.1 ± 1.9) matched on age and sex, completed a music familiarity task in a 151-channel whole-head MEG. Compared to TD, children with ASD showed intact processing of familiar songs but atypical processing of unfamiliar songs in theta and beta-bands. Theta and beta oscillations are associated with long-range communication between distant brain areas. Atypical functional connectivity of other unfamiliar stimuli has also been reported in ASD. Our findings reinforced that processing novelty is a challenge in ASD driven by maladaptive neural adaptation.

Infants relax in response to unfamiliar foreign lullabies

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Gather.town: Room 1 Code 26

Subtheme D - Music and Development

Music is a human universal which, like nonhuman vocalizations, is characterized by acoustical

forms that are predictive of its behavioral functions. Adult listeners use this fact to accurately distinguish between unfamiliar lullabies and love songs, dance songs and healing songs and so on, on the basis of those songs' musical features alone. This could be attributable to adults' extensive musical experience, however, as opposed to the basic design of the human mind. Here we show that American infants (N = 144) relax in response to lullabies from eight small-scale societies, relative to matched songs from other small-scale societies, as measured by heart rate and electrodermal activity. These results were consistent throughout the first year of life, suggesting the relaxation response is not a function of infants' rich musical experiences. Infants showed no visual preferences for the animated characters producing the songs, but they attended more to the lullabies, as evidenced by less blinking during the singing. Moreover, the infants' parents chose foreign lullabies as the songs that they themselves would use to calm their fussy infant, much more often than other foreign songs. Together, these findings raise the possibility that links between form and function in music are innately specified, in contrast to features of music perception that are culturally determined

A Digital Musical Instrument for embodied learning in music therapy and rehabilitation.

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Gather.town: Room 2 Code 1

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

This paper describes a pilot study with a Digital Musical Instrument, which we investigate functional brain changes using resting-state functional magnetic resonance imaging data. Participants performed in an octophone environment for 5 sessions, we collected MRI data pre-first and post the last session. We attributed audio-visual feedbacks to the left and right arm's subject position. We collected the jerk – body acceleration – to calculate the Motion Fluidity (MF) and give the audio feedback. MF sets the degree of dissonance or consonance that the subjects hear and the colours of visual feedbacks projected in front of the subject while performing. From brain analyses Subject 1 (S1) showed degree increase in the visual cortex (VC) and in the prefrontal cortex (PC) in the motor system. Subject 2 (S2) showed the largest degree increase in the anterior PC. Degree increases found for S1 in VC possibly underlie alertness and higher attention, and in the motor cortex, they could be related to movement improvement. For S2, degree changes in the anterior PC, could be related to an increase in the calibration of MF and self-awareness during the daily practice. Indeed, the anterior PC is responsible for strategic processes in memory recall and cognitive control of behaviour, which facilitate the attainment of the chosen goal; in turn, this is particularly important when referring to the rewarding system. A future experiment is following with 21 subjects and a more stable environment.

External validation of the Battery for the Assessment of Sensorimotor Auditory and Timing Abilities (BAASTA) with the Montreal-Beat Alignment Test (M-BAT)

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Gather.town: Room 2 Code 2

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Tapping to the beat of music is a well-known test of rhythmic skills. Several musical synchronization tasks have been developed in the past and incorporated into test batteries, such as the Battery for the Assessment of Sensorimotor Auditory and Timing Abilities (BAASTA) and the Montreal-Beat Alignment Test (M-BAT). In these batteries, synchronization to the beat is tested with different kinds of musical stimuli. BAASTA uses computer-generated excerpts of classical music with a fixed tempo (100 BPM). M-BAT contains more ecological music stimuli (i.e., real performances) that vary in terms of tempo (82-170 BPM) and genre (Merengue, Rock, Jazz, etc.). These two batteries have not yet received external validation, which was the aim of the present study. Forty-five non-musicians performed the synchronization tasks from the two batteries, as well as an unpaced tapping task to assess their spontaneous tempo. The results show that synchronization consistency (computed via circular statistics) is highly correlated between the two batteries ($r = .75$, $p = .01$), despite the differences in stimulus complexity and their ecological validity. This correlation is independent of motor variability and spontaneous tempo, indicating that both tasks primarily assess audio-motor coupling, rather than general motor variability. This study provides support for the external validity of both batteries for assessing synchronization to the beat of music.

Tracking the neural correlates of sensorimotor synchronization from age 6-7

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

When moving to the music the neurons in the brain synchronize to the beat of the music. In order to align movement to the beat, auditory and motor processes were found to interact, and oscillations that give rise to them will converge onto a cross-modulation frequency that corresponds to their individual sum. Sensorimotor synchronization takes time to develop and the neural correlates of this development are still unknown. In this study, we examined auditory

and motor processes through steady-state-evoked potentials (or SS-EPs) of children from age 6-7. SS-EPs corresponding to the processing of the auditory stimulus (2.4 Hz) were significant at each measuring time and did not change significantly throughout measurements. However, there were no significant SS-EPs at the target tapping rate (1.2 Hz) and its corresponding cross-modulation frequency (3.6 Hz) at any measuring times. Because individual tapping movements elicited activations in the motor areas of the brain, we concluded that the processing of the auditory stimulus and movement might mature earlier than the processes underlying auditory-motor coupling, which might extend beyond age 7.

Familiarity with your Partner's Synchrony: Help or Hindrance?

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Several studies assume that improvement in musical synchronization is based on learning how to integrate auditory and motor information. We address whether individuals' synchronization abilities change based on learning about a partner's synchronization abilities. Knowledge of a partner's synchrony could help or hurt future synchronization, depending on the partner's synchronization abilities. Participants with and without musical training tapped on a force sensor that generated melody tones with each tap. First, they performed a Solo rate task by producing a musical scale at a spontaneous (uncued) rate. Then they synchronized the musical scale with a constant metronome set to their Solo rate or to their future partner's Solo rate. In a Joint task, two partners took turns synchronizing the musical scale with a metronome cue; the cued rate matched each partner's Solo rate on different trials. Joint task asynchronies showed that partners with less musical experience were affected more by the sound of their partner's synchronization than were partners with more musical experience. The partner with better Solo synchronization abilities tended to have greater influence on their partner in the Joint task. This effect was larger when partners' Solo rates differed. We discuss these findings in terms of a bidirectional delay-coupling model (Demos et al., 2019) which relies on the memory of a partner's past events to maintain synchronization.

Aesthetic Sensitivity Across Domains

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Gather.town: Room 2 Code 5

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Sensory valuation is a fundamental aspect of human psychology, involving the assignment of hedonic value to a stimulus based on its sensory properties combined with personal and contextual factors. To investigate whether hedonic value is computed directly from sensory information or mediated by abstracted amodal attributes, we compared how individual aesthetic sensitivity to balance, contour, symmetry, and complexity affects liking responses to auditory and visual stimuli exhibiting these perceptual properties. No significant correlation for the same attribute across sensory modalities was found except for contour, indicating that modality-specific sensory representations drive the computations of hedonic value and, thus, define aesthetic sensitivities. The individual traits art experience, openness to experience, and desire for aesthetics were associated with aesthetic sensitivities but inconsistently across sensory modalities and structural features, also suggesting modality-specific and context-dependent influences. The results concur with current knowledge on the neurobiology of sensory valuation and contribute to understanding its underlying mechanisms

Action-perception coupling and near transfer: Listening to melodies after piano practice triggers sequence-specific representations in the auditory-motor network

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Gather.town: Room 2 Code 6

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Action-perception coupling can be established through practice. For example, non-musicians show activity in premotor regions after learning to play melodies on the piano, which remain absent for untrained melodies. The novel activity could reflect a general preparatory signal, or actual motor representations of the trained melody. To test these two hypotheses, we taught 12 non-musicians to play two melodies with different sequential structure on the piano. On the following day, participants were scanned with fMRI while listening to the trained melodies as well as to two untrained melodies. A matched control sample without piano training was also scanned while listening to the melodies. Multivariate pattern analysis was used to train a classifier to distinguish between melodies based on brain activity. In the trained group, accuracy was significantly above chance level for classification between trained melodies but also between untrained melodies, throughout the auditory-motor network. None of the melodies could be classified with above-chance accuracy in the control

sample. These results provide direct evidence for training-induced sequence-specific action-perception coupling, by showing that a series of sensory events can trigger sequence-specific representations in the auditory-motor network. Finding that novel melodies could also be classified in multiple brain regions interestingly suggests that action-perception coupling is potentially important also for near transfer.

Graphical Representations reduce Asynchrony during Rhythm Learning

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Visual representations play an important role in music, especially during learning. However, visual representations have been largely overlooked in the literature. External representations, such as musical notation, rely on the persistency and perceptual features of the object to facilitate cognitive processing. In order to address the effect of visual information on rhythm learning, the Rhythm Synchronization Learning Task (Padrao et al, 2014) was adapted to allow healthy subjects to learn to tap different rhythms with auditory and visual stimuli. The rhythms had varying levels of complexity and were each repeated 13 times. The visual representations were 1) graphics that displayed distances representative of intervals 2) categories that resembled the Western Music notation, and 3) a non-informative images. To asses learning, we measured asynchrony between the tapped rhythm performed by the subject and the rhythm of the auditory stimuli. The preliminary behavioural results indicate that the asynchrony was reduced between early and middle stages of learning. Graphical representation reduced asynchrony compared to categorical and non-informative images. The interaction between complexity and type of visual representation was not significant. Moreover, complexity increased levels of asynchrony. These findings suggest that graphical representations based on a direct correspondence between distance and duration interval might improve rhythm learning.

Normalization of a tablet version of the Battery for the Assessment of Auditory Sensorimotor and Timing Abilities (BAASTA)

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

The Battery for the Assessment of Auditory Sensorimotor and Timing Abilities (BAASTA) is a comprehensive set of perceptual and sensorimotor finger tapping tasks for testing rhythmic skills in healthy adults. BAASTA shows high sensitivity to individual differences and to timing and rhythm deficits in patient populations (e.g., Parkinson's disease, developmental stuttering, ADHD, and dyslexia). We recently developed a dedicated tablet app version of BAASTA that ensures high precision (<1 ms) for both perceptual and tapping tasks. Here, norms were collected twice from 84 healthy adults (18-87 years old) at an interval of 4 weeks. Participants completed perceptual tests (duration discrimination, anisochrony detection with tones and music, and the Beat Alignment Test - BAT), and sensorimotor tests (unpaced and paced tapping with tones and music, synchronization-continuation, and adaptive tapping to a sequence with a tempo change). Intraclass correlation coefficient (ICC) values confirmed test-retest reliability as good (>.4) to excellent (>.7) in this normative sample across all measures except for the adaptive tapping task (0.11-0.54). A small but significant improvement was found for metronome tapping accuracy, whereas all other measures showed no changes between sessions. These results validate the tablet version of BAASTA for high test-retest reliability, and open the way to constructing robust norms for healthy adults across the age span to be used in clinical studies.

Endogenously driven interbrain synchrony during joint piano playing

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Gather.town: Room 2 Code 9

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

During social interactions, such as joint music making, the brains of interactants synchronize. What remains unclear is whether this interbrain

synchrony (IBS) is merely based on shared auditory input that similarly drives each individual brain or on the alignment of cognitive processes relevant for social interaction. The current study aims to isolate the endogenous, cognitive contribution to IBS by manipulating cognitive variables of musical interaction in 14 piano duos while (1) keeping the sensory input as similar as possible across conditions, or (2) completely removing sensory input, testing IBS during joint pauses. Firstly, we compared IBS in periods of behavioural synchrony during performance that differed only in whether pianists were motorically familiar (or not) with the partner's part, which reduced (or enhanced) their joint attention. IBS in the gamma band across all electrodes was higher when joint attention was enhanced, despite similar shared sensory input. Secondly, we compared IBS during musical pauses, when pianists were silently planning to resume playing either at the same or a different tempo than their partner. IBS in the gamma band at right posterior electrodes was higher when pianists planned to play the same tempo. These combined findings illustrate that IBS during joint music performance is not necessarily an epiphenomenon of shared sensory input but can also hinge on the alignment of endogenous, cognitive processes - joint attention and action planning - that both serve fluent and successful interaction

Novice and Experienced Musicians' Perceptions of Discrepancies Between Intentions and Outcomes During Music Practice

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Gather.town: Room 2 Code 10

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

To effectively encode and refine procedural memories, learners must make attempts towards well-defined goals, perceive discrepancies between their attempts and their goals, and adjust their behavior accordingly. The extent to which music practice results in positive changes is, in part, a function of the precision of learners' physical and auditory goals and learners' ability to perceive discrepancies between their goals and the outcomes their movements produce. We designed three experiments to examine musicians' perceptions of their own and others' practice. In Experiment 1, immediately after recording individual practice sessions, high school, college, and professional musicians listened to their recordings while pressing a computer key to mark moments of discrepancy between what they had intended while practicing and what they heard on their recording; in Experiment 2, the high school and professional participants from Experiment 1 repeated the task 2 years later; in Experiment 3, high school and professional participants heard practice recordings of four other violinists' practice (two artist-level experts and two competent students), and pressed the key each time they perceived a discrepancy between what they heard on the recordings and what they would have intended had they been the practicer. Our results support the notion that the precision of performance goals and the acuity of perceptual discrimination are central features of musical expertise.

Neural control of learned rhythmic motor sequences - a MEG study

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Gather.town: Room 2 Code 11

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

We measured the activity in brain regions involved in motor sequence control with high temporal resolution, using magnetoencephalography (MEG) during performance of well-learned spatiotemporal finger sequences. Participants (16 non-musicians) learned four different sequences with eight buttonpresses, where the temporal (even/rhythmic sequence) and ordinal (one key/key sequence) structure varied in different conditions using a 2×2 factorial design, performed with the right index finger on three buttons aligned horizontally. During MEG, the participants performed 160 sequences after one or two days of the learning task. To identify modulations in large-scale functional networks underlying different motor sequences, we performed an all-to-all connectivity analysis of modulations in coherence between tasks. We found a large-scale network involved in ordinal aspects of the motor sequences, dominated by connections between prefrontal-sensorimotor regions and temporoparietal regions. This effect was frequency-specific, and was obtained for cortical oscillations in the alpha frequency band (7-13 Hz). No robust frequency-specific-network was found for the temporal aspect of the sequences. Our findings thus support, in part, the previous studies i.e., motor control relates to specific cortical oscillation within the motor network and the neural control of the temporal (rhythm) and ordinal (spatial) structure of explicitly learned motor sequences can be represented independently.

Surmounting limits of musicians' expertise through a novel somatosensory training

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Gather.town: Room 2 Code 12

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

One of the biggest questions in human learning is how to crystalize well-trained motor skills such as musical performance. Here, we show enhancement of somatosensory functions of expert pianists through a novel somatosensory training, which accompanies facilitation of fine motor control. Seventy-two expert pianists and 13 musically-untrained individuals participated in this study consisting of 3 experiments. In the experiment 1, we asked expert pianists to perform somatosensory training that aimed to enhance somatosensory functions of the fingertip of the right ring finger. We found that the somatosensory training

improved both the somatosensory function and fine motor control of the trained finger of the pianists. In the experiment 2, by contrast, we found no effect of the somatosensory training on both the somatosensory function and fine motor control in the non-musicians. In the experiment 3, we asked expert pianists to perform a conventional piano practice requiring precise force control in order to examine whether it enhances fine motor control. There was no enhancement of the skill. These findings indicate that enhancement of somatosensory functions through a specialized somatosensory training crystalizes a well-refined motor skill specifically for expert musicians. A lack of such a skill enhancement through a conventional piano practice further suggests that the present training can provide a unique means for surmounting the limits of well-trained motor skills.

Single, Double, and Triple Tonguing Speeds of Professional and Amateur Trombone Players

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Gather.town: Room 2 Code 13

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Trombone players show remarkable control of tonguing movements for playing the instrument, yet the quantitative assessment and comparison of tonguing speed between the amateur and professional players has not been performed. Here we investigated single, double, and triple tonguing speeds of professional and amateur trombone players. Five professional and eight amateur trombone players participated in this study. The participants were asked to perform the tonguing as quickly as possible for five seconds. Three tonguing tasks were performed: 1) single (repetition of "Tu"), 2) double (repetition of "Tu-Ku"), and 3) triple (repetition of "Tu-Ku-Tu") tasks. The median frequency was calculated for each trial and averaged over the three trials. The repeated measures of ANOVA showed that there was no significant interaction between the effects of Group and Task ($p = 0.75$, $F(2, 22) = 0.16$, $\eta 2=0.014$). The main effect of Group was significant ($p = 0.14$, $F(1, 11) = 8.55$, $\eta 2 = 0.44$), showing that the professional players (8.94 Hz) performed faster than the amateur players (9.91 Hz). The main effect of Task was also significant ($p < 0.001$, $F(2, 22) = 27.50$, $\eta 2=0.71$): Post-hoc analysis revealed that the double-tonguing was the fastest (8.40 Hz), followed by the triple-tonguing (10.48 Hz) and the single-tonguing (9.40 Hz) tasks. The results from this study is considered to be useful for setting goals in training and education for trombone players.

Play that same song! MRI evidence for the influence of motor-familiarity on joint piano performance

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Joint musical performance requires constant integration of sensory and motor information to rapidly predict and adapt to other's actions. When practicing a (solo) piece, musicians develop internal models that link their own performance to its expected auditory outcome. These models also aid predicting sensory feedback of familiar actions performed by others (e.g. playing a familiar piece). The present study examined how familiarity with a partner's action influences the neural processes underlying joint music performance. We recorded brain responses of 40 pianists in the MR-scanner, while they were duetting with a partner sitting outside. Pianists were motorically familiar (or not) with their partner's part, such that they could rely (or not) on internal models. We also used a tempo manipulation to induce differing degrees of synchrony between partners' keystrokes in order to disrupt the match between the sensory feedback from the partner and the model-based prediction. We found that pianists adapted less to their partners in less synchronous trials, especially in familiar pieces. This effect correlated with activity in sensorimotor regions of the cerebellum that was strongest when pianists were familiar with their partner's part and received conflicting sensory feedback. These results highlight the cerebellum's crucial role for sensorimotor integration during joint action, where predictions based on internal models are compared to the actual auditory feedback of the action.

Relation between impaired executive functions and rhythmic abilities in children with ADHD

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Attention Deficit Hyperactivity Disorder (ADHD) is commonly associated with timing disorders, affecting both the perception and production of durations and rhythmic auditory stimuli. For example, children with ADHD are less accurate than neurotypical children at determining whether two sounds have the same duration, reproducing single durations, detecting deviation from the beat, and moving to the beat of a rhythmic sound, such as music. In addition, poorer beat

perception and synchronization in ADHD is associated with lower scores in neuropsychological tests assessing executive functions, such as flexibility and inhibition. In this study, we further tested this relation between rhythmic abilities and executive functions. Children with ADHD (n = 41) and a control group of neurotypical children (n = 14) were submitted to the Adaptive tapping test (ATT) from the Battery for the Assessment of Auditory Sensorimotor and Timing Abilities (BAASTA) and flexibility/inhibition tests (TEA-CH). In the ATT, participants were asked to adapt their tapping rate to a tempo change (acceleration or deceleration), and report if they detected such a change. The results show that the adaptive scores obtained from the ATT can predict the performance in flexibility and inhibition tests in ADHD children. The findings suggest that deficits in rhythmic tasks may provide an additional indication of cognitive impairment in ADHD in conjunction with neuropsychological assessment of executive functions.

Beat Perception in the "Swarm": a look at tapping synchronization strategies using coupled metronomes

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

In order to play in a musical ensemble, performers must synchronize to a governing tempo that is negotiated among different members in the group. Oftentimes this involves using differences in sound-onset timings from individual players in the absence of a conductor's cue. In doing so, performers must construct an internalized sense of when the beat occurs, adapting to the beat dynamically as the performance is carried out. We examined this process by simulating individual sound onset timings with an ensemble of 40 coupled 'metronomes' within a tempo range of 72-120 bpm. Listeners were asked to tap along to the metronome stimuli, each with an approximately 22 beat duration. We manipulated the coupling strength at four levels (no-coupling, weak, medium, and strong) where stronger coupling forces the metronomes into tighter synchrony. We evaluated participants' responses by dividing their taps into six sequential beat sections of the trial duration and applying two different analysis techniques. We looked at the inter tap intervals (ITI) and phase coherence to observe both tap consistency and tap-to-stimuli phase relationships over each coupling condition. Using the results of their tap responses and depending on the coupling stimuli, we clustered the subjects into three tapping strategy categories. As expected, stronger coupling was associated with more stable ITIs for each group. Similarly, all of the coupling conditions resulted in more stable ITIs over consecutive beat sections. Interestingly, participants still managed to tap regularly even for the no-coupling stimuli. We suggest that internal beat formation in this context relies primarily on the stimuli's sound onset densities and that their individual sensorimotor synchronization tapping strategy for weakly coupled sounds depends on the individual participant.

Effects of Retro Sequential Practice (RSP) on Piano Skill Acquisition

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

After promising research on Retro Sequential Practice (RSP) in comparison to Anterograde Practice (AP) in trigram learning the actual study seeked to proof the results for musical tasks under lab conditions. The participants (20 amateur piano players and 4 experts, m=13/f=11) practiced short melodic patterns on a Midi-piano under both AP and RSP conditions and were tested in a balanced order on AP and RSP with an intermission of 7±2 days. During the acquisition phase chunks of the melodic patterns were presented via monitor and repeated 5 times (f=60 bpm, Δt=5s), preceded and followed up by overall 5 tests trials of the entire pattern for either AP or RSP condition (t0=pre-aquisition, t1= immediate after aquisition, t2=30', t3=7±2d, t4= t3+30'). The scoring considered number of correct takes, mean absolute asynchrony between ideal and actual time of keypresses, and standard deviation of keypress velocity and was statistically evaluated using mixed-effects ANOVAs with the factors practice (AP,RSP), test (t0,t1,t2,t3,t4), half (1st, 2nd half of the piece). The results showed no significant difference between AP and RSP. Under both conditions the number of correct takes increased over trials ($F(4,92) = 9.03$, $p < .001$) and the absolute asynchrony remained stable ($F(1,23) = 1.30$, $p > .266$). The velocity was more even in the second half of the patterns for both conditions ($F(4,56) = 30.43$, $p < .001$). Overall, both practice methods seem to bear equally good practice effects.

Can pitch orient visual attention in space in musicians and non-musicians?

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

The association between pitch and the vertical dimension is commonly described whereas the association between pitch and the horizontal dimension was only found with musicians (Lidji et al., 2006, Spence, 2011). A study of Chiou & Rich (2012) demonstrated that pitch can also orient visual attention vertically but not horizontally in non-musicians. However, this was not studied with musicians. At this time, 15 non-musicians without musical education and 9 musicians (average musical education: 13 years, 17.3 hours of practice a week) were included. An attentional cueing paradigm was used. The cue was either a low pitch or a high one. Contrary to Chiou & Rich (2012), the horizontal and vertical dimensions were evaluated in the same paradigm as the visual target can appear in four locations (left-low, left-high, right-low, right-high). Concerning the vertical dimension, pitch tended to orient

vertically the attention of non-musicians but not of musicians. Concerning the horizontal axis, in musicians, low pitch significantly oriented attention to the left and high pitch to the right side of space whereas the reverse effect seemed to appear in non-musicians. These findings suggest that the association between pitch and the horizontal dimension is learnt: pitch can orient visual attention of musicians in a horizontal way and this horizontal association seems to supersede the vertical association in them.

One Tap at a Time: Correlating Sensorimotor Synchronization with Brain Signatures of Temporal Processing

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

The ability to integrate our perceptions across the various sensory modalities and across time, to execute and coordinate movements, and to adapt to a changing environment rests on temporal processing. Timing is essential for basic daily tasks, such as walking, social interaction, speech and language comprehension, and attention. Impaired temporal processing may contribute to a number of disorders, from ADHD and schizophrenia to Parkinson's disease and dementia. The foundational importance of timing ability, though investigated, has yet to be fully understood; and popular tasks used to investigate behavioral timing ability, such as sensorimotor synchronization (SMS), engage a variety of processes in addition to the neural processing of time. The present study utilizes SMS via group and individual rhythmic tapping in conjunction with a separate passive listening task that manipulates temporal expectancy while recording electroencephalographic data. Participants display a larger N1-P2 evoked potential complex to unexpected beats relative to temporally predictable beats, a differential we call the timing response index (TRI). The TRI correlates with performance on the SMS task: better synchronizers show a larger brain response to unexpected beats. The TRI, derived from the perceptually driven N1-P2 complex, disentangles the perceptual and motor components inherent in SMS and thus may serve as a neural marker of more general temporal processing.

Individual Differences and Cardiac Dynamics of Performing Musicians

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Musicians display consistent individual differences in their spontaneous performance rates (tempo) for simple melodies, but factors responsible for these individual differences are unknown. This study aimed to identify physiological influences on music performance rates. Participants completed four testing sessions in a single day (09h, 13h, 17h, 21h). At each session, cardiac activity was recorded during an initial five minutes of rest and during melody performance. Pianists performed a familiar melody and an unfamiliar melody from memory at a steady, comfortable rate determined by each participant. Results showed slower tempi for familiar and unfamiliar melodies at earlier testing times. Individual differences in tempo were consistent across testing sessions for both melodies: participants with a faster tempo at 09h maintained a faster tempo at each later testing session. These individual differences were not explained by sleep pattern, chronotype, or cardiac activity during music performance. Linear (heart rate) and non-linear (recurrence quantification analysis) analyses indicated that heart rate increased and cardiac dynamics were more predictable during music performance than during rest at 09h and 13h. Furthermore, cardiac dynamics in some testing sessions were more predictable during performances of unfamiliar than of familiar melodies. These results suggest possible endogenous factors and learning effects on tempo and cardiac dynamics during music performance.

Shuffle and stumble: when binary rhythms are more entraining to the motor system than shuffle rhythms

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Gather.town: Room 3 Code 1

Subtheme C - Neural Correlates of Music Perception and Performance

Auditory rhythms induce motor entrainment. This may be enhanced in shuffle rhythms, which subdivide beats into long-short intervals and provide a sensation of swinging (Merker, 2014), and at faster tempo (Janata et al., 2012). Here, 20 non-musician young adults (13 ♀) rated how much they wanted to move to 12 realistic drum rhythms, presented as 'Binary' (1:1 beat subdivision) or 'Shuffle' (1:2 subdivision), and at Fast or Slow tempo (85 bpm vs 115 bpm). Then they synchronized finger tapping to the beat of the rhythms, while 64-electrode EEG was recorded. ANOVAs ([Binary; Shuffle] x [Slow; Fast]) indicated higher ratings for Binary vs Shuffle ($p<.01$), and Fast vs Slow ($p<.001$) rhythms, while synchronization (measured by the asynchrony between the beat and the tap) was more stable when tapping to Binary versus Shuffle rhythms ($p<.001$). This suggest higher complexity of the Shuffle rhythms. For EEG, alpha frequency showed an interaction effect within the left SMA, with lower alpha power, suggesting stronger activation, during Binary vs Shuffle rhythms at Slow tempo. We observed the reverse pattern at Fast tempo. These results suggest a differential implication of the left SMA as a matter of complexity. Lowest SMA activation was observed in the conditions with best (Binary-Fast) and weakest (Shuffle-Slow) behavioural preference and performance. Thus, the pattern of activation might reflect entrainment in the Binary-Fast condition and effort in the Shuffle-Slow condition.

Musical abilities in children with developmental cerebellar anomalies

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Subtheme C - Neural Correlates of Music Perception and Performance

The present study investigated both music perception and production in developmental disorders of the cerebellum. Developmental Cerebellar Anomalies (DCA) are rare diseases (e.g. Joubert syndrome) that affect the motor and non-motor functions of the cerebellum during childhood. Sixteen children with DCA and thirty-seven healthy matched control children were tested with the Montreal Battery for Evaluation of Musical Abilities (MBEMA) to assess musical perception and with two ludic singing reproduction tasks (Clement et al., 2015) to assess musical production. Analyses showed that children with DCA were impaired in the MBEMA rhythm perception subtest whereas there was no difference between the two groups for the melodic perception subtest. Moreover, production was also affected in children with DCA. Indeed, in the melodic reproduction task, 10 healthy adults were asked to rate the quality of the sung production of the children. Children with DCA received significantly lower mean ratings than the controls, and correlations were found between perception and singing production scores. We concluded that children with DCA are impaired in both musical perception and production, suggesting that the cerebellum plays a role in the development of musical skills. Moreover, in perceptual tasks, rhythm was particularly affected, confirming the known role of the cerebellum in timing. This finding is discussed in light of current studies on the role of the cerebellum in auditory-motor loops.

The Sound of Silence: An EEG study of how musicians coordinate expressive silences in individual and joint music performance

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Subtheme C - Neural Correlates of Music Perception and Performance

Pauses are an integral feature of social interaction. For example, conversation partners often pause between conversational turns, and musical co-performers often pause between musical phrases. How do humans coordinate the duration of pauses to ensure seamless interaction? The current study investigated this question in the context of music performance. 40 trained pianists (20 pairs) performed a simple melody featuring fermatas (i.e. notated expressive pauses of unspecified duration) first alone (Solo) and then with a partner (Duet) while electroencephalography (EEG) was recorded. Behavioural findings confirmed that pauses represent a challenge for interpersonal coordination, as Duet partners' tone onset synchronization was reduced for tones following pauses. Duet partners facilitated synchronization of tone onsets following pauses by reducing pause durations. Pauses were shorter in Duet relative to Solo performance, and synchronization of partners' Duet tone onsets was enhanced for tones following shorter relative to longer pauses. EEG analysis revealed stereotypical signatures of action preparation during musical pauses, namely decreases in the power of cortical beta oscillations (13-30 Hz) during musical pauses (event-related desynchronization, ERD). Beta ERD did not differ between pauses in Solo and Duet performance, but was enhanced for shorter relative to longer pauses, suggesting that reduced pause durations in Duet performance facilitated a neural state of enhanced action readiness. Taken together, our findings provide insight into how humans navigate pauses in natural social interactions such as music performance, and demonstrate both behavioural and neural signatures of action preparation during time-varying pauses.

Musicians' superior auditory and visual rhythm discrimination is not related to cross-modal neuroplasticity in auditory cortex

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Subtheme C - Neural Correlates of Music Perception and Performance

Cross-modal brain reorganization is possible not only following sensory deprivation (e.g. deafness) but also after intensive training (e.g. pianists), and can lead to superior sensory processing. Congenitally deaf recruit their auditory cortex for visual rhythm processing (Bola et al., PNAS, 2017). We examined whether similar cross-modal plasticity could be observed in expert musicians. 17 professional pianists and 20 non-musicians participated in an fMRI study during which they discriminated between sequences (rhythms) presented in visual (flashes) or auditory (beeps) modalities. In the control condition, the same flashes/beeps were presented at a constant pace. In an additional condition, participants were asked to imagine rhythms. Musicians performed both visual and auditory rhythmical tasks better than non-musicians. fMRI revealed that compared to the control condition, the visual task recruited the right-hemisphere auditory cortex in musicians. However, a weaker but similar activation was also observed in non-musicians for the same contrast. Comparison of the two groups revealed no significant between-group effects in the auditory cortex, only an increased activation in the right Angular Gyrus for musicians vs. non-musicians. We conclude that the musicians' superior rhythm discrimination is not related to cross-modal neuroplasticity in the auditory cortex, but most likely is related to the plasticity of higher cognitive functions.

Musical performance monitoring during scored and improvised actions in a turn-taking piano duet: A dual-EEG study

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Subtheme C - Neural Correlates of Music Perception and Performance

Previous studies have investigated the perception-action coupling in joint musical tasks using prescribed scores with altered auditory feedback. However, such coupling may function differently when performers improvise. This study used two-person EEG to examine how pianists responded to altered pitch feedback in both parts while alternating melodic phrases based on a pre-composed score or improvisation. Results showed that feedback-related negativity (FRN) and P3a were greater on scored than improvised conditions, reflecting that playing the score repetitively enhances action encoding. P3b, indexing later task-oriented processing, did not differ between scored and improvised conditions. Unsurprisingly, FRN and P3 complex were nearly undetectable in response to partners' improvisation, which could not be known beforehand. Interestingly, behavioral analysis showed positive correlation between the contours of improvised melodies of both players in a given trial, suggesting some degree of predictability in partner's improvised melodies. However, FRN in trials with both stronger correlation and weaker correlation was similar likely because of insufficient signals. Overall, the results suggest that representation of earlier processes of performance monitoring might be differently organized for improvisation compared to those based on prescribed scores, whereas later processes might involve between-partner coordination and integration of auditory-tactile feedback.

Exploring the reward prediction error and its relevance to music

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Gather.town: Room 3 Code 6

Subtheme C - Neural Correlates of Music Perception and Performance

The reward prediction error is a relatively young psychological concept. It was discovered in 1993 by a group of neuroscientists and later refined by Fiorillo, Tobler, & Schultz (2003). It was shown that the response of dopaminergic neurons is maximized when a presented reward (food) was least expected. The same thing happens with unexpected gifts for Christmas, unexpected lottery-wins or those of (inferior) sports teams etc. This poster will transfer and extend the concept of the reward prediction error to music and its aesthetic appreciation. So far, unexpected progressions or developments have mostly been conceptualized as violations of expectations, e.g. Koelsch and Siebel (2005). However, these sometimes miss the vast importance of higher-tier, more structurally important, and thus potentially positive musical violations. These kinds of violations may extend from the micro level of milliseconds to the meso level of formal processes up the macro level of historical stylistic change in music. In the first place, this is a theoretical approach and integrates a broad spectrum of sources from neuroscience, cognitive processes in music (Koelsch, Rohrmeier, Torrecuso, & Jentschke, 2013), research on expectation (Margulis, 2007) up to aesthetics and emotions (Meyer, 1956). To provide at least some empirical verification for formal processes in music, continuous response measurement (Geringer, Madsen, & Gregory, 2004) was applied to music with unexpected courses of development.

Predicting the Groove: A Combined EEG-Pupillometry Study

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Gather.town: Room 3 Code 7

Subtheme C - Neural Correlates of Music Perception and Performance

Groove, a pleasurable compulsion to move to musical rhythms, has been shown to follow an inverted U-curve with increasing levels of metric uncertainty. Predictive coding (PC) posits that moderate metric uncertainty drives us to move in an attempt to reduce sensory prediction errors and accurately model the meter (Koelsch, Vuust, & Friston, 2018). We aim to test this by combining two methods linked to cognitive effort and meter perception: pupillometry (Bowling, Ancochea, Hove, & Fitch, 2019) and EEG frequency tagging (Nozaradan, Peretz, Missal, & Mouraux, 2011), respectively. If PC underlies groove, then two specific patterns of results should arise.
In the EEG, the steady-state evoked potentials (SSEPs) at beat frequencies should decrease with increasing metric uncertainty since they represent the precision of sensory predictions (Nozaradan, Peretz, & Keller, 2016). The pupillometry data, however, should reveal the greatest pupil dilations at moderate metric uncertainty where groove is highest and more attention is needed to suppress off-beat notes; our pilot data indeed suggests that the pupil indexes subjects' ratings, in line with recent research (Bianco, Gold, Johnson, & Penhune, 2019). These results will not only provide new insights into PC's neurophysiological feasibility in groove, but they will also extend previous findings by investigating pupillometric arousal and neural entrainment at high metric uncertainty for a fuller understanding of why music moves us.

The Musicians Aging Brain

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Subtheme C - Neural Correlates of Music Perception and Performance

Brains of professional musicians show specific structural and functional features as reported in multiple neuroimaging studies. However, little is known about the preservation of these features in the brains of elderly musicians (age 70+). Here, we investigated the functional and structural neural correlates of old professional musicians (OM) in comparison to old non- and young- musicians (NM, YM) by performing structural and functional MRI. Functional analyses revealed extented activation networks including premotor and broca areas similarly in both musician groups (OM, YM), during attentive listening to instrumental sounds. Furthermore, YM showed increased activation of prefrontal-parietal and superior temporal areas as compared to OM. Structural analyses revealed larger and more complex morphology of auditory cortex in both musician groups (OM, YM) independent of age. Furthermore, YM showed bilateral increased cortical thickness (THK), volume (VOL) and surface area (SA) on a widespread network involving precuneus, orbitofrontal, superior-frontal and -temporal regions. Age slope differences were found between the musicians (OM, YM) in VOL and SA of the right precuneus and between the elderly (OM, ONM) in THK of the bilateral postcentral regions. An age slope difference between OM and YM could only be found in SA in the parstriangular region. Our results show that elderly professional musicians maintain most functional and structural features in the relevant brain areas.

Listening in the mix: Lead vocals robustly attract auditory attention in popular music

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Subtheme C - Neural Correlates of Music Perception and Performance

Listeners can attend to and track instruments or singing voices in complex musical mixtures, even though the acoustical energy of sounds from individual instruments overlap in time and frequency. In popular music, lead vocals are often accompanied by sound mixtures from a variety of instruments such as drums, bass, keyboards and guitars. However, little is known about how the perceptual organization of such auditory scenes is affected by attention and which acoustic features play the most important role. To investigate these questions, we conducted three online experiments in which participants detected single instruments or voices in musical mixtures with multiple instruments. We used 2-second excerpts from a multi-track database (http://musiclarity.com) consisting of reproductions of popular music. For each excerpt an isolated target instrument and a mixture of multiple instruments were extracted. The order of presentation of the target and the mixture was varied between subjects. In the first experiment the excerpts were presented unmodified, in the second experiment we equalized the sound level ratios between the target instrument and the mixture, and in the third experiment we filtered the target and mixture in a one-octave band to preclude spectral masking. Detection accuracy was generally better in the target-mixture condition compared to the mixture-target condition. Only for the lead vocals detection accuracy was unaffected by the order of presentation, the sound level ratios, or the usage of filtering. These results underpin that lead vocals serve as robust attractor points of auditory attention regardless of the manipulation of low-level acoustical cues.

Score-dependency: Relying on music notation over a lifetime may inhibit pitch perception

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Gather.town: Room 3 Code 11

Subtheme C - Neural Correlates of Music Perception and Performance

BACKGROUND Most music is performed or improvised by ear, but Western classical musicians primarily perform music from notated scores. Markedly different neurological activations have been found in 'score-dependent' (SD) and improvising musicians—especially in the bilateral auditory cortex, where SD musicians exhibited no greater activations than musically untrained controls (Harris & de Jong, 2015). METHOD Exploring the implications for aural perception, 20 score-reading classical musicians were asked to reproduce heard melodies under five conditions of visual support, where pitch and rhythm content was controlled for. Weighted task performance was used to determined participants' relative level of SD. RESULTS SD musicians showed a significant effect of struggling to reproduce pitch but not rhythm content by ear, but non-SD musicians showed no such difference. As pitch and rhythm is likely processed separately (e.g. Peretz & Kolinsky, 1993), SD may selectively affect aural pitch perception mechanisms, explaining the mentioned lack of auditory cortex activations. Participants' age correlated with their SD levels, suggesting that long-term reliance on notation may increase this effect. IMPLICATIONS Results have implications for music perception, education, performance, and neuroimaging research. As music and language may share networks for perception and literacy (Stenberg & Cross, 2019), results may also support wider research on literacy's effect on perception mechanisms.

Interleaved vs Blocked Practice Schedules: Does Practice Format Impact Music-Training Related Transfer to Auditory and Cognitive Abilities?

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Gather.town: Room 3 Code 12

Subtheme C - Neural Correlates of Music Perception and Performance

Short-term musical training, over the course of a few weeks or months, has been shown to enhance both auditory and cognitive abilities. These findings suggest that music training may be useful as a form of cognitive or auditory rehabilitation. It is critical that music training is optimized so that it is effective in the shortest time possible for better rehabilitation outcomes. Accordingly, the goal of this research was to compare two formats of music training on their capacity for music-training related transfer to auditory and cognitive abilities. A series of short, novel melodies were composed for this study. The blocked group practiced each melody multiple times before moving on to the next one within two weeks. The Interleaved group practiced the same melodies for the exact same time, but the practicing order was randomized within each practice session. In expert musicians, this type of practice has been shown to reduce performance in the short term and to improve performance in the long term. It remains unknown if these different practice formats differentially impact auditory and cognitive abilities. Both behavioural data and ERP data suggest that auditory and cognitive abilities were improved in both groups. Consistent with the contextual interference effect, we found the Interleaved group, compared to the Blocked group, exhibited lower performance during the practice sessions and more significant improvement in their performance during post-training sessions.

The neural mechanisms underlying vocal improvisation in trained and untrained singers

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Subtheme C - Neural Correlates of Music Perception and Performance

A recent controversy emerged from neuroimaging studies on jazz music about whether DLPFC is activated or deactivated during improvisation, suggesting that skilled musicians may use less cognitive control when improvising. The present fMRI study compared neural activation maps during singing the song "Summertime" by George Gershwin in score-based and freely improvised styles. Twenty classical singers, 20 jazz singers, and 20 non-singers were included. Preliminary results showed activation of main constituents of the "singing network". A main effect of singing style revealed increased activation across groups in SMA, bilateral cerebellum, basal ganglia, left BA45, left temporal pole, left anterior insula, and right ventral M1 during improvisation. An interaction effect between singing style and singing expertise showed experience-dependent hemodynamic response patterns in inferior parietal, frontal (DLPFC), as well as temporal areas between trained singers (decreased) and non-singers (increased). The opposite patterns were found in right anterior insula and the medial superior frontal gyrus. These preliminary data partly confirm the DLPFC hypothesis for trained musicians. Furthermore, creative behaviors like musical improvisation seem to engage both experience-dependent sensorimotor mechanisms as well as neural correlates that engage independently from interacting with musical improvisation across the life span.

Spectral signatures of the pupillary response as an implicit measure of musical absorption

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Subtheme C - Neural Correlates of Music Perception and Performance

The pupil of the eye can become entrained to rhythmic auditory patterns (Fink, Hurley, Geng, & Janata, 2018). However, whether this entrainment has a relationship to listeners' subjective experience of music remains to be determined. Because of the well-established relationship between pupillary activity and the attentional (norepinephrine) system, we hypothesized that feeling 'absorbed' in music – a state of focused, pleasurable attention – should be reflected in the pupillary signal. However, a previous study (Lange, Zweck, & Sinn, 2017) showed no relationship between mean pupil size and ratings of absorption when participants (N = 32) listened to ~60 sec clips of instrumental music from a variety of genres (rock, hip hop, classical, etc.). In this study, we re-analyze their pupil data to examine the continuous pupillary signal, rather than mean. Using a Gaussian classifier and 50 fold cross-validation, we find that pupillary activity in the 1-4 Hz frequency band can predict with up to 69% accuracy (M = 53%) whether participants report feeling absorbed (rating > 3 on a 5 point scale) in the music or not. Given these interesting, exploratory findings, we then ran a replication study (N = 28) and similarly found a prediction accuracy of up to 76% (M = 56%). In summary, we show that oscillatory pupil activity can be used as an implicit predictor of listeners' feelings of absorption in music.

Collaborative improvisation in piano duet: Melodic similarity and alpha oscillations

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Subtheme C - Neural Correlates of Music Perception and Performance

Creative ideation and quality of improvisation are related to increased alpha oscillations, while stronger interpersonal cooperation attenuates them . In ensemble improvisation, the quality also depends on the cohesion between all members. We investigated how two pianists exchange musical ideas and how their cohesion was related to frontoparietal alpha oscillations. Pianists were paid, and traded six-note, isochronous melodies either based on a score or by improvising. They each played two melodic phrases (playing order was counterbalanced). Melodies from improvisations were examined using the normalized edit distance between intervallic content, which was used to extract EEG to compare high-correlation vs. low-correlation trials. Within-person correlation (individual's own two improvised phrases) exceeded between-person correlation (consequent improvised phrases by different partners) throughout. Alpha power when listening to the partner's phrase was increased when the between-person correlation was high, consistent with less attention paid to similar melodic duet parts. Furthermore, alpha power while playing improvisation was increased for the first phrase of the trial when the within-person correlation was high, consistent with enhanced alpha for creative thinking. The results indicate that melodic similarity plays a role in improvisational quality and affects inter-partner attention.

Musician's motor and auditory brain centers implicated in Baroque and Contemporary academic music performance: an approach through functional connectivity neuroimaging techniques

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Subtheme C - Neural Correlates of Music Perception and Performance

The Contemporary academic music (C) breaks with established structures from previous styles such as tonality and incorporates new structures, concepts and ideas about sound, timbre or effects. Thus, new interpretation styles incorporates new technical and stylistic concepts denominated extended technique not developed in the musician's early learning period, a circumstance that could influence musicians C performance. This work is aimed in investigating this issue. For it, the motor and auditory encephalic centers involved during cello performance of two different musical styles, Baroque (B) and Contemporary (C) were investigated. Magnetic functional resonance images (fMRI) were acquired while 13 professional cellists with an active career performed B and C excerpts of 26 s with an adapted cello inside MR scanner and later analyzed with seed-based functional connectivity methods. The results shown: during B performance (style trained throughout cellist's musical life) motor seeds that correspond with regions controlling learned movements (cerebellar lobes and striatum caudate) and auditory cortex seeds (Heschl's gyrus, temporal and polar planum) with auditory-motor connectivity between precentral and Heschl's gyrus; however, during C performance (style mainly trained in a later learning and during the cellist's professional career) no motor-auditory connectivity but two main motor seeds (precentral gyrus and vermis) were found with connectivity targets in motor control regions of complex movements. Conclusion: the lesser training history of musicians in the C style affects their motor and auditory regions connectivity and can influence the musician performance in this style

Neural and Behavioural Correlates of Musical Perception and Performance in Children with Attention-Deficit Disorder (ADD), Attention-Deficit Disorder with Hyperactivity (ADHD) and Dyslexia

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Subtheme C - Neural Correlates of Music Perception and Performance

Children with developmental disorders exhibit a clear latency difference between right and left hemispheric primary auditory evoked potentials resulting in auditory deficits in sound processing. In this research we wanted to study P1 and N1 source waveforms in response to harmonic complex sounds, and to observe whether we can detect different relationships between musical performance measurements and atypical asymmetries in auditory cortex function which are typically associated with auditory perception deficits. Therefore, we hired a diagnose group (ADHD= 33; ADD= 34; dyslexic=24) and a control group (N=79) who all performed a newly developed music performance assessment scale with which different pitch accuracy and rhythmic performances were measured. Preliminary results revealed that the control group performed significantly better than the diagnose group in the perception, the rhythmic and melodic replication tasks. However, children with ADHD showed better results in the musical expression measurements in contrary to the controls. At neural level good melodic performances were related to lower P1 latencies in the pooled disorder group, whereas correlations between the rhythmic performances and the bilateral synchronization of the P1 and N1 responses of the controls were found. Our findings show that the role of musical performance and its positive influence on neural circuits in the brain is presently underestimated. In this respect understanding the underlying mechanism of neurophysiological processing and its relationship to musical performance would provide crucial information about interventions in the pedagogical and the therapeutic context for children with developmental disorders.

The Open Multimodal Music and Auditory Brain Archive (OMMABA)

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Subtheme C - Neural Correlates of Music Perception and Performance

OMMABA is a multimodal behavioural and neuroimaging dataset characterizing healthy human auditory processing. OMMABA is unique because it will allow researchers to address individual differences in auditory cognitive skills across brain functions and structures, and it will serve as a baseline for comparison with clinical populations. Our core objectives are to create a standardized framework with which to administer a battery of curated tasks. We are currently acquiring data from 70 young adults and we intend to share our framework, analysis pipelines, stimuli with linked descriptors, and metadata with the community through open data repositories. The dataset contains cognitive and psychophysical tasks, as well as questionnaires designed to assess musical abilities, speech, and general auditory perception. It also includes EEG and fMRI recorded during resting state, as well as naturalistic listening to musical stimuli and speech. The EEG session includes MMN data acquired using melodic multi-feature and FFR paradigms. The MRI session includes T1, DTI, and quantitative maps. The key question we want to address is individual variability in auditory processing. We think that OMMABA will allow us to formulate and test new hypotheses about the origin of these differences across individuals in underlying neural circuits and experience-related plasticity. So far, we have analyzed and optimized parameters for every task and replicated previous results seen in the literature.

Neural Representations of Rhythm and Beat Perception

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Subtheme C - Neural Correlates of Music Perception and Performance

Humans spontaneously perceive an underlying pulse, or "beat," arising from the rhythmic structure in music. Functional magnetic resonance imaging (fMRI) studies show that motor regions of the brain, such as the basal ganglia and supplementary motor area, have increased activity when people listen to rhythms with a strong beat (Grahn & Brett, 2007). However, previous fMRI studies have generally used univariate analyses, which investigate activity averaged over voxels in a region, whereas multivariate techniques identify patterns of covariance across voxels that allow greater sensitivity and better identification of neural features that predict brain–behavior relationships. Thus, here we use multivariate pattern analysis to compare neural activity patterns elicited by rhythms with strong, weak, or no beat. The results enable us to determine which neural regions are sensitive to beat strength, as they will have high dissimilarity between activity patterns elicited by individual strong-beat rhythms, and low dissimilarity between patterns elicited by individual weak- and non-beat rhythms. Data collection is ongoing, but preliminary results reveal that multivariate patterns do indeed appear sensitive to individual rhythm types, building on previous univariate work.

Effects of musical training on the development of music perception abilities investigated with the music multifeature ERP paradigm

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Subtheme C - Neural Correlates of Music Perception and Performance

The present study explores the effect of a primary school education program (Active Music Learning) on the development of music perception abilities of young children. In assessing the impact of music education programs, a crucial question is whether the training will improve the participants' musical abilities. Here, we aimed to study the neural background of these abilities by applying the music multifeature ERP paradigm developed by Putkinen et al. (2014), in which participants hear short melody pieces consisting of a major chord followed by five musical notes. Occasionally, so-called deviant melody sequences can be heard, which contain six different changes: melody, rhythm, tone, timbre, tuning, timing. In the study, we used the music multifeature paradigm to assess the development of participants before the training, at the beginning of the 1st school year, and after 7 months of training, together with a control group not participating in the training. According to the results, the Mismatch Negativity ERP component elicited by the deviant melody sequences were different before and after the training, but the groups did not differ significantly, indicating a non-specific maturation effect. Despite the lack of difference between the groups, the music multifeature paradigm was found to be an effective tool to follow changes in music perception in children.

The neural basis of consonance preferences in chronic stroke patients: A resting-state fMRI study

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Subtheme C - Neural Correlates of Music Perception and Performance

Perceptual difference between consonance and dissonance is fundamental to Western music, and its biological basis and cultural variation have attracted scholars since ancient times (McDermott et al., 2016). However, little is known about the perceptual difference between consonance and dissonance in stroke patients. In this study, we aimed to investigate the neurological basis of consonance preferences in chronic stroke patients. Eight chronic stroke patients with left hemiparesis (four females, 62.0 ± 6.0 years of age) participated in this study. The participants were asked to rate the pleasantness of ten major (consonant) and ten augmented (dissonant) triads. The difference between the ratings of major and augmented triads was calculated as a measure of consonance preferences (McDermott et al., 2010). Resting-state functional magnetic resonance imaging (fMRI) was performed to determine the resting-state brain functional connectivity (rsFC) correlated with the consonance preferences. We found that the consonance preferences was positively correlated with the rsFC between the left nucleus accumbens (NAcc) and the right superior parietal lobe (SPL), and negatively correlated with the rsFC between the anterior cingulate gyrus (AC) and posterior superior temporal gyrus (STG) ($p < 0.05$, FWE corrected). Our results suggest that increases of NAcc-SPL connectivity and decreases of AC-STG connectivity maybe the neural bases of consonance preferences in chronic stroke patients.

The effect of singing lessons on frequency following responses in children with central auditory processing disorders: Pilot Study

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Subtheme C - Neural Correlates of Music Perception and Performance

Preliminary research suggests that there is the potential for functional improvements in auditory processing through music training. We decided to focus on voice lessons rather than instrumental music lessons to remove motor skills challenges and allow the focus to be on auditory skill development. Our study investigated the effects of formal singing lessons on subcortical auditory responses in children with central auditory processing disorders (CAPD). Eleven school aged children (7-11 years old) participated in the study. Auditory brainstem responses (ABRs) were recorded using click and speech stimuli (/da/) before and after 6 to 8 months of singing lessons. The lessons included curriculum specifically designed to address deficits in pitch and timing perception. Frequency following responses (FFR) and temporal analysis were studied. Results revealed delayed latencies in CAPD children before and after singing lessons compared to the normative published data. However, no significant latency differences were observed after the six to eight months of singing lessons. Significantly larger amplitudes were observed for F0, Wave A and the VA slope after musical training. The data suggest that efficacy of singing lessons can be demonstrated by FFR in some children with CAPD. Amplitude responses could be more sensitive than latencies to demonstrate the positive effect of singing lessons. However, this duration would be insufficient to reveal an improvement for the neural timing.

Hemodynamic response during live and virtual piano duo performance: an fNIRS study

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Subtheme C - Neural Correlates of Music Perception and Performance

Temporal coordination during musical joint actions requires complex cognitive and motor processes that enable us to represent shared action goals and to anticipate and adapt to other's actions in real-time. Recent research has indicated that social processes involved in understanding other's mental states and predicting their intentions are also crucial. Imaging studies suggest that brain areas associated with the mentalizing network (e.g. temporoparietal regions) are particularly involved during interpersonal coordination. Here, we examined the role of the mentalizing network during live vs. virtual piano duo performance. Pianists (n=12; 6 males; age: 32±11 years; years of training: 9±7 years) performed the right-hand part of piano pieces (adapted chorales by J.S. Bach) in synchrony with a complementary left-hand part that was either played by a co-performer (with/without auditory information) or a computer-generated recording. Hemodynamic response correlates of functional neural activity elicited during performance were recorded using fNIRS. Results showed no significant differences in oxy-Hb activation in sensorimotor or temporoparietal areas comparing the duo and solo conditions during live and virtual piano performance. It is possible that the unchallenging musical material elicited mainly internally driven processes and did not require much interaction, raising the question of whether the complexity of the interaction plays a role in the involvement of social processes

Suppression, Maintenance and Surprise: Mechanisms of predictive processing specialization for musical rhythm processing in the temporal cortices.

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Subtheme C - Neural Correlates of Music Perception and Performance

Auditory repetition suppression and omission activation are opposite neural phenomena, and manifestations of principles of predictive processing. Repetition suppression describes the temporal decrease in neural activity when a stimulus is constant or repeated in an expected temporal fashion, omission activity is the transient increase in neural activity when a stimulus is temporarily and unexpectedly absent. 10 healthy participants underwent scanning while listening to musical rhythms with two levels of metric complexity, and with beat-omissions with different positional complexity. Participants first listened to 16-second long presentations of continuous rhythms, before listening to a longer continuous presentation with beat-omissions quasi-randomly introduced. During normal presentation of the rhythmic stimulus, activity in bilateral superior temporal gyri, went down, more so in the left hemisphere. Omission activation of bilateral middle temporal gyri were right lateralized. Persistent activity was found deeper in bilateral superior temporal gyrus/planum temporale, not overlapping with either listening, suppression or omission activation, perhaps specialized for working memory maintenance. We found no effect of metric complexity for either the normal presentation or omissions, but at an uncorrected threshold, omissions in the more salient position showed higher activation in frontal areas, perhaps reflecting the saliency of the stimuli.

Meter processing and grammatical skills in school-aged children: an EEG study

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Gather.town: Room 3 Code 25

Subtheme C - Neural Correlates of Music Perception and Performance

Neural oscillations across frequency bands synchronize with linguistic and rhythmic structures in the absence of acoustic cues and motor movements (Ding et al., 2016; Iversen et al., 2009; Jones & Boltz, 1989). The present study aims to investigate whether meter processing differences, beyond the perception of acoustic patterns of rhythms, can account for individual differences in grammatical abilities. Expressive grammar (SPELT-3) and meter processing are measured in 5-8-year-old typically developing children together with nonverbal IQ (PTONI), and language abilities (TOLDP-4). Meter processing is measured with EEG in a passive listening paradigm, in which a simple rhythm is presented repeatedly with a physical accent 1) in the whole block (physical beat condition) or 2) only for the first ten trials of the block (induced beat condition). Neural responses to the beat are measured after the tenth trial of each block. Preliminary results (N=11, 8 female, mean age = 6.57) indicate a similar event-related response to the physical beats as to the induced beats. Furthermore, when considering children's expressive grammatical abilities, preliminary results indicate a difference in the pattern of ERP responses given to the physical and induced beats in above-average expressive grammar (N=5) versus average expressive grammar participants (N=4). These results suggest that differences in meter processing skills may account for individual differences in grammatical abilities.

Periodic and aperiodic rhythm-based temporal predictions

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Gather.town: Room 3 Code 26

Subtheme C - Neural Correlates of Music Perception and Performance

We can use rhythms in the environment to predict when something will happen in the future. Temporal predictions allow us to align our perceptual resources to specific points in time, which in turn can optimize sensory processing. The neurobiological processes underlying temporal prediction are not fully understood, but one explanation is that endogenous neural oscillations entrain to the rhythmic stimulation. The phase of neural oscillations reflects the excitability state of neuronal populations, and by employing an entraining rhythmic stimulus, the optimal phase will synchronize to the predicted points in time. However, most findings are limited to temporal predictions based on periodic rhythms, and it is unknown whether neural entrainment models can account for findings showing that also predictions based on aperiodic rhythms can improve perceptual performance. The aim of the current study is to investigate whether performance on an auditory detection task is improved by predictions based on both periodic and aperiodic rhythms, and whether both kinds of predictions are related to the phase of delta oscillations. This will give evidence to whether there are shared or separate neural mechanisms underlying temporal prediction based on periodic and aperiodic rhythms.

Neural entrainment to vibrotactile beats in hearing and deaf participants

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Gather.town: Room 3 Code 27

Subtheme C - Neural Correlates of Music Perception and Performance

Research on the neurocognitive basis of beat perception has suggested that our perception of the beat is underpinned by the entrainment of endogenous neural oscillations. This research has largely involved auditory presentations of

rhythms while recording neuro-electric activity from participants. Comparatively few studies has assessed whether it may be possible to perceive a beat through non-auditory presentations of rhythm (e.g., vibrotactile, visual), and still fewer have done so incorporating neural methods. Recent research from our lab has found that levels of neural entrainment are similar for auditory and vibrotactile presentations of isochronous rhythms. However, for non-isochronous rhythms, levels of neural entrainment are stronger under auditory presentations. One interpretation of this findings concerns the nascent experience that hearing listeners have in sensorimotor coordination with vibrotactile rhythms. If this is true, we should expect a different outcome from deaf listeners who have considerably more experience in this regard. In addition, compensatory plasticity may lead to enhanced temporal processing of vibrotactile input. The current study examined differences between deaf and hearing populations in their ability to entrain to vibrotactile rhythms that varied in temporal complexity. Results show that overall rates of neural entrainment for vibrotactile rhythms are significantly higher in individuals who are deaf compared to those who are hearing. We found no effect of complexity and no interaction with hearing status.

A Comparison of Verbal Fluency Functions of Vocalists and Non-musicians

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Gather.town: Room 4 Code 1

Subtheme F - Music and Language

Research suggests that music has a positive effect on brain plasticity and cognitive functions. Moreover, it has been founded that professionally engaging with music for a long time has a positive effect on diction, word interpretation and facilitates the learning of the second language. This study aimed to investigate the verbal abilities of those who get vocal training compared to non-musicians. Twenty musicians and 20 control subjects participated in our study. Verbal fluency test, comprising of two different sections, the letter category and the supermarket category, were applied for measuring verbal memory and function. A preliminary questionnaire (Hand preference, musician background, general knowledge) was used to determine the appropriate study group and which would be effective in eliminating other factors expected to cause a significant change in cognitive functions. Only right-handed participants (age range of 18-40) and the vocal performers with practice for more than 5 years were included. Mann Whitney U test was used in the analysis of the market category and $p>0.05$ was found. The Student T-Test was used in the analyses of letter category scoring and $p>0,05$ was found. The results show that there is no significant difference in terms of verbal functions. To sum up, singing doesn't improve verbal tasks to the extent expected. The fact that verbal tasks were affected by many multifactorial factors may have led to emerging these results.

What can ultrasound-based brain stimulation reveal about the neural bases of music and language?

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Gather.town: Room 4 Code 2

Subtheme F - Music and Language

Parallels between music and language have inspired research across disciplines. A particularly difficult question to resolve has been that of the modularity of neuronal resources necessary to process information in these domains. Despite prominent existing models proposing a compromise between modularity and overlapping resources, several questions remain unanswered with regards to the exact division of labour of these hypothesised common neuronal bases. One of these questions concerns the causal implication of brain areas believed to underlie hierarchical processing in these and other domains, and the connectivity between those areas. Here we have employed a non-invasive brain stimulation paradigm employing ultrasound to attempt to causally modulate the functioning of brain areas responding to harmonic processing. Using magnetic resonance imaging, subjects were scanned before and after receiving brain stimulation, while solving a harmonic well-formedness task. Activation and connectivity patterns were compare pre- and post-stimulation, for the harmonic task as well as for a syntactic language localiser. Pilot data has confirmed our intended harmonic manipulation, and the results will be presented at this poster session.

Effects of musical training on hippocampus-dependent spatial learning in auditory and visual navigation tasks

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Gather.town: Room 4 Code 3

Subtheme E - Music and Memory

Musical training increases brain plasticity both on a morphologic and functional level in various brain regions including the hippocampus, which plays a major role in memory formation, especially in spatial learning. The Morris water maze task represents the gold standard to assess spatial learning in rodents. Computer-based VR versions have been developed for humans, and although humans learn the task much faster, emerging behavioral patterns seem highly similar. To assess whether musical training has an effect on memory and spatial learning we used two different virtual water maze tasks. One standard version relied on visual cues, while the other was based entirely on auditory cues. These tests were flanked by well-established neuropsychological assessments. We examined 30 music students

compared with a control group matching in age and sex.We found that learning curves were similar for both water maze tasks, suggesting that spatial learning is independent of the sensory system providing the spatial information. In memory tests, musicians showed better short term memory, with no difference in visual, verbal or overall scores. Further neuropsychological assessment showed musicians to have better alertness and mental flexibility. In both water maze tasks, musicians had slightly shorter pathlengths with similar latency times. This suggests that musical training might alter the ways hippocampus-dependent spatial information is acquired and used for spatial navigation.

Impact of emotion on musical memory consolidation

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Gather.town: Room 4 Code 4

Subtheme E - Music and Memory

Emotional events are better remembered than neutral ones. Known as the emotional enhancement of memory, this effect becomes particularly pronounced over time suggesting an impact of emotion on memory consolidation. However, little is known about the role of emotional components (valence and arousal) in this memory process. To further explore the consolidation mechanism, we used music, which has strong emotional power, to examine the role of emotional valence (positive/negative) and arousal (high/low) conveyed by musical excerpts on memory recognition after a short (15mn) and a long (24h) delay in 80 healthy adults. The results showed an interaction between Valence and Delay on the recognition of musical excerpts. Inspection of the data revealed that music recognition increased after a long delay as opposed to a short. However, this effect varied as a function of emotional valence. Whereas recognition of positively valence music significantly increased after 24h-delay, recognition of negatively valence music did not change over time suggesting that the positive valence and/or the experienced music reward improve memory consolidation of music. This finding sheds new light on the relationship between memory consolidation and emotional valence in music. Understanding how musical emotion can boost memory consolidation is critical from a theoretical and a rehabilitation perspective and will allow developing training paradigms for patients with memory disorders across the lifespan

Auditory-related differences in AD(H)D-subtypes and the influence of music practice

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Gather.town: Room 4 Code 5

Subtheme E - Music and Memory

Attention deficit (hyperactivity) disorder (AD(H)D) is one of the most common childhood onset neurodevelopmental disorders characterized by age-inappropriate symptoms of inattentiveness, impulsivity and hyperactivity. The exact mechanisms of AD(H)D pathophysiology are not yet completely resolved and especially the differentiation between subtypes lacks scientific attention. Here, we investigated auditory-related neuroanatomical and -functional differences in adolescents diagnosed with either ADHD or ADD and typically developing controls by combining structural and task-based functional neuroimaging. Significant differences between AD(H)D-subtypes in cortical thickness of primary auditory regions and in overall brain activation during an auditory N-back working memory task could be reported. The influence of regular music practice was investigated by further dividing each group into "musicians" and "non-musicians" according to an index of cumulative music practice. Differences between musicians and non-musicians in auditory working memory-related brain activity were most significant within the ADHD-group. These findings are in line with previous work suggesting a different, subtype-dependent manifestation of auditory-related deficits implicated in AD(H)D and a beneficial influence of music practice in that respect, which could provide a deeper understanding of its etiology and allow for wide-reaching applications in the diagnosis and therapy of AD(H)D-subtypes.

Values and moral attitudes are prone to extreme types of music: Cyber metal has stronger effects than gangsta rap - a CNV priming study

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Gather.town: Room 4 Code 6

Subtheme F - Music and Language

Young people's susceptibility to cyber metal and gangsta rap often gives rise to controversial debates in public. Here, the priming method was used to test whether violent music has the power to shift values and moral attitudes immediately. Participants (n = 14) listened to 20 s excerpts taken from five musical genres (gangsta rap, cyber metal, sacred choral music, baroque instrumental, easy listening), each followed by a directly-adjoined 'You should [plus moral or immoral verb]' as the target phrase (5 x 2 design; blockwise presentation). To simulate action, subjects had to respond with a finger tap immediately after the target's final word was presented. Based on the results of a previous study (Neuhaus, 2019), the Contingent Negative Variation (CNV) was used as an indicator. There, a new type of 'moral CNV' reacted to pure three-word constructions of either moral or immoral meaning, indicating that general guidelines for social life were processed. In the present study, EEG data were bandpass filtered (0.1–30 Hz) and analyzed at the second word onset of the target phrase. A CNV could be observed for moral and for immoral phrase types. It was more enhanced after priming with cyber metal compared with gangsta rap, even though in the latter case certain keywords (e.g. 'kill') were included. In moral phrase contexts priming with cyber metal and with sacred choral music yielded similar CNV amplitudes (which is in line with results obtained by Thompson et al., 2018, where subjects reported having experienced power, joy, and peace

when listening to metal music). Sub-analyses reveal that target phrases with abstract meaning ('You should hope') are far more prone to effects of violent music than target phrases evoking clear motor associations ('You should pray' -> 'folding hands').

Do musicians have better mnemonic and executive performances than actors? A lifespan study of cognitive performance

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Gather.town: Room 4 Code 7

Subtheme E - Music and Memory

The effects of musical practice on cognition are well established yet rarely compared with other types of artistic expertise, such as theater. Both of these activities require many hours of individual or collective training in order to reach an advanced level. These practices require the interaction between higher-order cognitive functions and several sensory modalities (auditory, verbal, visual and motor), as well as the regular learning of new multimodal information. The objective was to determine whether expertise in these practices had different effects on cognitive performance. In this study, 50 musicians, 46 actors, and 50 healthy controls, matched for sex, age (18 to 84 years old) and education were included and underwent a neuropsychological battery targeting processing speed, executive functioning, working memory, long-term memories, and non-verbal reasoning abilities. Results showed that music and theater artistic expertise were strongly associated with cognitive benefits. Musical expertise mainly improved executive functioning, working memory and non-verbal reasoning, whereas theater expertise mostly influenced verbal long-term memory. Thus, these results may indicate a positive effect of expertise over cognition, although each activity had different benefits of its own. As artistic expertise appears to influence cognition at any age, future studies should focus on its potential to preserve healthy cognition throughout aging.

Improving Working Memory in patients with epilepsy by rhythmic sounds

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Gather.town: Room 4 Code 8

Subtheme E - Music and Memory

The poster describes a planned working memory (WM) intervention study. The aim of the study is 1) to investigate whether temporal regularities, in the form of an external periodic acoustic rhythm, can improve WM performance, and 2) to investigate the neural mechanisms underlying the hypothesized WM improvement. Impaired WM can disrupt a range of cognitive processes, and have a marked impact on everyday functioning. Patients with epilepsy frequently suffer from impaired WM. They will constitute our study population along with healthy controls. We will use an adapted version of a WM task with concurrent auditory rhythmic stimuli that has been found to increase WM performance in healthy adults (Plancher et al., 2018). In each trial, 6 letters are successively presented on a screen. A following retention delay contains either a rhythmic stimulus stream, an arrhythmic stimulus stream, or no stimuli. Participants are instructed to repeat the letters in either the same ("low load task") or reversed ("high load task") order after the retention period. To investigate neural correlates of WM processes, we will record EEG during task performance. Based on studies (e.g., Albouy et al., 2017; Hanslmayr et al., 2019; Thaut & Abiru, 2010) indicating that entrainment of brain oscillations by rhythmic stimulation can improve cognitive function and behavior, we propose entrainment of neural oscillations to the rhythmic sounds as a likely mechanism underlying the hypothesized WM improvement.

The influence of musical activity on memory functioning

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Subtheme E - Music and Memory

Musical training positively impacts on cognitive functions, such as learning and memory. Moreover, music can be strongly associated with distinct episodic memories, even in persons with no musical expertise. Here, we asked how musicians and non-musicians use music to integrate distinct but related non-musical information into a coherent episodic-like representation. In a cross-sectional study, we compared 30 professional musicians and 30 non-musicians using a musical associative inference task. Participants studied overlapping associations of objects and melodies (A-B- and B-C-associations, i.e. object-melody- and melody-object pairs). Subsequently, they were tested on studied pairs (direct trials) and on inferential AC-associations (indirect trials). The experiment consisted of three cycles with alternating encoding/retrieval blocks. For accuracy, results showed that both groups efficiently used musical information (B-stimuli) to associate non-musical stimuli (A- and C-stimuli). Musicians, however, outperformed non-musicians in both trial types. Reaction times revealed that non-musicians reacted faster in indirect compared to direct trials, whereas the opposite pattern was found in musicians. Our findings show that musicians and non-musicians can efficiently use melodies to build associations with non-musical information. Different reaction time patterns suggest distinct strategies, reflecting fundamental differences in how music is used for non-musical cognitive tasks.

Mechanisms of music-related memory formation: Involuntary musical imagery strengthens memory for details of associated events

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Subtheme E - Music and Memory

Why do music-evoked autobiographical memories come to mind easily throughout the lifespan? Across three experiments, each comprising three sessions separated by at least one week, we tested the hypotheses that increased amounts of involuntary musical imagery (INMI) for pieces of music strengthen not only the memory for the pieces themselves, but also for otherwise unrelated details that we paired with each piece. On the first day, we manipulated the probability of subsequent INMI by exposing participants to repeating soundtracks consisting of four repeating multi-instrument music loops each. One week later, we paired those soundtracks as well as novel and scrambled soundtracks with unfamiliar Walt Disney cartoons. Immediately following music-movie exposure and also at delays of 1, 2, or 4 weeks, participants were cued with each soundtrack and asked to recall as many details from the associated movie as they could. Separately, participants performed a mental imagery task that tested the accuracy of their memory for each of the loops to which they had been exposed. Greater amounts of loop-specific INMI across experiment days resulted in more accurate memory for the loop and better retention of movie details from the specific 30-second segment of the movie with which that loop was paired. We conclude that INMI serves as a rehearsal mechanism that strengths memory for the details of both the music and episodes that have become incidentally associated with the music.

Styles of learning a musical piece in early stages of piano studies

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Subtheme E - Music and Memory

This work has been inspired by my observations at work as a piano teacher that refer to probable different ways of acquiring a musical composition. I have noticed that although I teach all my pupils comparatively the same way, some of them start memorizing the piece quite quickly and prefer to practice and perform it by memory. The others rather like relying on the score during the whole learning process. The aim of this study is to find out if these two kinds of learning styles actually exist and if so, describe their most distinguishing features. In case the hypothesized distinction gets confirmed, the realm can be studied further to find out how it can be linked to the previous findings about different learning styles and theories of information processing and learning. It would also enable to derive possible applications for making piano pedagogy more uniquely and personally designed in approach, which could lead to both improving the efficiency and results of the learning process as well as making the cooperative relationship between the pupil and the teacher subjectively more enjoyable. To study learning styles in early stages of piano studies I conducted and videotaped lessons, where pupils with as similar background as possible were given among other tasks also tasks that tested their memory and sight-reading. By analyzing the assembled information I am deriving conclusions about the existence and nature of these two particular intuitive learning styles.

Memory in time: Neural tracking of low-frequency rhythm dynamically modulates memory formation

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Subtheme E - Music and Memory

This study investigated whether temporal cues provided by low-frequency environmental rhythms influence memory formation. Specifically, we tested the hypothesis that neural tracking of musical rhythm serves as a mechanism of selective attention that dynamically biases the encoding of visual information at specific moments in time. Participants incidentally encoded a series of visual objects while passively listening to background, instrumental music with a steady beat. Objects either appeared in-synchrony or out-of-synchrony with the background beat. Participants were then given a surprise subsequent memory test (in silence). Results revealed significant neural tracking of the musical beat at encoding, evident in increased electrophysiological power and inter-trial phase coherence at the perceived beat frequency (1.25 Hz). Importantly, enhanced neural tracking of the background rhythm at encoding was associated with superior subsequent memory for in-synchrony compared to out-of-synchrony objects at test. Together, these results provide novel evidence that the brain spontaneously tracks musical rhythm during naturalistic listening situations, and that the strength of this neural tracking is associated with the effects of rhythm on higher-order cognitive processes such as episodic memory

On the relationship between language and music syntactic processing

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Gather.town: Room 4 Code 16

Subtheme F - Music and Language

My poster investigates the relationship between language and music syntactic processing. First, I introduce different levels to investigate language and music as neurocognitive systems, and elucidate problems of explanatory gap (e.g., Embick & Poeppel, 2015; Marr, 1982). Second, based on the results of two ALE meta-analyses of musical syntactic processing – tonal-harmonic and rhythmic syntactic processing – (Asano, 2019) and a co-activation-based parcellation of the left BA44 of Broca's region (Clos, Amunts, Laird, Fox, &

Eickhoff, 2013), I discuss the relationship between neural correlates of music and language syntactic processing. The results suggest that both language and music syntactic processing activate the fronto-temporal networks and the cortico-basal ganglia-thalamocortical (CBGT) circuits, but they show different hemispheric dominance and activate different portions of the same brain regions. Finally, based on previous research concerning functional gradient and asymmetry of the frontal and prefrontal cortex (Clos et al., 2013; Fuster, 2008; Hartwigsen, Neef, Camilleri, Margulies, & Eickhoff, 2019; Koechlin & Jubault, 2006) as well as parallel organizations in the CBGT circuits (Alexander, Delong, & Strick, 1986), I propose that different recruitment of the fronto-temporal networks and the CBGT circuits mirror different goal representations for top-down control in language – conceptual control – and music – motor and socio-affective control.

Right-left hemispheric synchronization of the auditory cortex: examining the relationship between P1 and N1 response differences of unfamiliar speech perception and production

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Gather.town: Room 4 Code 17

Subtheme F - Music and Language

Research revealed that perception and production of new speech can be dissociated which means that individuals who perceive foreign speech well are not always those who pronounce new words well. Previously, we illustrated that enhanced right-left hemispheric synchronization of the primary evoked response (P1) improves linguistic skills. In this research we wanted to study P1 and N1 source waveforms in response to harmonic complex sounds and to observe whether we can detect different relationships with language perception and production tasks. Therefore, two different groups of participants between 14 and 20 years of age were consulted. One group had a diagnosis in dyslexia or AD(H)D (N= 32), the most common developmental disorders in childhood and adolescence. The other group was a control group (N=45) without any developmental disorder. Results revealed that as expected the control group and those who perceived new languages more melodically performed significantly better in all language tasks. A separate analysis of the diagnose group showed that speech perception was negatively correlated with the left P1, left and right N1. This illustrates that the better the participants discriminated speech the lower their latency was. In marked contrast, speech production was negatively correlated in the control group and positively correlated in the diagnose group with the absolute P1 asynchrony │latency of the P1 (Peak) {right-left}│ which means that the better the control group reproduced foreign languages, the smaller the absolute P1 asynchrony was and vice versa for the diagnose group. Results indicate that both speech production and perception tasks need to be included when analysing auditory cortex functions.

Comorbidity and cognitive overlap between developmental dyslexia and congenital amusia in children

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Subtheme F - Music and Language

Developmental dyslexia and congenital amusia are two specific neurodevelopmental disorders that affect reading and music perception, respectively. Similarities at perceptual, cognitive, and anatomical levels raise the possibility that a common factor is at play in their emergence, albeit in different domains. However, little consideration has been given to what extent they can cooccur. A first adult study suggested a 30% amusia rate in dyslexia and a 25% dyslexia rate in amusia (Couvignou et al., Cognitive Neuropsychology 2019). We present newly acquired data from 38 dyslexic and 38 typically developing children. These were assessed with literacy and phonological tests, as well as with three musical tests: the Montreal Battery of Evaluation of Musical Abilities, a pitch and time change detection task, and a singing task. Overall, about 34% of the dyslexic children were musically impaired, a proportion that is significantly higher than both the estimated 1.5-4 % prevalence of congenital amusia in the general population and the rate of 5% observed within the control group. They were mostly affected in the pitch dimension, both in terms of perception and production. Correlations and prediction links were found between pitch processing skills and language measures after partialing out confounding factors. These findings are discussed with regard to cognitive and neural explanatory hypotheses of a comorbidity between dyslexia and amusia.

Investigating musical skills in children at risk for learning disabilities: An investigation in Brazilian public schools.

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Subtheme F - Music and Language

Several studies have identified associations between musical and linguistic abilities. A variety of musical skills have been shown to correlate with early language and reading abilities in children. However, the cognitive processes that explain such associations remain unclear. We selected a set of musical and cognitive-linguistic tasks that were used in this study to evaluate public school students. The objectives were to investigate how musical perception is associated with verbal and nonverbal cognitive domains and partially replicate and investigate the applicability of the Musical Sequence Transcription Task (MSTT), a tool with the potential of identifying children at risk of specific learning disorders (Zuk et al., 2013). We assessed a variety of musical and cognitive-linguistic skills of students

in the public-school system (n=94). In a follow-up study one year later, the performance at MSTT task was assessed longitudinally, measures for writing skills and a socio-demographic survey was also included. Comparisons between groups revealed that poor performance in phonological awareness was associated with poor performance in the MSTT. The score for errors at the MSTT task significantly predicted poor performance in writing skills assessed 12 months later, corroborating with Zuk and colleagues' findings. Future studies with children in both typical and atypical development could elucidate which cognitive mechanisms support the results shown here.

Does rhythmic priming enhance speech-in-noise perception?

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Gather.town: Room 4 Code 20

Subtheme F - Music and Language

Music and language contain temporal structures that provide cues for upcoming events and facilitate predictive processing. The observation of common rhythmic processing mechanisms in music and speech has motivated research on the potential benefit of music rhythm regularities to the processing of the less regular speech signal. For example, regular rhythmic primes enhance grammaticality detection in naturally spoken sentences compared to irregular primes or baseline conditions in children and adults. Within a dynamic attending framework, regular rhythms entrain neural oscillations that sustain after the rhythm finishes, boosting subsequent sentence processing. Enhanced speech processing is particularly valuable when the signal is degraded, such as in a noisy environment and for hearing-impaired listeners, including cochlear implant users. To simulate this situation, 31 normal-hearing adult participants were presented with naturally spoken sentences in noise (-3 dB signal-to-noise ratio), and asked to detect grammatical errors. Sentences were preceded by regular and irregular rhythmic primes. Results revealed that participants were more sensitive to grammatical errors after irregular primes compared to regular primes, suggesting that the noisy background reversed the prime's influence. This finding will be discussed in relation to tracking of the speech envelope, temporal fine structure of sentences in noise, and implications for rhythmic priming

Neuroanatomical correlates of speech and singing production in chronic post-stroke aphasia

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Subtheme F - Music and Language

A classical observation in neurology is that aphasic stroke patients with impairments in speech production can nonetheless sing fluently. This preserved ability suggests that singing could promote speech recovery. Understanding the neuroanatomy supporting singing production in chronic stroke aphasia may guide the selection of patients for treatment. However, to date, this remains unknown. Here, we combined a multivariate lesion-symptom mapping (SVR-LSM) and voxel-based morphometry (VBM) approach to analyse the relationship between lesion patterns and grey matter volume with production rate in speech and singing tasks. Lesion patterns for spontaneous speech and repetition of formulaic phrases extended into a wide frontotemporoparietal network overlapping with the speech production network. Spontaneous singing of a familiar song was preferentially associated with damage to anterior-posterior STG and MTG. The results from the VBM analysis provided converging evidence whereby preservation of GMV in the same regions as identified with SVR-LSM supported better speech and singing production. When dividing the patients in fluent and dysfluent singers based on singing performance from demographically-matched controls, we found that preservation of MTG was related to better spontaneous singing. These findings provide insights into the structural correlates of singing in aphasia and have potential implications for future clinical trials using singing-based interventions for speech rehabilitation.

Musical Training is Associated with Better Reading and Differences in Resting State Functional Connectivity in Adults

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Subtheme F - Music and Language

Musical training has been linked to better language and reading performance. This has been shown in correlational and interventional studies. Few studies have examined the neural networks supporting these cognitive advantages. We compared the performance of adults (mean age: 26 years, SD: 5.97) with (MUS, N=11, mean years of musical training: 6.59, SD: 3.79) and without (NMUS, N=25) musical training on multiple

reading and language measures. We conducted a whole-brain seed-to-voxel resting state functional connectivity (RsFc) analysis to compare intrinsic differences in language and reading (i.e. left ventral occipitotemporal-vOT seed region) networks between MUS and NMUS. All results were thresholded at a voxel-wise $p < 0.001$ and a cluster extent $p < 0.05$ FWE corrected. MUS performed significantly better than NMUS across language and reading measures ($p < 0.05$). There was a greater RsFc in MUS between the right posterior superior temporal gyrus and the right hemispheric superior parietal, inferior frontal, and supramarginal regions. This network of regions has been shown to support syntactic processing in both language and music. There was also stronger RsFc between the vOT region, a key region for letter/word identification, and the right angular gyrus, a region important for visual-auditory integration and semantic processing. These findings provide insights into the neural mechanisms underlying the positive effects of musical training on language and reading skills.

Phenotypic differences in rhythm and grammar abilities in typically developing children

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Subtheme F - Music and Language

Rhythm is integral to both music and language. Rhythmic cues help resolve informational ambiguities and provide information such as context, emotion, and tone. Studies have shown the association between musical rhythm measures and grammar performance, and that musical priming and training improves performance on grammar tasks. In the study we explored the associations between musical rhythm and grammar, and possible mediators of their association (working memory, speech rhythm). We collected behavioral data on rhythm discrimination (PMMA and BBA), expressive grammar (SPELT-3), speech rhythm (prosody matching task), working memory (KABC number recall) and nonverbal IQ (PTONI) from N=134 typically developing children (age 5;5-7;11, mean=6.5 years). Our data shows a robust positive correlation between musical rhythm discrimination and speech rhythm processing ($r=0.48$, $p<0.001$), and between musical rhythm discrimination and expressive grammar ($r=0.28$, $p=0.002$). IQ as a covariate did not impact the rhythm-grammar association. With a path model, we tested the mediation of music rhythm and grammar via speech rhythm and working memory (N=111). The results indicate that musical rhythm independently predicts grammar, and the association is not mediated through working memory or speech rhythm. Future directions include polygenic analyses on genetic data from the typically developing and language impaired cohort to understand the genetic influences behind the rhythm-grammar relationship

Within-category phoneme discrimination distinguishes musicians from non-musicians in categorical perception

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Gather.town: Room 4 Code 24

Subtheme F - Music and Language

Categorical perception (CP) – the brain's capability of "many-to-one mapping" – is an important prerequisite for dealing with a complex acoustic signal such as speech and extracting relevant phonetic information for later processing (1). While a feature universal to listeners of all the world's languages, musicianship has been associated with perceptual and neural enhancements in CP in previous studies (2). We sought to better understand the dynamics of CP and the extent to which it is modulated by musical expertise. To this end, we conducted an EEG experiment with a sample of musicians (n = 31) and non-musicians (n = 39). Participants performed a categorization task and a discrimination task with a set of nine phonemes ranging on a continuum from /o/ to /a/. We assessed behavioral performance in response to the speech stimuli (response times & accuracy) and neural representations thereof in the form of classical ERP analysis (N1, P2, P3, N400, P600). Counter to our predictions, our results mostly reflect no effect of musical training on categorical speech perception, neither in terms of behavior nor electrophysiology. However, while musicians might not have a more categorical perception of phonemes per se, their enhanced accuracy for within-category discrimination does suggest that musical experience has tuned the neural encoding of certain acoustic features, in this case frequency, leading to more accurate behavioral responses (3). On the other hand, non-musicians lacking this specific expertise may rely more heavily on learned phonetic templates. In situations where a focus on local features is appropriate, as is the case for within-category discrimination, this reliance may decrease behavioral performance (4)

The mental representations of speech and song in English and in Mandarin

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Gather.town: Room 4 Code 25

Subtheme F - Music and Language

Speech and song differ in their acoustics but phenomena such as speech-to-song illusion and talk-sing suggest that acoustics alone may not sufficiently differentiate the two. Here, using a reverse correlation paradigm, we examined whether speech and song may have different mental representations in a familiar vs. unfamiliar language. Native British English listeners (n=16) were presented with 200 pairs of the same four-word phrase with randomly manipulated pitch and duration for each word. Within each pair, they decided which was more speech/song-like. Each participant completed four conditions over two sessions: type (speech/song) x language (English/Mandarin). To analyse the representations'

pitch contour, we obtained the best fitting model for each condition to estimate its overall shape and compared two model parameters (y-intercept (b0) and slope at midpoint). We found that English speech and song have the same overall shape (cubic) but different b0 and slope direction whereas Mandarin speech and song have different shapes (cubic and linear, respectively) and slope direction but similar b0. In terms of duration, we found consecutive durational differences in English speech but not in English song. Conversely, we found similar consecutive durational patterns in Mandarin speech but a durational difference in the middle portion of Mandarin song. Our findings thus suggest that listeners have different underlying speech and song representations within and across languages,

Theta-gamma phase amplitude coupling in human hippocampus supports auditory short-term memory retention.

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Gather.town: Room 4 Code 26

Subtheme E - Music and Memory

Phase Amplitude Coupling between theta and gamma oscillations has been hypothesized to implement the retention of information during short-term memory (Lisman and Jensen, 2013). However, the role of theta-gamma coupling in short-term memory functions, still needs to be confirmed. In this study, we investigated if hippocampal theta-gamma PAC supports memory retention, as compared to simple perception, and if theta-gamma coupling strength increases with increasing duration of the memory retention period. Stereotaxic EEG recordings were obtained in 16 pharmaco-resistant epileptic patients who performed delayed match-to-sample tasks for tone sequences, and a passive listening control condition with the same material. To investigate working memory functions, the duration of the silent retention period between the to-be-compared sequences was manipulated (2000, 4000, 8000 ms). Time frequency analyses during the encoding period of the task show that each tone was encoded by a transient gamma burst in the auditory cortex, while the entire sequence elicited sustained theta oscillations in the ventral auditory stream. During the retention period, theta-gamma coupling increased in bilateral hippocampi in memory trials as compared to perception trials. Finally, increasing theta-gamma coupling was observed with increasing duration of the retention period during memory. This result suggests, in line with Lisman and Jensen's model, that hippocampal theta-gamma coupling supports the retention of memorized items in short-term memory. This expands our knowledge of the general role of cross-frequency coupling as a global biological mechanism for brain information processing and integration in the human brain.

Language, executive functions, and rhythm abilities in Greek pre-schoolers: a correlational approach

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Gather.town: Room 4 Code 27

Subtheme F - Music and Language

Previous research has shown links between children's music abilities and music exposure at home with language and literacy skills. In our study, we collect measurements on children's rhythmic abilities, language and executive functions aiming to assess potential links and moderating factors between these three, which have not yet been reported jointly within a single sample. The administered tests cover the assessment of morphosyntactic and phonological processing, auditory and visuospatial selective attention, verbal and phonological working memory, as well as scale and rhythm perception (Peretz et al.,2013), and the perception of complex and simple meter (Einarson & Trainor,2016). Music exposure at home and parental beliefs about music education are measured with a translated version of the Music@Home questionnaire (Politimou et al.,2018). Data are collected from typically developing children (n=30) and children with Developmental Language Disorder (n=20), aged 5;6–6;6. We predict correlations between rhythm and linguistic skills, notably related to phonological and morphosyntactic processing, as well as with music exposure at home. We further explore the relation of visuospatial and auditory selective attention to pre-schoolers' other abilities tested here, expecting enhanced correlation with auditory attention. Data collection is in progress and first results will be presented in June.

Impact of active music training on the electrophysiological functioning underlying language acquisition in infancy

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Gather.town: Room 4 Code 28

Subtheme E - Music and Memory

Basic Rapid Auditory Processing (RAP) develops early in life and is involved in language acquisition. We exposed infants (aged 7-9 months) to a music training (1 hour/week for 6 weeks) providing exposure to and active synchronization with complex musical rhythms. The training's efficacy was tested on ERP markers of RAP and on early linguistic skills, with 13 infants participating to the music training (M+) and 14 not (M-). All infants underwent the same evaluations: at age 6 and 12 months (1) RAP was characterized via ERP using a double-deviant oddball paradigm (Cantiani et al., 2016) and (2) expressive/receptive language skills were assessed (Bayley Scales). The results show that M+ infants presented at age 12 months a more mature ERP pattern, characterized by shorter latency of the P1 peak and enhanced amplitude of the P2 peak. Interestingly, such ERP pattern resembles that of M- children at later

ages. In addition, M+ infants show significantly broader improvement in expressive/receptive language skills. Taken together, these results provide preliminary evidence on the efficacy of an early active music training in modifying infants' neuronal functioning underlying RAP, as well as early linguistic skills. Next steps include the linguistic follow-up of M+ and M- infants at later ages and, importantly, the investigation of the training's efficacy on infants with a family history for Developmental Language Disorder, who have higher risk of atypical developmental trajectories.

Evaluating the Consistency and Thematic Content of Music-Induced Visual Mental Imagery

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Gather.town: Room 5 Code 1

Subtheme G - Music and Emotion

There has been a resurgence in research into visual mental imagery (VMI), mental images formed in the absence of an external stimulus, during music listening. Very little is currently known about the content of music-induced VMI, and its consistency within individuals and across listening situations. We aimed to examine the thematic content of music-induced VMI descriptions. Further, we aimed to investigate the rate of consistency of VMI content across participants, and to determine factors influencing within-person VMI consistency. In an online survey (repeated three weeks later), 353 participants listened to three short musical excerpts, and described the content of their VMI in response to the excerpts (Q1) and the musical features contributing to their VMI (Q2). We carried out two thematic analyses and calculated consistency based on common terms across reports using a systematic numeric labelling system. Our analysis for Q1 revealed four higher order themes (Storytelling, Associations, Non-Visual Experiences, and Music), and all lower levels themes fell with high consistency across participants. Our initial analysis for Q2 revealed four themes associated with the music heard (Instrumentation, Elements, Soundscapes, and Composition & Arrangement) with preliminary evidence for links between musical features and VMI content. We anticipate that our findings will encourage further investigations into how musical features may contribute to music-induced VMI

Seeing or hearing? Feeling The influence of music on paintings

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Gather.town: Room 5 Code 2

Subtheme G - Music and Emotion

Music has been investigated in a variety of contexts. Previous studies reported evidence of the influence of music on the perception and emotional evaluation of faces. Moreover, it has been demonstrated how an art context promotes evaluation processes that influence the emotional experience of an artwork. The aim of the present study was to investigate how emotionally significant music can affect the perception of emotions elicited by artworks. It was hypothesized that listening to a musical piece with an incongruent emotional value compared to the emotion induced by a painting would negatively affect the emotional categorization of the visual stimulus. On the basis of a validation process, for both visual and auditory stimuli, the considered emotional categories were: Happiness, Relax, Fear, and Sadness. Each category comprised 48 paintings. They were paired with either a congruent or an incongruent background music. Participants were 20 students, who were asked to categorize the artworks on the basis of the emotion expressed. A 2-way rmANOVA was performed on the artworks' categorization judgements. Background music could be congruent, incongruent, or null (silence). The analysis revealed the significance of the background music factor. Post-hoc tests showed significant differences between congruent and incongruent conditions, and between silence and incongruent conditions. In the incongruent condition, the ability to correctly categorize the emotions expressed by the paintings was significantly worse, regardless of the emotional category. These data further suggest that background music can influence emotions aroused by other sensory channels. Further research should explain when does the integration occur.

A continuous model of pulse clarity: Towards inspecting affect through expectations in time

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Gather.town: Room 5 Code 3

Subtheme G - Music and Emotion

Music has a unique capability to evoke emotions. Tension is a feeling that arises in a situation of dissonance and uncertainty that yearns for resolution. This is a kind of affect that develops in time, given that it is dependent on expectations about what will happen next. Specifically in rhythms, two concepts have been explored that relate to its comfort and understanding: pulse clarity and rhythm complexity. Several computational models have been introduced to analyze these concepts. In most cases their analysis is static -- i.e. full passage is studied -- and does not consider how they evolve in time. We present THT, a novel beat tracking model, that given a rhythmic passage provides continuous information of which tacti are most reasonable and how

salient they are. In this work we set to evaluate the output of the THT model as a proxy for pulse clarity. We performed a beat tapping experiment to evaluate the metric extracted from the output of the model. The experiment consisted in asking participants (N=27) to tap the subjective beat while listening to 30 rhythmic passages. The proposed metric was summarized to a single value by taking the mean of the continuous pulse clarity curve. After each trial they were asked about task difficulty to gather a subjective measure of clarity. We also calculated the within subject tapping clarity as an empirical measurement. Our metric correlated with similar spearman correlation coefficient when compared to previous work.

The role of music in the emotional well-being and psychoactive substance use of young adults who experience homelessness.

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Gather.town: Room 5 Code 4

Subtheme G - Music and Emotion

Homeless young adults are particularly vulnerable to the harmful consequences of problematic psychoactive substance (PAS) use. Problematic PAS use leads to the dysregulation of the brain reward pathways and in turn to difficulties regulating emotions and PAS use. Through its impact on the reward pathways, music could promote the well-being of those suffering from such dysregulation. Yet, literature reports heterogeneous results and little is known about the mechanisms underlying the mixed responses to music. This field study aims to describe and understand the role of music in the well-being of homeless young adults who use PAS problematically. Twenty-five participants aged 18 to 30 years old will take part in semi-directed qualitative interviews addressing their experiences with music, emotional well-being and PAS use. Data follow an iterative and thematic analysis. Preliminary results support the crucial role of music in homeless PAS users' lives, though music at times promotes and hinders emotional and PAS use outcomes. Namely, the participants' responses to music are modulated by individual and contextual factors, including the memories and behaviors associated with the music as well as the unique environment to which they are exposed. This study will promote our comprehension of the role of music in the context of PAS use and homelessness and facilitate the development of outreach interventions that are adapted to individuals' living context, experiences and interests.

Oscillatory networks underlying music-reward processing of familiar and unfamiliar music

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Subtheme G - Music and Emotion

Listening to pleasant music engages reward-related brain areas. These areas, in turn, interact with other structures related to music processing and the mechanisms that support it, such as auditory processing and working memory. However, little is known about the temporal dynamics of these brain interactions. The goal of the present experiment was to study the oscillatory activity associated to music-evoked pleasantness and familiarity. EEG was recorded from 22 healthy subjects while they were listening to both familiar and unfamiliar music and rating the experienced degree of evoked pleasantness in two experimental sessions. By using a multilevel Bayesian approach we found that phase synchronization in the theta band between right temporal and frontal electrodes increased with the degree of pleasure experienced by participants only when music was unfamiliar. In turn, this positive relationship emerged in right temporal to left-parietal connections when music was familiar, while the opposite was true for unfamiliar music. These findings show that theta oscillations are a means of communication between areas involved in music-reward processing, with different network distributions as a function of familiarity.

Relaxing effects of music and odors on physiological recovery after highly demanding executive tasks

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Gather.town: Room 5 Code 6

Subtheme G - Music and Emotion

Music and odors are granted with relaxing properties that are linked to changes in the autonomic nervous system (ANS) activity. Few studies compared the presentation of these stimuli within a same experimental protocol. Here, we examined whether relaxing music (slow-paced classical pieces) or odor (lavender essential oil) would facilitate physiological recovery after an arousing event consisting in completing timely constrained executive tasks (Trail Making, Stroop, and Miyake tests) for 10 minutes. We continuously recorded the electrocardiogram to assess the high-frequency component of heart rate variability (HF-HRV), a measure of parasympathetic activity and electrodermal activity (EDA), a measure of sympathetic activity, 10 minutes before, during and 30 minutes after the arousing event in 81 participants distributed in three conditions (control N=28, odor N=26, music N=27). As expected, the arousing event led to a significant increase in EDA and a significant decrease in HF-HRV (compared to baseline). Then, during the recovery period, the odor elicited a greater decrease in EDA compared to an odorless and silent control whereas no difference in HF-HRV was observed. By contrast, during this period, music elicited a greater increase in HF-HRV compared to control whereas no difference in EDA was observed. This study showed that both odors and musical stimuli do have relaxing effects on ANS, but that these effects may rely on distinct neural mechanisms and autonomic pathways.

The forgotten role of absorption in music reward

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Subtheme G - Music and Emotion

Music is one of the greatest pleasures in life. Inter-individual differences in music-related reward, as measured by the Barcelona Music Reward questionnaire (BMRQ), are characterized by five facets: musical seeking, emotion evocation, mood regulation, social reward and sensory-motor. A further component, related to how humans decode music as a rewarding experience, is musical absorption (measured through the Absorption in Music Scale, AIMS). Musical absorption has been associated to music-driven induction of states of complete immersion, a momentary loss of self-consciousness and even a disorientation of time and space (sometimes referred to as mystical experiences). Our aim was to investigate the interrelation between individual differences in music absorption and music reward. We hypothesized that higher sensitivity to derive pleasure from music (including music reward facets) should predict larger tendency to being engaged in music-related absorption states. 370 participants (73% women, 26.3 ± 7.9 years old) completed both BMRQ and AIMS questionnaires. In line with our hypothesis, results showed that both constructs were highly interrelated ($r = .77$, $p < 0.001$). However, using confirmatory factor analysis, we also identified a possible dimension of absorption (4-AIMS items) that could be implemented when assessing individual differences in music reward, thus complementing the previously identified five-dimensional BMRQ space.

Tales from the dark side: Exploring negative musical response

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Subtheme G - Music and Emotion

Although we have made steady progress in specifying the psychological and neural mechanisms that operate when listeners enjoy music, we do not know much about negative musical responses. The present study surveyed an online sample (N = 960) to obtain retrospective accounts of respondents' experiences when exposed to disliked music. Respondents first identified their most liked and most disliked musical genres and rated how strongly they liked/disliked them (-5 = hate; 5 = love). For their most liked music, 43% of respondents indicated 5 (M = 4.0, SD = 1.1); for their most disliked music, 29% indicated -5 (M = -3.1, SD = 2.1). In response to the question, "have you ever been in a situation where you were forced to listen to your most disliked genre of music," 67% agreed that they had had this experience. The poster will report detailed content analysis of their accounts of these experiences. Finally, when prompted respondents provided 358 distinct emotion words describing this experience, with the 10 most frequent being annoyed (270), irritated (237), bored (206), angry (179), disgusted (122), frustrated (101), hate (94), sad (64), uncomfortable (44), and unhappy (37). The results reveal that listening to disliked music is a common experience that merits further empirical study. As we continue to learn about the brain mechanisms underlying musical pleasure, we will likely find it useful to also consider the complementary, "dark side" of negative musical response

Boosting reward and pro-social behaviours through shared music listening

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Subtheme G - Music and Emotion

Music triggers intense pleasure through the activation of the reward system. This can be also activated by other high order abstract rewards such as the social sharing of an emotional experience and plays a key role in the generation of the motivation that drives individuals to cooperate. The intrinsic social nature of music, both in the active playing and as a shared pleasurable listened content, showed the capacity to intensify perceived emotion and to promote altruistic behaviour. Therefore, this work aimed at increasing both musical reward and pro-social behaviour through an ecological, online music sharing experience. After evaluating inter-individual differences in sensitivity to musical pleasure and pro-social/altruistic personality traits, we counterbalanced groups of subjects in three social conditions: alone (i.e., with nobody), low social (i.e., with 10±3 partners), high social (i.e., with 20±3 partners). Subjects thought to be in synchronized music listening through seeing the position of other participants as icons on a map of their current country, fixed on the screen. They were asked to listen to music (4 of their favourite songs and 4 other participants' favourite songs) while providing continuous ratings of pleasure. After, participants thought to play with a partner two economic games (Ultimatum and Dictator Game), well established in the evaluation of pro-social behaviours. The collection of the data will end by May. We expect to find increased music reward experience in the social conditions, which in turn will increase participants' pro-social behaviours. These results would shed new light on music reward processes and have important applications in both education and social contexts.

Investigating the aesthetic experience with continuous measures: how psychophysiology reflects the temporal development of music

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Gather.town: Room 5 Code 10

Subtheme G - Music and Emotion

Music evokes powerful emotions, which may lead to an aesthetic experience. Such emotions can be related to psychophysiological responses. To date, music and emotion studies using psychophysiology typically investigate a limited range of stereotypical musical stimuli, namely the pieces chosen each represent only one of the basic emotions or one specific location on the arousal and valence dimensional space. However, as neuroaesthetic literature has highlighted the role of prediction, uncertainty and surprise as influencing pleasure in music, an aesthetic experience may stem from the continuous development of music. In a sonata form, for example, music fluctuates between opening arousing and transitional calming passages. To investigate responses occurring to music that develops over time, the current study recorded continuous psychophysiology from 90 participants while they listened to a concert performance of full-length string quintets by L. v. Beethoven, J. Brahms and Brett Dean. Linear models with fixed effect of dynamic changes (derivatives of low-level musical features, extracted with MIRToolbox) or structural changes (different sections and themes), showed significantly higher skin conductance in response to intensity changes, as well as heart rate changes at passage transitions. As these psychophysiological responses occur at both low-level and high-level musical changes, they may represent the initial processing of emotions that lead to an aesthetic experience.

Entropy and information content as modulators of affect and memory encoding

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Gather.town: Room 5 Code 12

Subtheme G - Music and Emotion

Theories explaining why we like music have mainly focused on expectation generation and resolution. These expectations, in turn, arise from implicit knowledge of a music syntax and explicit knowledge of particular compositions. These predictive states can be defined by two aspects of music complexity, namely entropy and information content. Since music is a sequence of notes organized in patterns and complex structures that unfold over time, it provides an ideal paradigm for studying the neural encoding of uncertainty (entropy) and predictability (information content). In the present experiment we generated 10000 stimuli based on a C-Major alphabet of transitional probabilities and exposed a cohort of participants to melodies of different complexities, where some of them were repeated several times. In addition, participants rated their liking of the stimuli and performed a recognition task. Results show that complexity was related to liking ratings and memory encoding. This highlights the importance of familiarity in modulating predictive complexity and its associated value. These findings contribute to existing research on interactions between memory retrieval and music-evoked pleasantness, underscoring the role of learning in music-reward processing.

Neural spiking in the human medial temporal limbic system to emotions expressed in music

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Gather.town: Room 5 Code 14

Subtheme G - Music and Emotion

Limbic brain areas associated with affective music listening are relatively well known. However, higher temporal resolution techniques such as intracranial EEG (iEEG) are needed to better understand the sensitivity of these areas to the auditory features inherent to music, which remains unknown. In this iEEG study, we aim at clarifying the influence of aesthetic and naturalistic music on the amygdala (AMY), the anterior hippocampal complex (antHPC) implicated in music elicited emotions as well as in the entorhinal cortex (EC). We recorded local neural spiking activity from microelectrodes implemented in the AMY (n=5), in the antHPC (n=7) and in the EC (n=2) while epileptic patients were listening to music. The set of musical excerpts evoked 9 distinct emotions identified in the Geneva Emotional Music Scale (GEMS) model. After spike detection and sorting, spike events identified in bilateral AMY, antHPC and EC were preliminarily analyzed across four types of emotion (i.e. Joy, Tenderness, Tension and Sadness). Spiking activity revealed increased neural firing during music listening compared to silence in the antHPC. Critically, we found a differential effect of emotion in the antHPC with greater spike events during tender music compared with happy and tense music exposure. Further analyses demonstrated an effect of the arousal dimension, showing an increase of spiking activity during low compared to high arousal excerpts.

Dissociation of Rhythm Perception and Production Abilities in Patients with Treatment-Response Schizophrenia: A Behavioral and Voxel-Based Morphometry Study

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Gather.town: Room 5 Code 15

Subtheme G - Music and Emotion

Dopamine D2 receptor antagonists are mainstay for treatment of aberrant dopaminergic function in patients with schizophrenia (SZ). About 30% of patients with SZ show poor response to these drugs (i.e., treatment-resistant schizophrenia

[TRS]). We hypothesized that there would be a difference in the rhythm processing between those with TRS and non-TRS given that they have different pathophysiology. We investigated rhythm perception and production abilities in 55 patients with SZ (29 non-TRS and 26 TRS) as well as 30 healthy controls (HCs) using the Harvard Beat Assessment Test (H-BAT). Furthermore, the gray matter volumes (GMV) measured with magnetic resonance imaging were analyzed with the voxel-based morphometry. Six out of seven H-BAT scores were worse in those with SZ compared with HCs ($F2,82 > 5.09$, $p < .001$). The SZ showed reduced GMV in the right thalamus, bilateral pars opercularis, right superior frontal gyrus, and left medial frontal gyrus ($p < .001$, FWE cluster corrected) compared with HCs. The GMV in these areas were correlated with the H-BAT scores ($r > - .28$, $p < .01$). Interestingly, the non-TRS performed similar ability of rhythm production in the Beat Finding and Interval Test in the H-BAT compared with HCs, while the rhythm production was worse in the TRS than HCs. Our results suggest that GMV may be associated with the reductions of rhythm processing abilities, and that there is a dissociation between rhythm processing abilities in non-TRS but not in TRS.

An auditory-reward network processes musical uncertainty and surprise to pleasurable effect

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Subtheme G - Music and Emotion

Enjoying music consistently engages key structures of the neural reward system such as the nucleus accumbens (NAc). Expectancies seem to play a large role in this effect, as both uncertainty about the musical future and surprise about the musical past have been shown to modulate liking ratings and neural responses. In the present study, we examine how these expectancies jointly affect behavioral and neural pleasure responses across individuals. During fMRI scanning, 24 participants listened to and rated 50 real-world musical excerpts varying widely in uncertainty and surprise, as characterized by a well-validated computational model. As in previous studies, we observed an uncertainty-by-surprise interaction on liking ratings. To link this phenomenon to its neural bases, we identified the neural correlates of the liking ratings, and then extracted individual hemodynamic responses to different levels of uncertainty and surprise in these regions. Comparing these responses to each participant's liking ratings at the same uncertainty and surprise levels, we found significant brain-behavior correlations, across individuals, in the bilateral NAc, ventromedial prefrontal cortex, auditory cortex, precentral gyrus, cerebellum, and left amygdala and precuneus. Together, these results highlight the role of expectancies in musical pleasure and shed light on the individual differences in this phenomenon, supporting the role of an auditory-reward network in the subjective response to music.

Functional connectivity pattern of the auditory cortex in music-induced positive emotional processing

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Gather.town: Room 5 Code 17

Subtheme G - Music and Emotion

Music can be powerful to induce intense emotional experience in humans. I the last years, unraveling brain correlates of music evoked emotions have become a focus in neuroscience research. Yet, little is known about the functional and integrative role of auditory cortex in emotional aspects of music processing. And although some studies compare distinct musical emotions directly, few studies have investigated the comparison within specific positive emotions. In the present study, participants with musical background listened to forty musical pieces of joy and tenderness of diverse genres while scanned by functional Magnetic Resonance Imaging while feeling or not feeling the emotion (analytical task). We aimed to investigate the pattern of functional integration between associative auditory cortex (superior temporal gyrus, STG) with regions of the fronto-mesolimbic system and supplementary motor area (SMA). Our results indicate a pattern of functional dissociation with a stronger connectivity of left STG with bilateral ventral striatum (nucleus accumbens) for tenderness compared to joy. For the opposite contrast (joy vs tenderness), we found a stronger connectivity of right STG with right SMA and left STG. To our knowledge, our study is the first to investigate the brain pattern of connectivity of STG to distinct positive musical emotions, such as joy and tenderness.

Investigation of the neural correlates of music chills using High-Density EEG.

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Subtheme G - Music and Emotion

Peak pleasure associated with music corresponds to an increase of emotional pleasure and increased arousal up to the occurrence of chills. Physiological and neuroimaging investigations of these music chills revealed activation of the parasympathetic system, producing increased heart rate and increased skin conductance responses, as well as dopaminergic releases in the dorsal striatum during anticipation of chills and in the ventral striatum during peak pleasure. As social neurosciences move toward natural conditions, chills that are objective markers of musical pleasure can provide relevant information for the study of the emotional synchronisation of groups. This study was a first approach for the investigation of the neural correlates of chills associated

with music using High-Density EEG. Our results revealed a specific increased theta activity in the right prefrontal region related to increased arousal and increased pleasure. Source localisation analysis suggested that this activity is produced by the orbitofrontal cortex. Furthermore, decreased theta/beta activity in the left and right central areas may be specific to the occurrence of chills. We hypothesized that this decrease in activity is produced by the supplementary motor area and could be related to the planning/anticipating of musical sequences or processing of musical imagery. This study demonstrates that EEG can provide relevant information in the study of chills for further ecological investigations.

Evaluation of musical outreach programs

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Gather.town: Room 6 Code 2

Subtheme J - Music Intervention Programs – Community and Education

Background. In the last ten years, there has been an increasing awareness of musical programs aimed at socially marginalized children and adolescents. Many of these programs have been influenced by the El Sistema program. However, there seems to be very different perceptions of the programs and their effect. With this project I aim to get behind this discussion by 'evaluating the evaluations'. The purpose of the research project is to contribute to the encouragement of applying reliable, objective evaluations of such initiatives and hence obtain results that can form the basis for new initiatives. It may also help professional music educators to gain a more realistic view of what music can and cannot do. In this way, the study will be a relevant contribution to the discussion whether music should be judged on its intrinsic values or on its derivative effects. Methods. Based on the research question 'how are the programs evaluated?' the study reviews academic literature (in English, German and Scandinavian languages), published within the last ten years, that evaluate such programs. Results. The literature seems to reflect very opposing positions. This lack of consensus also reflects a wide range of evaluation methods and different priorities in the choice of the observed parameters. The findings suggest that the application of a transparent set of evaluation methods may improve the validity of the research within the field.

Jazz Piano Training Increases Neural Oscillations and Cognitive Performance in Older Adults

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Gather.town: Room 6 Code 3

Subtheme J - Music Intervention Programs – Community and Education

Individualized piano training has been shown to enhance executive functions and working memory, areas most susceptible to cognitive impairment in aging adults. However, little is known about jazz styles1. The purpose of this study was to evaluate the effects of a jazz piano training program on executive functions in older adults. Participants (60-85 years) were recruited and assigned into one of two groups: jazz piano instruction or a no treatment control group. Criteria for research participation included those: 60-85 years, fluent in English, no history of neurological impairment, sensory disabilities, or learning disabilities, less than 3 years of formal music education, and no difficulty with hand or wrist movements All participants completed a battery of standardized cognitive and neurophysiological measures pre and post-training. Jazz piano training included a 10-day camp with improvisation, aural skill development, and chordal accompaniment. Results of a Repeated Measures ANOVA (Group X Time) on composites for all cognitive domains showed significantly enhanced processing speed following jazz piano training. There was no significant difference in simple processing, self-efficacy, or quality of life. Neurophysiological data reveal enhanced theta activation post-training. Preliminary results suggest that partaking in a novel intense jazz piano training program may enhance some areas of cognition and memory performance. Future studies with attention-based control groups will help us to examine targeted areas of cognitive performance and whether these areas can be enhanced with a jazz piano training program

Musical experience, and the ability of musicians to harmonize, is associated with enhanced planning and problem-solving

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Subtheme J - Music Intervention Programs – Community and Education

Musical experience is associated with enhanced executive function but little is known about the extent to which harmonic aspects of musical experience are associated with components of executive function. In the current study, an array of cognitive tests, each associated with one or more components of executive function, was administered to participants with a wide range of musical experience. To investigate how harmonic aspects of musical experience relate to executive function, a test of the ability to compose a four-part harmony was developed and administered

to musically experienced participants. We hypothesized a positive relationship between musical experience and executive function, and that among high experienced participants, scores on the test of ability to harmonize would correlate positively with measures of executive function. The current results indicate that scores on the Tower of London task, a measure of planning and problem-solving, are positively associated with musical experience. No relationships were detected between musical experience and tasks more selective for inhibitory control, conflict resolution, or working memory components of executive function. The harmony assessment was found to have high levels of inter- and intra-rater reliability. Among highly experienced participants, scores on the harmony assessment were positively correlated with performance of the Tower of London task. Taken together, the current results support a robust relationship between musicianship and planning and problem solving abilities, and indicate that the ability to harmonize is associated with components of executive function contributing to planning and problem solving.

Guided Audiomotor Exploration (GAME): Improvisation-based instrumental music training for cochlear implant users

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Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Hearing loss at any age can substantially affect quality of life. Cochlear implants (CIs) can partially restore hearing by stimulating the auditory nerve electrically. Unfortunately, complex auditory signals, such as found in music or in cocktail- party situations, remain challenging for CI users, largely due to the degradation of information stemming from electrical stimulation. But, through rehabilitation, CI users manage to adapt to these degradations to different degrees. One possible approach to boost rehabilitation in CI users is improvisation-based musical training, such as the Guided Audiomotor Exploration (GAME). As opposed to traditional score-based learning, improvisation-based training promotes audiomotor integration by relying on procedural memory and learning that couple movements on an instrument to sound production. Audiomotor integration, in turn, has been shown to boost activation of the auditory cortex in conjunction with top-down effects. These plastic changes could lead to improved central auditory processing of the degraded input. The current randomized controlled trial will offer GAME to adult CI users. In a pilot study with three CI users, participants enjoyed learning piano, gained personal confidence, and (re)gained appreciation for music. We aim to expand these results, and pursue transfer of learning effects to music and speech perception in CI users.

The Sound of Exercise: A Pilot Study Investigating the Effects of Music Listening in Cardiorespiratory Exercise for Inpatient Stroke Rehabilitation

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Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

The objective was to assess the feasibility and investigate the effectiveness of in-task music listening in group-based cardiorespiratory exercise. A randomized controlled pilot study with cross-over design and randomized condition order was used. Subjects were adult inpatient stroke survivors receiving cycle ergometry exercise. While exercising, participants received three conditions: 1) a group-tailored music playlist, 2) a radio channel, and 3) a non-auditory control condition. The primary outcomes were exercise duration and exercise duration spent in the recommended heart rate intensity by clinical guidelines, as well as the feasibility. Secondary outcomes assessed affective valence state and condition preference. A total of 19 patients were recruited to the study. For all participants, music resulted in a positive affective valence from pre to post measure of the exercise and a tailored music playlist was largely preferred. In addition, both auditory conditions significantly increased the exercise duration (radio: 7.7 minutes; playlist: 6.42 minutes) and the playlist was furthermore able to increase the amount of time spent in the recommended heart rate intensity (5.41 minutes). However, these effects occurred only in participants with a low gait functioning (FIM walk sub-score $\leq$ 5). Based on data from this pilot study, music can have a positive impact on affect and exercise intensity, lending support to further investigation of music in cardiorespiratory exercise.

Instability of Tone Production: A Means for Objectivizing Embouchure Dystonia

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Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Musician's dystonia is a task-specific loss of voluntary motor control of the fingers or the embouchure. In contrast to pianists' dystonia, which can be objectively assessed based on movement kinematics and muscular activities, no objective quantitative measure has been established for embouchure dystonia. We focused on acoustic signals, and investigated, whether the fluctuation of the time-varying fundamental frequency of a note can provide an objective and reliable measure of embouchure dystonia. We included seven professional musicians with embouchure dystonia and ten healthy controls and each

participant was asked to play six notes in the three pitch registers (low, medium, high) in medium loudness for 5 seconds with maintaining loudness and pitch as precisely as possible, and without vibrato. A 2-way mixed design ANOVA with group (patient, control) and pitch (low, medium, high) as independent variables found a significantly higher variability of the fundamental frequency for the patients. We thus provide a method to objectivize ED. The advantages of this method are firstly that it can be applied in addition to the less reliable subjective rating; secondly assessment occurs at the instrument, an important prerequisite in a task specific disorder. We believe that this measure has the potential of assessing improvement or deterioration in the course of ED. Whether the acoustic analysis may be useful to diagnose ED has to be investigated in future studies.

The Impact of Music Training on Inhibition Control, Phonological Processing, and Motor Skills in Kindergarteners: A Randomized Control Trial

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Subtheme J - Music Intervention Programs – Community and Education

The aim of this presentation is to explore how music training impacts the development of inhibition control, phonological processing, and gross and fine motor skills in preschoolers. In a randomized controlled trial, 160 kindergarteners in a music programme, a motor programme, or a control group were examined. Children in the two experimental conditions took part in 19 weekly 40-minute sessions. At pretest and post-test, inhibition control and phonological processing were measured with two subtests from the NEPSY-II. Gross and fine motricity were assessed with the BOT-2 Short Form. Post-test results showed that children in the music condition improved significantly on automatic response inhibition. Phonological processing skills did not differ significantly between the two experimental conditions, but the music condition produced significant improvements over control. These findings corroborate previous evidence that music training contributes substantially to develop executive function and phonological awareness in preschoolers.

Community Music Therapy to manage stress and anxiety in university students – A proposal

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Gather.town: Room 6 Code 9

Subtheme J - Music Intervention Programs – Community and Education

This research explores the efficacy of on-campus community music therapy (CMT) as a proactive intervention for university students to manage stress and anxiety in comparison to the standard of care, verbal counseling. In collaboration with the Music Therapy Academy, students self-select to participate in a 6 week pre-established verbal counseling or CMT group. Students choosing CMT are randomly assigned to one of Music Improvisation, Song-Writing, or Music Listening protocols (8-10 students/group; 3 groups/protocol). Demographic information including music background is collected. Before and after each session, students rate their stress on a Likert scale and heart rate and tactile pain thresholds are measured. Before and after the 6-week intervention, students fill out the State Trait Anxiety Inventory Tool, Perceived Stress Scale, and hair samples are taken to measure cortisol. A waitlisted group also fills out these measures. We expect that before to after each session, heart rate variability and pain tolerance will increase and rated stress will decrease; and before to after the 6-week protocols, cortisol levels and questionnaire stress measures will decrease. We expect CMT to be as effective as verbal counseling but more students to opt for CMT. Improvising and songwriting are anticipated to be more effective than music listening. The end goal is to develop a proactive approach to managing stress and anxiety that lowers the strain on health care supports on campuses.

Is participation in an early childhood music program related to child socio-emotional development? A meta-analysis.

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Gather.town: Room 6 Code 10

Subtheme J - Music Intervention Programs – Community and Education

Background: The impact of music training on developmental outcome has been demonstrated through systematic reviews with school-age children and adolescents but not in early childhood. However, music is increasingly recognized as having a social role, insofar as it is linked to emotional regulation and to early interactions in infancy and the preschool years. The goal of this meta-analysis to examine the association between participation in an early music program and indices of socio-emotional development in children under 5 years of age. Method: Studies were selected if they included participation in an early childhood music program and an assessment of the socio-emotional development of children under five. Results: Eight studies revealed a medium to large effect size ($d = .67$, $p < .001$). Effect size was moderated by type of assessment (observed versus reported) and the duration of the program. Conclusions: Results confirm a positive association between the participation to an early childhood music program and the socio-emotional development of young children. Nevertheless, the number of studies conducted to date and the methodological limitations of some of these studies do not allow us to conclude in a causal effect neither to clearly know under which conditions participation in an

early childhood music education program could have an impact on the child's socio-emotional development.

The effect of music training on inhibition control in children: A meta-analysis

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Gather.town: Room 6 Code 11

Subtheme J - Music Intervention Programs – Community and Education

Although a vast literature exists on the relationship between executive functioning and music training, it is still unclear whether or not music training causes a strengthening in executive control during child development. Inhibition control is an important executive function for music practice and is often required when synchronizing in an ensemble, prioritizing among auditory streams and processing complex rhythms. This study performed a meta-analysis of longitudinal changes in inhibition control during music training in children. A rigorous literature search of studies from 1995 to 2019 yielded 1559 potential studies of which 10 studies reported data from longitudinal randomized control designs in children aged between 4 to 12 years. Inhibition control measures included the Flanker, Go/No-Go and Stroop tests or similar inhibition control tests. As a result of this meta-analysis we found significantly greater improvement in inhibition control for music training programs as compared to non-musical control programs (SMD = 0.36, CI = 0.11 to 0.60, p = .004). These findings suggest that music interventions foster skill transfer in inhibition control in young children. They pave the way to further research on the benefits of music training as a way to improve self-control in a school environment, and to remediate clinical populations with difficulties in inhibition control (e.g., ADHD and ASD)

A music and arts program for individuals with aphasia

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Gather.town: Room 6 Code 12

Subtheme J - Music Intervention Programs – Community and Education

Aphasia, an acquired language disorder resulting from damage to language regions of the brain, significantly impacts individuals' quality of life and capacity for self-expression. The arts, particularly music performance and listening, can afford cognitive, emotional, and neural benefits to individuals with communication disorders (Särkämö, 2018). We implemented a music and arts program for individuals with aphasia through the Aphasia Group of Middle Tennessee, with the goal of offering individuals an alternative means of self-expression in a supportive community environment. Sessions met every other week during the semester and each consisted of a choir rehearsal, visual arts projects, and rotating guest artist and music appreciation segments. Preliminary results suggested that individuals found choir beneficial for a variety of reasons including social engagement, progress in language function, self-expression, and improvements in breathing and posture. Individuals also indicated an improvement in mood during music appreciation sessions. Future work will assess lyric production in pre- and post-semester choir rehearsals as well as individuals' experience with music and art before and after the onset of aphasia.

Music playschool improves children's rapid naming skills

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Gather.town: Room 6 Code 13

Subtheme J - Music Intervention Programs – Community and Education

Several studies have suggested that intensive music training enhances children's linguistic skills. We tested if traditional Finnish music playschool – only 45 minutes of weekly group music – affects 5–6-year-old children's linguistic abilities. Control children received dance lessons or neither of the activities. Children (N=66) were tested four times within two years with several linguistic tests. We have previously shown that music playschool has a positive effect on children's phoneme processing skills and vocabulary knowledge. Here we report that attending to music playschool had a statistically significant effect also on the development of the word acquisition speed (rapid serial naming) but not accuracy, tested with pictures of colours and objects. The result is based on a linear growth curve model, which takes into account the length of a child's participation in the inspected activities, since many children had started music playschool and/or dance lessons before the start of the longitudinal study. Our study further supports our previous results suggesting that even playful group music activities – if attended to for several years – have a positive effect on pre-schoolers' linguistic skills. As a consequence, we promote the idea of implementing regular music playschool lessons given by professional teachers in early childhood education.

The effects of a rhythm-based reading training for dyslexia in adolescence and early adulthood

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Gather.town: Room 6 Code 15

Subtheme K - Music Intervention Programs - Neurodevelopmental disorders

Developmental dyslexia (DD) is associated with deficiencies in temporal processing of auditory stimuli, depending on atypical oscillatory neural activity, that contribute to phonological and reading impairments. To induce a more accurate entrainment to the spectral properties of auditory stimuli in students with DD, we explored the possibility to synchronize speech prosody during reading with an isochronous rhythm. Accordingly, an intervention program for DD, called Rhythmic Reading Training (RRT), was designed. Since DD-related difficulties persist into adulthood, the effects of RRT in older populations of students with DD have been tested. First, 28 adolescents with DD (age: 11-14) took part in a study aimed at measuring the effects of 9 biweekly sessions of 30 minutes of RRT. The RRT group was compared with a matched non-intervention group. Results showed that RRT had a significant effect on both reading speed and accuracy. In the second study, 14 university students with DD (age: 19-26) undertook RRT for 10 30-min daily sessions. To maximize the medium-term effect of RRT, the behavioral training was combined with neuromodulation (tDCS). Participants' left temporo-parietal region was stimulated at a constant current of 1.5mA for 20 minutes during each training session. Preliminary results showed slightly higher performances at 4 weeks after the end of the intervention in the active tDCS group, thanks to the neuromodulation-induced plasticity of the involved networks.

Moving Matters: Virtual Reality and Music Guided Rehabilitation for Neglect Patients

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Gather.town: Room 6 Code 16

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Stroke is a leading cause of disability affecting a global population. One consequence of stroke is the condition known as neglect, which involves the loss of awareness of one side of one's body and/or visual field. Lesions found at the parietal cortices often lead to neglect. AIMS This project assess how VR combined with music-guided rehabilitation produces a positive clinical outcome as a therapeutic intervention in a neglect rehabilitative setting. A positive clinical outcome is defined as symptom reduction for neglect patients. The study intends to address the following question: (1) Over an 8-week exposure period, do symptoms of neglect reduce or increase after a neglect patient has been exposed to the VR therapy? METHOD This is a mixed method pilot study consisting of an (1) observational study (2) VR motion data will be extracted post- rehabilitation sessions for analysis. (3) The Catherine Bergego Scale (CBS) will be complete by the patients' physiotherapist to measure the reduction or severity of neglect pre- post- 8 weeks to assess the therapeutic outcome of the VR therapy. RESULTS Data is scheduled to be collected in March 2020. CONCLUSIONS AND IMPLICATIONS It is expected that the VR therapy will be more motivating for patients' to engage in their rehabilitation compared to standardised treatment. A preliminary literature review supports this expectation. The data gathered provides supporting information for the ongoing development of innovative health technology.

Home-based music therapy for children with developmental disorders during the COVID-19 pandemic

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Gather.town: Room 6 Code 17

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Introduction: During the COVID-19 pandemic, children with neurodevelopmental disabilities could not attend their usual rehabilitation therapies, with a consequent reduced support of developmental process and risk of worsening of their clinical conditions. Methods: We prospectively enrolled 14 children with developmental delay, who had already tried a personalised music therapy (Euterpe method). We included them in a 12-day programme of home-based music therapy. The children and their parents were investigated using the Sleep Disturbance Scale for Children and the Parent Stress Index-Short Form. Results: Fourteen children started the intervention, while only 12 children completed all the planned home sessions and assessments. We observed a significant improvement in children's sleep quality and a reduction of parental distress. Discussion: The significant improvements in parental distress and sleep quality must be considered important achievements for the quality of life of a child and their family. Home-based music therapy can provide a feasible approach to improving sleep and parent's stress for children with developmental disorders.

Impacts of the social context on rhythmic synchronization to music and metronome in Alzheimer disease

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Gather.town: Room 6 Code 19

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Patients with Alzheimer Disease (AD) spontaneously synchronize their movements with musical rhythm, particularly in presence of other persons. However, very few studies examined the effect of the social context on this rhythmic behavior. To address this issue, we examined sensorimotor synchronization (SMS) abilities in responses to metronome and musical rhythms in 48 patients with mild-moderate AD and 49 matched controls. Participants performed a hand-taping task jointly with a musician physically present (live condition) or virtually present (video condition). SMS was analyzed in terms of the consistency and the asynchrony of the taps. The results showed that SMS was more constant and more anticipated with metronome than with music confirming previous findings. Moreover, SMS was modulated by the social context, being even better when facing a video than facing a live performance of the singer in the metronome but in music condition. This improvement of SMS in response to metronome is likely due to the absence of social pressure in the video condition. However, the social pressure effects seem to decrease in a more enjoyable context that involves moving with others with music. Lastly, the lack of group differences suggests that SMS abilities are not impaired at this stage of the disease. By improving our knowledge about the complex interaction between social and auditory contexts in rhythmic engagement, we provide new insights for developing music-based interventions in AD

Effect of music on attentional control: evidence from a longitudinal ERP study

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Gather.town: Room 6 Code 20

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Music training has been suggested to improve children's cognitive abilities via executive functions. However, it remains unclear whether and how the executive functions might be improved by music training. In the present study, we employed a cross-modal oddball ERP paradigm to investigate children's auditory attention during a parallel visual task. Participants were asked to perform a visual judgment task and ignore the auditory stimuli in the background. The P3a evoked by the novel sound was measured. The EEG recording was conducted before and after a one-year training program in a primary school. 123 children (age from 7 to 11 years) were recruited and randomly assigned to three groups: music, second language, and passive control. Music and language groups were given extracurricular lessons twice a week. There was no significant group x time interaction for P3a amplitude or latency. The main effect of time on the P3a latency was significant, P3a latency being longer in post-test than in pre-test. So, while the training programs had no effects on attentional control (as indexed by the P3a), prolonged P3a latency may indicate more focused auditory attention during the visual task. Since this was seen in all three groups it was most likely caused by maturation.

Music Upper Limb Therapy - Integrated (MULT-I): A Mixed Methods Study

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Gather.town: Room 6 Code 21

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Objective: To test the efficacy of MULT-I, a combined music therapy and occupational therapy group intervention, to improve physical, emotional and social well-being post-stroke. Methods: Thirty adult stroke survivors were randomized to either MULT-I or the control intervention, which consisted of a self-led home exercise program (HEP). Pre- and post-intervention assessments included the upper limb Fugl-Meyer Scale (FMS), the Patient Health Questionnaire (PHQ)-9 and a semi-structured interview. Nineteen participants (n=10 for MULT-I and n=9 for HEP) completed the assessments within 10 weeks of the intervention and were included in the analysis. Results: Despite randomization, at baseline, MULT-I participants were more acute with greater impairment of upper limb function. Nonetheless, MULT-I participants significantly reduced median depression levels on the PHQ-9 ($p = 0.049$) while HEP participants significantly improved median hand and wrist function on the FMS ($p = 0.029$). Between-group comparisons approached significance. Qualitatively, MULT-I provided emotional support, enjoyment and social interaction, while HEP allowed convenience and one-on-one physical assistance from caretakers. Conclusions: The MULT-I intervention demonstrates support of emotional and social well-being of stroke survivors with high levels of upper limb impairment. Future research will investigate how the MULT-I intervention can be tailored based on level of impairment to optimize outcomes.

Brief working memory increases after music-feedback exercise in people with stroke

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Gather.town: Room 6 Code 22

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Jymmin® is an intervention combining the benefits known to both physical exercise and making music, and can be used as an addition to established therapeutic interventions in neurorehabilitation. Transforming strenuous movements into musical sound, Jymmin® has been shown to lead to significant benefits, for example reduced physical exertion, improved mood, increased self-efficacy experience during drug rehabilitation, reduced pain perception, and improved divergent thinking. In the context of neuro-rehabilitation it has been shown to be a practical tool during unilateral hand training post-stroke. Using a cross-over design (N = 8), this pilot study investigated the feasibility of Jymmin® during cognitive rehabilitation and its immediate effects on executive functioning in subacute and chronic stroke survivors (Mtime since stroke = 60.7 weeks, SD = 21.14). Results indicated that Jymmin® is a feasible intervention that can be applied during the rehabilitation of stroke and that the participants explicitly enjoyed doing. Wilcoxon Signed-Rank tests compared group differences and indicated positive effects on the performance during a task requiring working memory after a single session ($p = .033$), as compared to exercise combined with passive listening. A possible explanation for this effect lies in "musical agency", relating to the potential of combining music creation and physical exercise to induce positive affect, also leading to greater physical endurance.

Rehabilitative effects of choir singing on verbal, emotional and social functioning in chronic post-stroke aphasia: a randomized controlled cross-over trial

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Gather.town: Room 6 Code 23

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Aphasia is one of the most common and debilitating consequences of stroke. Despite treatment efforts, over 60% of aphasic stroke patients show language impairments one year after stroke. While individual singing-based methods, such as melodic intonation therapy (MIT), have been used successfully in aphasia rehabilitation, little is known about the clinical efficacy of group-based singing in aphasia. Using a cross-over RCT design, 50 stroke patients with chronic non-fluent aphasia and their family members (FMs) were randomized to two groups that received a 4-month singing intervention that consisted of weekly choir training and group MIT and home-based singing training using a tablet computer. Outcome measures comprised language and cognitive tests and questionnaires performed three times (baseline, 5-month, 10-month). Compared to the control group, the singing intervention group showed significant improvement in subjective communication and social participation and caregiver (FM) well-being and burden as well as, to a lesser extent, in naming ability (WAB Naming). Subgroup analyses showed that singing improved naming ability especially in mild-moderate aphasia and subjective communication and social participation especially in severe aphasia. These findings suggest that group-based singing training is a viable and beneficial method to support recovery from post-stroke aphasia, even at the chronic stage which is traditionally considered resistant to change.

Electronic music boxes as a tool for spousal couples living with dementia: A feasibility study

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Gather.town: Room 6 Code 24

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

There is growing evidence that music is one of the most effective care interventions for dementia. Music therapy for dementia involves interactive interventions, where clients play or sing with a therapist, and receptive interventions that focus on clients listening to music that they have strong emotional connections to from their past. Interactive interventions can provide additional benefits to receptive interventions but possibilities are more limited for individuals without musical training. We report a feasibility study that investigates electronic music boxes as a means for individuals with dementia and their spousal caregivers to make music together, irrespective of musical training. E-music boxes transform rotational movements into digital musical output, allowing people with no musical experience to play duets together. We first developed a visual interface, a duet song database, and temporal smoothing parameters to allow older couples to play together the recorded songs from their youth. We then iteratively collected rich, contextualized descriptions of couples' experiences playing the songs together and used those descriptions to make improvements to the E-music box system. We first recruited couples unaffected by dementia and then couples in which one partner was diagnosed with early-stage dementia. We discuss the couples' experiences and identify key features that increase their likelihood of having enjoyable and evocative musical experiences with one another.

The neural mechanism of pain modulation by music: a perspective from the personality

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University of Electronic Science and Technology of China

Gather.town: Room 6 Code 25

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Pain is a subjective feeling which has a negative impact on human mental health. Among numerous ways of pain relief, music therapy, which has no side effect is proved effective in many cases. However, its neural mechanism still needs to be clarified. In this study, we use EEG to explore the neural mechanism from the perspective of personality, which is an important factor for the pain relief.28 participants were recruited under the sixteen personality factor questionnaire. The pain was induced by putting hands into the cold water. Meanwhile, participants were listening to a piece of happy music and their EEGs were recorded. After the experiment, they were divided into the remission group and the non-remission group.The functional connectivity between the prefrontal lobe and the occipital lobe in the remission group is weaker than that in the non-remission group ($p<0.01$) in the alpha band, which has been shown as the perceiver of pain modulation. The clustering coefficient and the global efficiency are negatively correlated with abstractedness personality index in the remission group ($p<0.05$). Our study shows that individuals with abstractedness personality could have better effects on the pain modulation by music and the clustering coefficient and the global efficiency could be the neural index. These findings can help understand the effect of music therapy on pain.

The effects of a learner-centred music training program on intrinsic and extrinsic motivation

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Gather.town: Room 6 Code 26

Subtheme J - Music Intervention Programs – Community and Education

According to self-determination theory, autonomy-supportive contexts tend to enhance intrinsic motivation, while controlling contexts tend to undermine internal regulations. Autonomy support refers to the ability of the instructor to take the student's perspective while providing pertinent information and opportunities for choice and minimizing the use of pressure and demands. In the last decade an innovative learner-centred orchestral music training program has been developing. In this study we wanted to investigate the effect of this specific music program on intrinsic and extrinsic motivation. We recruited 130 children 8–10 years of age, enrolled in public schools in Southern Italy. Half of them attended 3 months of an orchestral music training while the rest of the children did not have any music training (control group). The training included two hours lessons per week during the afternoon and a final concert. All children were administered the Academic Self-Regulation Questionnaire (ASRQ) near the beginning and end of the 3-month period of orchestral music training. Compared to the control group, children in the music group showed significantly larger reduction of external motivation. Moreover, the children that underwent the music program showed a significant increase of intrinsic motivation. The results suggest that learner-centred music training is able to modulate intrinsic and extrinsic motivation. This research has implications for music pedagogy and education.

POSTER SESSION 3
Online in Gather.town

Poster rooms 7-12
10.45-11.25: Posters 1-14
11.25-12.00: Posters 15-27

Does oxytocin underlie the evolution of joint music making?

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Gather.town: Room 7 Code 1

Subtheme A - Nature vs Nurture in Music

Its cross-cultural omnipresence suggests that joint music making plays an adaptive role in human evolution, e.g. by inducing group-serving cohesion. The neuropeptide oxytocin (OT) which modulates social behaviour provides a promising candidate for a neurobiological underpinning. This study was designed to replicate and expand upon our previous findings that OT improves sensorimotor synchronisation with an unresponsive human partner by reducing tapping variability. Following a randomised, double-blind protocol, single-sex dyads of 72 male and 66 female non-musicians received OT (24IU) or placebo nasal spray during two sessions. Situated in separate testing booths, participants subsequently drummed along to isochronous (120 bpm) or tempo-changing (~100-150 bpm) sound sequences generated by their human partner or an adaptive computer partner employing 10% phase correction. Participants were sometimes deceived to believe they were interacting with a human when their partner was in fact a computer. While the collected female data awaits analysis, the results from the male dyads only partly replicated the earlier study. Specifically, OT decreased synchronisation in the previously tested unidirectional condition. OT also interfered with performance in the more challenging tempo-changing computer condition, but only when males believed their partner was human. These novel findings suggest that OT modulates synchronous musical behaviour in more complex ways than first envisioned.

Adapting to the sound of music - development of music discrimination skills in recently implanted CI users

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Gather.town: Room 7 Code 2

Subtheme D - Music and Development

Cochlear Implants (CIs) are optimized for speech perception but poor in conveying music, especially pitch, melody and timbre. Here, we investigated early development of discrimination of music in recently implanted CI users (CIre). The CIre group was tested twice, 1) shortly after activation of the implant (T1) and 2) approximately 3 months later (T2), using an MMN-paradigm and a behavioral test. For reference, a group of experienced CI users (CIex) and a group of normally hearing (NH) controls were tested once. Four different deviant features (intensity, pitch, timbre and rhythm) at four levels of magnitude (small, medium, large and extra-large) were presented in both tests, adding to a total of 16 variants. While no significant MMN responses were found at T1, CIre showed significant MMN responses for the timbre and pitch deviants at T2. This reflected significant progress in the neural discrimination of these particular deviants. In their behavioral discrimination, CIre scored above chance level at both times of testing for all features, but significantly below the NH reference for all features except rhythm. Both CI groups scored significantly below NH in discrimination of pitch. The CIre group's behavioral discrimination showed no significant progress, suggesting that the early development is more clearly reflected neurophysiologically. Qualitative data showed significant progress in the CIre group's rating of the quality of the sound of music.

On the flexibility of the perception of broken expectations

Pagès-Portabella, C., Toro, J.M.
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Gather.town: Room 7 Code 3

Subtheme A - Nature vs Nurture in Music

In western music, harmonic expectations can be fulfilled or broken by unexpected events. The present study explores the factors interacting with the processing of dissonant violations of context. Previous research described the neural responses of unexpected dissonance but it remains unclear to what extent they can be flexible. In two experiments, we examined to what extent long-term musical training modulates the perception of dissonance and how it interacts with the amount of expectation and the short-term experience. First, we compared the event-related potentials of musicians to dissonant chords placed at intermediate or ending positions of chord cadences. Second, we analysed the ERPs of musicians and non-musicians to a high proportion (50%) of cadences ending in a dissonant chord. We found that the degree of expectation does not influence the early ERPs in musicians. Thus, the enhanced sensitivity to dissonance of expert listeners may prevent them to detect dissonance as a violation of context (as opposed to naïve listeners). We also observed that frequently-occurring dissonance elicits similar early responses regardless of musicianship, but it attracts more the attention of musicians. Musicians may anticipate frequent dissonance because they show less effort in integrating it. Our study suggests that, while dissonance is hard to assimilate as closure of musical context (even if it occurs frequently), musicianship influences the neural mechanisms that are recruited.

Effects of musical training on the morphology and network plasticity of the auditory brain in children and adolescents with either typical development, AD(H)D or dyslexia

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Gather.town: Room 7 Code 4

Subtheme D - Music and Development

Although the relationship between musicality and brain functions has been investigated in cross-sectional studies with different age groups, until now longitudinal studies from childhood to adulthood were lacking. However, such neuroscientific longitudinal observations are indispensable to disentangle the interplay between musical aptitude, the biological maturation of auditory functions and learning-induced plasticity. Since 2009, we have conducted an extensive longitudinal study with 220 children / adolescents with either typical development, AD(H)D or dyslexia and five follow-up measurements from elementary school age (7-8 years) until adulthood (18-19 years). MRI revealed time-invariant stable markers of musicality in right auditory cortex (enlarged Heschl gyri with characteristic gyrification patterns), which were present already at the outset of formal musical education. Musical training had a substantial influence on the functional activation of the auditory brain, as measured by fMRI and MEG. The more the participants had practiced their instruments, the faster and more synchronized were their auditory responses across hemispheres. This effect was highly relevant for participants with developmental disorders, who showed remarkable temporal asynchronies of 20-40 ms. These novel findings do not only shed light on the neural foundations of auditory dysfunctions, but also bear a considerable potential for hearing-therapeutic, diagnostic and music-pedagogical applications

Musical sophistication and mental speed in the Danish general population

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Gather.town: Room 7 Code 5

Subtheme A - Nature vs Nurture in Music

The common belief that musical training is strongly linked to superior cognitive function is mainly supported by evidence from experimental group designs. However, due to the shortage of scientific instruments measuring musical expertise on a continuous scale and in a multifaceted way, it is unclear to what degree this association extends to the general population. We report preliminary results of an ongoing study to a) validate a Danish version of the Gold-MSI, a self-report questionnaire that fills this gap, and b) to collect performance data on a mistuning perception test (MPT) and auditory and visual reaction time (RT) tests. Significant correlations (current N = 143, age: 18-26) are observed between visual RTs and musical training ($r = -.28$, $p < .001$), RTs and MPT ($r = -.33$, $p < .001$) and RTs and self-reported perceptual abilities ($r = -.34$, $p < .001$). This is consistent with a model that links mental speed (as measured by visual RTs) with musical training. However, mediation analyses suggest that the influence of training on RTs is fully mediated by self-reported as well as by objectively measured perceptual abilities. In both analyses, the direct effect is non-sig. ($p = .365$ and $p = .056$) and the indirect effect is sig. ($p = .011$, $p = .01$). These preliminary results confirm the usefulness of the Gold-MSI subscales to capture different aspects of musical expertise and challenge the notion that mental speed in musicians is a direct or exclusive result of musical training.

Perceived Cultural Distance in Music

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Gather.town: Room 7 Code 6

Subtheme I - Cross-cultural Studies

Globalization threatens to homogenize music with alarming implications on music perception. Music perception involves using previously internalized, culture-specific regularities to process incoming musical structures, which cultural distinctiveness has been conceptualized in the 'cultural distance hypothesis', and quantified by IDyOM, a computational model on music cognition. Within the predictive coding framework, this study served three scientific ends: 1) to empirically validate the cultural distance hypothesis; 2) to determine if individuals can categorize melodies according to their cultural origin (in- vs. out-culture); 3) to examine whether categorization performance correlates with individual traits such as musicality, personality ('openness'), and/or implicit cultural bias. We addressed these questions on 100 adult Chinese participants using behavioral tests (Musical Ear Test, MET and Implicit Association Test, IAT), centered around a task of categorizing melodies from either ambiguous or distinct Chinese or Western traditional folk songs. Our results showed that participant's cultural categorization of melodies was significantly better for melodies of high cultural distance (distinct), but insignificant for ambiguous melodies. MET results correlated positively with ambiguous melody categorizations and low-scoring MET participants exhibits a stronger likelihood of making in-culture categorizations regardless of melodic origin, suggesting a music-sensitive cultural bias. We speculate that Chinese listeners are affected by globalization either by an obstruction of appropriate internal model application or due to bimusicalism.

Predictors of exerted force in a music-cued sensorimotor synchronization task

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Gather.town: Room 7 Code 7

Subtheme H - Music and Aging

Rhythmic auditory cueing is increasingly used in clinical settings such as movement rehabilitation, and personalizing such interventions is thought to facilitate treatment effectiveness. In two studies, 159 healthy young and older adults (70 males; age 18-87; M = 36; SD = 21.5) completed finger tapping tasks using 38 different music stimuli, measuring the tapping force as an index of exertion. Participants rated each stimulus, and completed cognitive tasks. A linear mixed model assessing musical preference, familiarity, and their interaction as predictors of tapping force, revealed preference was a modest but significant predictor (estimate = 0.018, SE = 0.007, $p < 0.05$), in line with previous research associating preference and movement displacement. Participants also tapped significantly harder to music which they indicated to be uplifting (estimate = 0.017, SE = 2.21, $p < 0.05$), this may be due to the motivating effects of music. Lastly, performance on the Stroop task predicted applied force (model estimate = 0.72, SE = 0.27, $p < 0.02$), as supported by evidence attributing variance in motor planning speed to psychomotor speed and executive function. No effects of aging on tapping force were observed. These preliminary findings further support the personalisation of music-cued interventions in rehabilitation of movement disorders, by using uplifting music that is preferred by the patient, while neurocognitive testing may indicate the ability to engage in such interventions

How learning to play musical instruments shapes the adult brain: Insights from longitudinal research

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Gather.town: Room 7 Code 8

Subtheme A - Nature vs Nurture in Music

Learning to play a musical instrument is a complex task that integrates multiple sensory modalities and higher-order cognitive functions. Therefore, musical training is considered a useful framework for the research of training-induced plasticity. Cross-sectional studies identified structural and functional differences between the brains of musicians and non-musicians, especially in regions related to motor control and auditory processing. However, the classical nature-or-nurture question whether these differences are due to predispositions or result from the training itself remains. Few longitudinal studies showed functional changes between pre- and post-training conditions, including passive listening and music production in the motor network and its connectivity with the auditory system. Parallel changes within the motor system and between the motor and auditory systems were revealed for structural connectivity. In addition, potential predictors of musical learning success were found including increased brain activity in the auditory and motor systems during listening, the microstructure of the arcuate fasciculus, and the functional connectivity between the auditory and the motor systems. Here we present a review of recent publications and experimental design for an upcoming project aiming at understanding both brain reorganization and the neuronal markers of predispositions when learning to play a keyboard.

Associations of Individual differences in Inter-hemispheric structural connectivity with music perception abilities minimally dependent on training

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Gather.town: Room 7 Code 9

Subtheme A - Nature vs Nurture in Music

Individual differences in music perception skills are driven by a number of factors that stem from and are differentially weighted by both nature and nurture. This can sometimes be reflected in the structural architecture of the brain involving a number of grey matter regions and white matter connections between them. However, only a very few studies have tried to study gradations of music perception abilities minimally dependent on training in a broad spectrum of individuals ranging from little to no musical training to expert professional musicians. To explore this, the Profile of Music Perception skills- short version (PROMS-S) was administered to a heterogeneous group of 27 individuals (Age 24.3 ± 2.7 years, 14 M) with different degrees of musicianship status and musical training (0-18 years) ranging from non-musicians to professional musicians. Structural neuroimaging data that included T1 weighted MPRAGE images and High Angular Resolution Diffusion Imaging (HARDI; 64 directions, b value of 2000s/mm2 and a single unweighted b0 image) were also acquired. Network based statistics (NBS) revealed positive linear associations between PROMS-S d prime total scores and a widespread fronto-temporal and motor network of structural connectivity that were predominantly inter-hemispheric. Similar associations were also observed with sub-scores in the tonal domain like Rhythm and Embedded Rhythms, probably elucidating it's more universal and minimally training dependent nature.

Does listening to music increase your ability to discriminate musical sounds?

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Gather.town: Room 7 Code 10

Subtheme A - Nature vs Nurture in Music

Music listening plays an important role in the daily lives of many. It remains unclear what explains variation in how much time people spend listening to music and whether music listening improves musical auditory discrimination skills. In 10,780 Swedish twin individuals, data were available on hours of music listening, musical engagement and musical auditory discrimination. Genetic and shared environmental factors together explain half of the variation in music listening in both sexes. Hours of music listening was positively associated with musical auditory discrimination in both sexes and this effect was independent of whether individuals played a musical instrument. However, the effect disappeared when applying a co-twin control analysis to control for genetic and shared environmental confounding. These findings suggest that music listening may not causally improve musical auditory discrimination skills, but rather that the association is likely due to shared familial factors.

Orff-based music training induces plasticity in the developing brain – a behavioral and neuroimaging longitudinal study

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Gather.town: Room 7 Code 13

Subtheme D - Music and Development

Music training is a well-known model for studying plasticity. Here, we investigate near and far transfer effects of music training on children's behavior and brain plasticity. We conducted a longitudinal training study to compare the effects of a 6-month collective Orff-based music training to those of an analogous training in sports and to a passive control group with no specific training. Fifty-eight children participated in the study (33 girls; mean age 8.29 years). Prior to training, children were pseudorandomly assigned to either one of the groups matched on major cognitive and demographic variables. Behavioral measures on cognitive abilities and brain structural MRI were collected at pre-test and post-test, and the training programs were conducted within the regular school activities of a low-income community. Music-specific benefits were found in near transfer domains, such as music and motor abilities, but far transfer effects in visuo-spatial short-term memory, pseudoword reading and simple arithmetics were also found. Music training drove plasticity on gray-matter volume of the left cerebellum that related to rhythm discrimination at pre-test and correlated with gains in motor performance, suggesting the role of music training in strengthening audio-motor integration. A short and affordable music training was sufficient to induce specific behavioral benefits partially reflected in plastic changes in the children's brain.

Newborns Brainstem Neuroplasticity and Music: First Data of a Randomised Control Trial

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Gather.town: Room 7 Code 14

Subtheme D - Music and Development

Exploring the perinatal nootropic potential of music, a small number of studies have successfully managed to discuss early neurophysiological evidence. These studies have mostly shown an interest on cortical activation. Few of them have also explored the brainstem; mainly focusing on 3 y/o children and above. In fact, there is no neurophysiological study exploring newborns' brainstem neuroplasticity through music. Our study, trying to fill this gap, follows a randomised control trial approach to measure full-term newborns (APGAR score 8+) in the first 10 days postpartum. We recruited newborns in Latifa Hospital Dubai (Dubai Health Authority approved) to form two different intervention groups (Music and Story passive listening while breastfeeding) and a control group (no intervention) (n=40x3=120) while we use the auditory brainstem response to study brainstem maturation pre and post the 7 days intervention application. Based on the concerned literature, we hypothesise to find a statistically significant faster brainstem (pre-post) maturation pattern on the music group, shown in the recorded Δ _of the peak V latencies; in the recorded Δ _of the inter-peak (V-III;V-I) latencies; and in the extended amplitude Δ _of the V-SN10 complex, evoked on a recurring (65-45-35dbnHL) ckABR exposure. This poster will more specifically present statistical trends recorded from the first 10 newborns, and will compare the results on newborn norms previously recorded in the first 96 hours postpartum.

Defining Features of Music Practice by Artist-level Performers and Their Students

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Gather.town: Room 7 Code 15

Subtheme D - Music and Development

We focus on the thinking and behavior that underlie artist-teachers' practice in order to characterize the differences between their work and that of highly skilled music majors. Three artist-teachers learned an unfamiliar 14-measure concerto excerpt in individual practice sessions that were video recorded. At the conclusion of each practice session, they performed the complete

passage three times. Six students from each of their applied studios were recruited to complete the same process, and immediately afterward, they watched their artist-teachers' video and described what they noticed about their teachers' practice. Content analysis of all video recorded practice and examination of coded student interview data revealed that both groups of musicians implemented common practice strategies, but there was a marked difference in their practice approach. Artist-teachers performed expressively over the course of learning, allowing their conceptions of beauty and expressivity to focus their attention on the physical and auditory goals of performance. All students commented on this striking feature of expert practice, reacting to their teachers' expressive approach to learning. Our behavioral observations and interview data suggest that a critical component of continued musical development is the focus on expressive aspects of music performance, which serve as the unifying element around which all physical and perceptual tasks cohere.

Musical aptitude, music training and digit span in children and adults

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Gather.town: Room 7 Code 16

Subtheme D - Music and Development

There is substantial interest in understanding how musical factors correlate with nonmusical cognitive abilities. Here, we examined strength of associations of two musical factors (aptitude and training) with forward and backward digit-span performance. With training held constant, correlations with music aptitude suggest that the associations are due to factors independent of training. With aptitude held constant, associations with music lessons suggest factors specifically relevant to training. Musically trained and untrained adults (Study 1) and children (Study 2) completed tests of digit span (forward and backward) and music aptitude (Study 1: Musical Ear Test; Study 2: the short version of the Montreal Battery of Evaluation of Musical Abilities). We also collected information about participants' history of music lessons and socioeconomic status (SES). Across studies, both music training and music aptitude had significant simple associations with forward and backward span. With training held constant, aptitude was significantly correlated with forward span in both studies, but the association with backward span was only evident in adults and not in children. With aptitude held constant, music training was associated with backward span, but not with forward span. This association persisted even when SES and forward span were held constant. In sum, whereas forward span is important for aptitude-test performance, backward span is more important for music training.

Variability in white matter organization in infancy is prospectively associated with subsequent musicality in early childhood

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Subtheme D - Music and Development

The study of musical training as a framework for structural plasticity has evolved dramatically over the past decade. Characteristic structural alterations between musicians and nonmusicians have been identified, with emerging longitudinal evidence depicting training-induced plasticity. However, putative neural predispositions have also been proposed, which raises an intriguing question of whether training effects may be influenced by variability in brain structure in early childhood. To address this, the present study investigated whether white matter organization in infancy relates to subsequent music aptitude skills in preschool. Initially, structural neuroimaging was successfully acquired with infants (ages 4-18 months) using a natural sleep technique. Automated Fiber Quantification was employed to estimate fractional anisotropy (FA) of key tracts previously implicated in the musical training literature. Infants were then reinvited for follow-up in preschool, and 26 completed music aptitude assessment. Longitudinal analyses establish significant relationships between FA in the (i) bilateral corticospinal tract in infancy and subsequent rhythm discrimination skills, and (ii) right corticospinal tract and tonal discrimination skills in preschool. This research provides developmental evidence in early childhood to support the notion that white matter organization prior to the onset of formal training may serve as a scaffold upon which ongoing experience can build.

When Amnesic Patients Learn New Melodies: A Comparative Analysis Between Alzheimer's Disease and Korsakoff's Syndrome

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Subtheme H - Music and Aging

Alzheimer's Disease (AD) and Korsakoff's Syndrome (KS) are two different forms of severe anterograde amnesia. However, recent findings suggest that familiarity-based musical learning may be preserved in AD patients. In this study, we aim at identifying whether such musical learning is preserved in both forms of amnesia by comparing AD and KS patients. 10 patients with Moderate AD (MMSE m=18.8±3.1), 16 patients with Severe AD (MMSE m=8.75±2.4), 6 KS patients (MMSE m=25.0±1.1) and 47 healthy controls (MMSE m=28.6±1.3) were included in the study. Participants underwent daily exposure sessions of 8

unfamiliar songs. Then, these songs were presented amongst distractors (unknown and well-known songs) during a recognition task. Results indicate that despite severe episodic memory deficits, amnesic patients are still capable of musical learning. More precisely, both AD groups took a longer time to learn the exposed songs as compared to KS patients and controls. This result could be explained by a gradient of episodic memory deficits. However, during the testing phase, all groups succeeded in recognizing at least 75% of the learned songs. These findings suggest that the implicit acquisition of new songs is indeed possible in AD and KS patients, which puts into question the usual vision that amnesic patients are unable to acquire new information. This new perspective offers opportunities for improving care of patients with amnesia.

„Song of Life": First results of a multicenter, randomized trial on the effects of music therapy in palliative care

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Gather.town: Room 7 Code 19

Subtheme H - Music and Aging

Palliative care patients commonly report stress-related symptoms, both on a physical (e.g., fatigue) and a psychological level (e.g., anxiety). Still, research on psychosocial interventions combining psychological and psychoneuroendocrinological outcomes is rare. The purpose of the present study thus was to investigate the effects of music therapy on subjective distress as well as stress biomarkers. 104 patients from two palliative care units were randomly allocated to three sessions of either music therapy or relaxation. Before and after the second session (N = 89 participants), patients assessed their momentary distress and delivered three saliva samples for cortisol and α-amylase analysis. In addition, continuous photoplethysmography recordings were used to compute mean heart rate and heart rate variability. Data analysis included multilevel modeling of all available data and sensitivity analysis with multiply imputed data. Results revealed a significant time*treatment effect on distress ($b = -0.83$, $p = .02$) pointing to a greater reduction in the music therapy group. There were no interaction effects regarding psychobiological outcomes (all $p > .05$), but a significant reduction in cortisol ($b = -0.06$, $p = .01$) and mean heart rate ($b = -7.89$, $p = .05$) was observed over time regardless of the intervention. The study indicates a beneficial effect music therapy on distress while no treatment effects on psychobiological outcomes were found. Future studies should further explore optimal stress biomarkers for research on music therapy in palliative care.

Can we automatically assess cognitive impairment using Brain-Computer interface and Music?

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Gather.town: Room 7 Code 20

Subtheme H - Music and Aging

Formal neuropsychological assessment is critical for optimizing patients' treatment, yet it requires expert personnel and may last several hours. Recently, Brain-Computer Interface (BCI) with inexpensive mobile EEG devices has been used to assess mental workload in healthy participants. However, such investigations are still lacking with regard to aging and cognitively impaired populations. Additionally, BCI-guided mental workload assessments have mostly focused on the visual modality, although the auditory modality may be more appropriate for automatically administered tasks. In this exploratory study, we created auditory versions of the n-back task, the difficulty of which could be adapted to test both healthy and cognitively impaired participants. We used the Neurosteer single-electrode EEG mobile device, once with healthy participants and once with geriatric patients. The behavioral hit rate of geriatric patients on the easy auditory n-back task was highly correlated with their mini-mental score previously established by clinicians, thus validating our task. The BCI results revealed a novel neuro-marker of mental workload, the VC9, extracted using a wavelet based on harmonic analysis from the delta frequency bands. The VC9 increased with cognitive load in both auditory n-back tasks and was negatively correlated with the participants' performance. These preliminary findings may lead the way towards an automatized BCI cognitive assessment with auditory tasks.Formal neuropsychological assessment is critical for optimizing patients' treatment, yet it requires expert personnel and may last several hours. Recently, Brain-Computer Interface (BCI) with inexpensive mobile EEG devices has been used to assess mental workload in healthy participants. However, such investigations are still lacking with regard to aging and cognitively impaired populations. Additionally, BCI-guided mental workload assessments have mostly focused on the visual modality, although the auditory modality may be more appropriate for automatically administered tasks. In this exploratory study, we created auditory versions of the n-back task, the difficulty of which could be adapted to test both healthy and cognitively impaired participants. We used the Neurosteer single-electrode EEG mobile device, once with healthy participants and once with geriatric patients. The behavioral hit rate of geriatric patients on the easy auditory n-back task was highly correlated with their mini-mental score previously established by clinicians, thus validating our task. The BCI results revealed a novel neuro-marker of mental workload, the VC9, extracted using a wavelet based on harmonic analysis from the delta frequency bands. The VC9 increased with cognitive load in both auditory n-back tasks and was negatively correlated with the participants' performance. These preliminary findings may lead the way towards an automatized BCI cognitive assessment with auditory tasks.

Asymmetrical ageing of singing and speech in the brain—preliminary results from a cross-sectional fMRI study

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Gather.town: Room 7 Code 21

Subtheme H - Music and Aging

In young adults, singing induces more extensive bilateral activation in frontal and temporal regions than speech. In neurocognitive models of ageing, speech processing has been linked to increased bilateral recruitment of frontal, temporal, and parietal regions, whereas potential age-related reorganisation of singing networks is still unknown. In an ongoing cross-sectional fMRI study, we compared young (20–39 years old), middle-aged (40–59 years old) and older (60–89 years old) adult non-musicians (N = 100) to examine ageing effects in the functional activation patterns of speech and singing. In a 3x2 fMRI design, subjects produced song and speech (proverb) phrases by (i) repeating them, (ii) completing their ending from memory and (iii) improvising an ending to a novel phrase. Results indicated clear ageing effects in speech tasks, with the old group showing increased activation in left parietal and bilateral cerebellar areas in repeating, right frontal areas in completing, and right frontal and bilateral parietal areas in improvising compared to the young or middle-aged groups. In singing tasks, the old group showed increased left parietal activation in completing, but there were no ageing effects in the other tasks. In sum, these preliminary results suggest that ageing may induce more extensive reorganisation in speech than in singing networks.

Is experience playing a musical instrument related to lifetime change in cognitive ability?

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Gather.town: Room 7 Code 22

Subtheme H - Music and Aging

Observational research into the benefits of learning to play a musical instrument suggests that this activity is related to some cognitive advantages in childhood and in older age. However, little is known regarding the potential effects of playing a musical instrument on cognitive change occurring across the life course. Data from the Lothian Birth Cohort 1936 (LBC1936) provides a rare opportunity to examine the relationship between experience playing a musical instrument and cognitive change occurring between ages 11 and 70. In this study, we will test whether LBC1936 participants with greater experience playing a musical instrument perform better on a test of cognitive ability at age 70 than would be expected given their score on the same test at age 11. This will be the first study to test for an association between playing a musical instrument and cognitive change over a ~60-year follow-up period and will provide valuable insight regarding the relationship between instrumental experience and cognitive ability across the life course.

A RCT on the benefits of music therapy in care homes: Improvements in cognitive, wellbeing and physiological measures

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Gather.town: Room 7 Code 23

Subtheme H - Music and Aging

Music therapy (MT) can be used to mitigate the effects of cognitive aging and enhance wellbeing in older adults with neurocognitive disorder. However, the scientific quality of studies evaluating the effectiveness of MT is inconsistent, which limits the results generalizability. We report on a pre/post RCT study, combining neuropsychological tests and biomarkers. 43 adults aged 65+ with mild-moderate cognitive impairment living in UK care-homes were randomly assigned to either an experimental or active control group attending one2one 40-min MT or Story-Telling (ST) weekly for four months. The interventions were matched based on improvisation and the mood-matching approach [1]. Assessment included: a) standardized cognitive-behavioural neuropsychological tests; b) a novel neuropsychological test created to assess cognitive functions stimulated by music tasks (Music Cognitive Test) [2]; c) wellbeing; d) a measure of autonomic regulation, Respiratory Sinus Arrhythmia (RSA); e) Salivary Cortisol/DHEA ratio; vi) EEG cortical-entrainment [3]. Overall, convergent outcomes showed MT>ST in both neuropsychological tests and biomarkers. Results elucidate the relationship between different types of measures in monitoring the effectiveness of MT to mitigate decline in cognitive functions and wellbeing with ageing, hence supporting the suitability of MT for social prescribing.

Protective effects of a lifetime of music practice

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Gather.town: Room 7 Code 24

Subtheme H - Music and Aging

Life expectancy is currently greater than decades ago, also rising the prevalence for cognitive impairment. Carriers of some dementia-related genetic variants, such as APOE-ε4 allele, show neural and cognitive deterioration before the onset of dementia symptoms. Studying factors able to delay cognitive decline, even when carrying the genetic risk, is, thus, of outmost importance. Music practice has been suggested as one of those factors since it plastically alters brain networks, increasing cognitive reserve. Here, we compared a single professional musician (MSCL, female) with a group of sex, age and education matched non-musicians (NM, n=5). Participants completed: a neuropsychological assessment of general cognitive, verbal, memory, and visuo-spatial abilities; an MRI scan session, from which structural data was parcellated using FreeSurfer; and a MEG resting-state session to obtain the alpha peak frequency, a marker of neurological ageing. Despite being older and an APOE-ε4 carrier, MSCL showed significantly greater grey-matter volume (GMV) than the NM group (>2SD from NM mean) in right inferior frontal gyrus, right precuneus, left thalamus, right putamen, and caudate bilaterally. GMV in these regions correlated with logic memory, verbal fluency and visuo-spatial abilities. Also, alpha peak frequency showed a tendency to be greater in MSCL than in NM, not reaching significance. Our results point to a protective effect of a lifetime of music practice against dementia risk.

Walking and rhythm: understanding cognitive-motor interactions in aging using a dual-task paradigm

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Gather.town: Room 7 Code 25

Subtheme H - Music and Aging

Cognitive and motor tasks draw on common prefrontal resources in the brain. Competition for common resources results in costs to performance while simultaneously performing cognitive (e.g., talking) and motor (e.g., walking) tasks. Multi-tasking is age-sensitive, as costs to performance are larger for older adults compared to young adults. Research shows that walking to an auditory beat (i.e., rhythmic auditory cueing) can facilitate walking in patients with Parkinson's disease. How rhythmic properties and complexity of a secondary task interact to impact walking stability in the context of normative aging is less well known. We investigated these issues with the dual-task design. Young (n = 15) and older adults (n = 5) performed a listening task and a walking task separately then simultaneously. The listening task had three levels of complexity. In the Simple condition, participants synchronized their steps to a series of low tones, in the Moderate condition to a series of low tones and high tones, and, in the Complex condition to a series of low and high tones while responding via a manual clicker each time they heard a target pattern of tones. Preliminary results suggest that walking, as measured by the coefficient of variation of stride time, was less stable under dual-task conditions compared to single-task walking. The magnitude of dual-task costs was greater for older adults. Contrary to predictions, walking to an auditory beat did not facilitate walking performance.

Affective responses to musical harmony in remote villages in Papua New Guinea

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Gather.town: Room 7 Code 26

Subtheme I - Cross-cultural Studies

Music is an essential part of most cultures and is commonly considered to be strongly associated with emotion. The extent to which associations are cross-cultural is, however, widely debated. Associations may originate from: intrinsic psychoacoustic musical features that are not culture-specific; long-term and culture-specific exposure to a corpus of music; or to consistent pairings between specific musical features and specific affects. But, as yet, there is no consensus as to the relative importance of these different mechanisms and hence no consensus as to the ability of music to communicate consistently across cultures. By testing non-Western communities in a remote area in Papua New Guinea, who have had differing levels of exposure to Western music and its cultural context, we examined whether associations between specific musical features and emotions are learned through longitudinal exposure or might be cross-cultural. Participants from PNG and from Sydney listened to pairs of intervals, melodies, triads and cadences in a forced-choice experiment. We found very strong evidence that roughness, harmonicity, spectral entropy, mode (major/minor) and average pitch affect ratings for Sydney participants. Strong evidence was found for some features for PNG participants. This suggests that the effect of psychoacoustic features on affective ratings of musical fragments is not culture-specific, but that its strength might be dependent on familiarity with a musical system.

Sung improvisation as a new tool for revealing implicit tonal knowledge in congenital amusia

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Gather.town: Room 8 Code 1

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Individuals with congenital amusia have notorious difficulties detecting out-of-key notes. A recent model of amusia proposes that this deficit is caused by the disruption of conscious access to tonal knowledge, rather than the absence of tonal knowledge (Peretz, 2016, TiCS). This model predicts residual tonality in amusic productions such as singing, and indeed, some amusics show the ability to sing well-known songs accurately. However, the tonality of amusic singing has never been measured systematically. Here we asked amusics (n = 18, M = 57.0 ± 4.9 years) and controls (n = 15, M = 58.6 ± 5.5 years) to improvise melodies (n = 28 each). The number of notes per improvised song was similar for both amusics (M = 41.5 ± 31.5) and controls (M = 41.0 ± 29.1). The tonality of each song was assessed by comparing the proportion of in-key notes (PIK) relative to the closest key (Krumhansl-Schmuckler), which was z-transformed (zPIK) against a distribution of randomly-generated pitch sequences of matching length. The average zPIK score was greater than chance (i.e., z-score of 0) for both amusics (M = 0.64 ± 0.91) and controls (M = 1.79 ± 1.36). Moreover, the final note in 30.6% of amusic and 41.1% of control improvisations was the tonic of the closest key (chance = 1/12 chromas = 8.3%). These results confirm that amusics can access some tonal knowledge, even if unaware. They also demonstrate the utility of sung improvisation as a method to study implicit musical knowledge.

The role of self-other integration in rhythmic social interaction

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Gather.town: Room 8 Code 2

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Rhythmic interpersonal synchronization is a core feature of musical interaction, and has been suggested to play an important role in social relationships. In recent studies individual and dyadic differences have been found to result in multiple synchronization strategies such as leading-following and mutual adaptation. These cannot be distinguished based on synchronization measures alone, but instead by the directionality of adaptation and information flow within an interacting dyad. Here, we describe a metastable attractor model of self-other integration, which explains how synchronization strategies arises in dyadic rhythmic social interaction. The model describes synchronization strategies as dependent on individual's levels of integration between other-produced and self-produced actions. This results in a nonlinear metastable dynamic system with two main attractor states, one where an individual maintains two separate internal models where one is self-related and separate from the other-related model. The other attractor state exists where these two models fuse into one, forming an action-perception loop aligning produced and observed behaviour. Together, this system explains dyadic synchronization strategies as a function of individual's self-other integration. We propose that the function of self-other integration in rhythmic social interaction is performed by a brain network with key contributions from the temporoparietal junction, precuneus, and supramarginal gyrus.

Effects of experimentally induced emotion on sensorimotor synchronization

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Gather.town: Room 8 Code 3

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Synchronizing to external rhythm involves making predictions about the timing of the next beat. Affective states serve as an overall indicator of the body's allostasis, affecting many cognitive functions. The aim of this study is to explore relationships between affective states and the ability to synchronize one's tapping with changes in given tempo. The hypothesis, based on previous research, is that negative valence will decrease one's ability to adapt to changes in tempo, in comparison to positive valence. This effect is expected to be more salient when slowing down is required, which may be caused by distortions in the sense of time due to negative affect. A study of 30 non-musician volunteers is currently underway. In a repeated measures design the participants are exposed to different emotion inducing pictures from the International Affective Pictures System. The stimuli differ in valence (positive, negative or neutral) while being similar in arousal. The participants then undergo a sensorimotor synchronization tapping task, where the tempo changes four times, every thirty beats. A significant effect of emotional valence on synchronization is expected. Results will be presented on Neuromusic VII. The results will contribute to ongoing discussion about relationships between emotion, perception and motor control in the context of active inference frameworks.

FormingPerforming – new tools for understanding perception and action in musical practice

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

The cognitive processes involved in mastering a classical musical piece at a professional level are difficult to access via traditional research methods, as it entails a complex blend of analytical strategies, automated motor learning expertise and emotional and imaginative involvement. With this project, I have systematically used first-person methods such as self-observation and reflection in order to search for categorization and conceptualization of important aspects of the learning process. The method involved in my investigation was primarily observation of video recordings of my own piano practice. Around 70 hours were recorded and subsequently reviewed and analyzed applying critical reflection, leading to a set of derived conceptualizations. Some of the videos, including synchronized on-screen analyses, were published on YouTube. Furthermore, the results were published in an e-book. Key findings: Unconscious strategy changes appear rapidly, resistance in the learning process is often resolved covertly and several techniques were developed which increased the speed of learning, such as conscious attention shifts between perception and action as well as self-awareness strategies. The project demonstrates the validity of using a first-person perspective in order to gain new insights directly relevant for professional musicians but also as a way of gaining a better understanding of the cognitive processes involved in advanced level musical practice.

Neural signatures of interacting sensorimotor and temporal expectations during rhythm learning

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

We constantly generate expectations for patterns of events, such as the sensory outcomes of our actions (sensorimotor expectations) or temporal regularities in the environment (temporal expectations). Evidence suggests that sensorimotor and temporal expectations each facilitate pattern learning, but it is not known how they interact. We investigated how these expectations interact with each other and with individual beat sensitivity in rhythm learning. During EEG recording, healthy adults learned rhythms over series of trials in which they first listened once to a standard rhythm and subsequently either 1) listened again (auditory condition), 2) tapped back the rhythm without auditory feedback (motor condition), or 3) tapped back the rhythm with auditory feedback (auditory-motor condition). In each condition participants also heard and tapped back an infrequent deviation to the standard rhythm with an omission that violated either its beat (regularity violation) or only its onset pattern (rhythm violation). P300 responses were largest to rhythm violations in the auditory condition and largest to regularity violations in the auditory-motor condition. The P300 was largest for individuals with high beat sensitivity in the auditory condition and largest for low beat sensitivity in the auditory-motor condition, despite similar tapping improvements. Sensorimotor expectation may facilitate temporal expectation and potentially compensate for low beat sensitivity in rhythm learning.

Auditory Time Perception and Auditory-Motor Synchronization Deficits in Children with Developmental Coordination Disorder (DCD)

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

DCD is a neurodevelopmental disorder involving deficits in motor coordination, affecting 5-15% of school-age children. Children show deficits in motor and visual-motor timing, but auditory and auditory-motor timing has not been well studied, despite its importance for speech and music perception and production. Given previous research showing motor areas are involved in auditory time perception, we hypothesized children with DCD would have impaired auditory time perception and auditory-motor synchronization. Our first study showed, compared to typically developing (TD) children, children with DCD aged 6-7 have larger perceptual discrimination thresholds for duration and rhythm-based timing, but not for pitch. Our second study investigates auditory-motor synchronization and explores whether auditory rhythmic stimuli can help children with DCD to execute rhythmic motor movements. We are testing tapping phase consistency when tapping alone, with an auditory metronome, continuation tapping (maintaining tapping after metronome stops), and tapping the beat of musical dance excerpts. Data from 7-year-old TD children (n = 40) shows tapping consistency is significantly better when an auditory cue is present than absent. Data collection with DCD children is ongoing, investigating whether they also benefit from an auditory cue. The results will inform whether auditory-motor training may confer additional benefit over motor training alone for children with DCD.

Peg tapping: Task presentation impacts motor inhibition performance in young children.

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Peg tapping tasks are commonly used as a measure of inhibitory skill in young children. However, differences in the way the task is presented may influence children's performance. For example, if a peg tapping task is presented at regular intervals, children can entrain to the presentation pulse, which may in turn support their performance. This study assessed how different aspects of presentation may support or impair children's results. An experimenter was filmed delivering the tapping task at two different speeds (120bpm and 150bpm). Additionally, they were filmed delivering the task at regular intervals (ie. the onset of each trial was predictable) or at irregular intervals (the onset of each trial was unpredictable). 103 children aged between five and six years old were tested on the task. They completed one block with 20 regular interval trials and another block with 20 irregular interval trials. Block presentation order was randomized. Children who achieved over 90% accuracy on the task were then presented with two more blocks at 150bpm. Children's response accuracy and reaction times were measured. Our results show a difference in children's accuracy across all conditions. The study demonstrates how speed and regularity of presentation can affect children's scores on a tapping task used to measure inhibition. Demands on working memory, motor ability and speed of processing are all affected by adjustments in presentation.

The music of smell

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Gather.town: Room 8 Code 8

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

In order to investigate the relationship between olfactory perception and music, we asked trained musicians to smell an odorous sample and, next, to improvise for 20 seconds on a MIDI keyboard. A set of 20 smells was used, which were chosen to be representative of the universe of perfumery scents and also to have pairs of samples with a similar smell aimed at checking consistency (i.e., check that similar musical patterns are inspired by similar odor samples). Our results showed that, even in free improvisation, smells elicited reliable and consistent musical patterns. Smell pleasantness correlated negatively with pitch-class entropy and with two measures of chord dissonance; smell familiarity correlated negatively with dissonance; smell intensity correlated positively with dissonance. The music elicited by the two different lavender samples we used was significantly more staccato that the music inspired by the rest of odor samples. The mean pitch of the improvisations was positively correlated with citrus and odor freshness, which is an important perceptual dimension related with light and daytime conditions. Conversely, the mean pitch was negatively correlated with odors described as heavy (i.e., warm, preferred for night) and animal. This last result seems to be consistent with the well-known luminosity-pitch crossmodal correspondence. A possible field of application is therapy by combining aroma and music.

Temporal illusions and audio-motor synchrony

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Many acoustic features influence the perceived tempo of music. Past research has shown that music appears faster when played in a higher register, louder amplitude, brighter timbre, or with larger pitch intervals. Sequences that ascend in pitch appear faster than those that descend in pitch, and music appears to slow down when its pitch direction changes. Features such as these have been shown to influence not only perceived tempo, but also tempo preferences, neural phase dynamics, and audio-motor synchrony. While pitch intervals and contour changes have been shown to influence motor timing in a continuation tapping task, features including loudness, pitch height, and pitch direction have not been similarly tested. The present study investigates whether these three characteristics of music also influence audio-motor synchrony and tests the extent to which perceived tempo predicts differences in motor timing. In a two-phase experiment, participants first completed a continuation tapping task in which they were asked to tap in time with short melodies of varying loudness, pitch height, direction, and tempo—first synchronizing with the melody and then controlling its tempo with their taps. They were later asked to judge how much faster or slower the same melodies were, relative to a standard reference. Analyses will examine the joint impact of pitch and loudness on perceived tempo and tapping rate, as well as the correlation between these two measures of illusory tempo change.

Dancing with my robot!: A case study of baby´s development of dance moves and interaction with musical toy robot

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Gather.town: Room 8 Code 10

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Studies have shown that similarly to preference of the infant-directed speech mode (motherese), infants also prefer special mode in visual cues (motionese). This case study analyses baby boy R.'s spontaneous bodily reactions from 0-24 months to musical sounds and the interactions with toy robot BeatBo (BB). BB is made of pla-

stic and fabric, bright-coloured and resembles a humanoid-animal hybrid that starts to move side-to-side, talk and play music when its buttons are pressed. R. was 9 months old when he first encountered BB and actively engaged with the toy by crawling towards it and touching BB's buttons. By 12 months of age R. already tried to synchronize his swinging movements with BB. In addition to bodily reactions R. also reacted vocally in response to BB's sounds. During the period of 12-24 months the engagement with BB passed several stadiums including different emotional reactions and play activities. At the end of the observation period, R. had developed different movement routines for different songs played by BB and he defined the action verbally as "dancing with his robot". BB's rather clumsy and slow movements seemed to catch R's attention while also fitting in the concept of motionese. BB produces always the same stable response that may help balance child's emotional state and create safe environment. This encourages social activities like dancing while also providing the child to have control over the situation.

Motor excitability fluctuates in response to an isochronous rhythm

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Gather.town: Room 8 Code 11

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Rhythm perception activates motor areas of the brain. In addition, isochronous stimuli induce oscillations in excitability that are similar in motor and auditory areas. However, changes in motor excitability over the time course of isochronous stimuli have not yet been investigated. Thus, this study examined whether motor excitability fluctuates at the stimulus frequency in response to an isochronous rhythm, and whether the magnitude of excitability fluctuations differs between perception and internal generation of the rhythm. Participants heard a 10-tone isochronous stimulus that ended with a silent period, during which participants continued imagining the stimulus, and a final tone. To measure motor excitability, motor evoked potentials (MEP) were induced using single pulse transcranial magnetic stimulation over M1 while participants listened to the rhythm. MEP amplitudes were organized in a time series to assess excitability changes over audible and silent intervals. Preliminary results suggest motor excitability fluctuations are fit by a cosine model at the stimulus frequency better than at unrelated frequencies, suggesting excitability fluctuates at the stimulus rate. However, the phase of the cosine fits varies across participants. The magnitude of fluctuation doesn't differ between audible and silent intervals. Therefore, although motor excitability fluctuates at the stimulus rate, the phase of fluctuations is not reliably related to the stimulus across participants.

The 'drifting metronomes' paradigm: cooperation and competition in dyadic entrainment

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Music is a form of joint activity which requires an exceptional level of coordination, engaging players in a continuous exchange and integration of multisensory information. Minimal forms of rhythmic interactions such as joint finger-tapping are a valid and controlled approach for investigating the coordination dynamics underlying such a process. Here we propose a novel paradigm specifically designed to drive the dyad through a set of coordinative states (e.g. in-phase and anti-phase), manipulating visual and auditory couplings across conditions. Our behavioral results showed that dyadic entrainment occurred spontaneously, according to modality-specific dynamics. We observed highly consistent coordination patterns in visually-mediated entrainment, whereas its auditorily-mediated counterpart exhibited more variable profiles. Dual-EEG recordings were implemented in the study. Focusing our analyses on brain dynamics in the beta range, we identified a ~20 Hz component whose power was modulated by the phase of the finger-tapping timeseries. Crucially, the same component was also coupled to the partner's movement cycles, which points at the existence of one shared mechanism for tracking self-generate and perceived rhythmic movement. Our findings suggest that such a pacing mechanism in the beta range, previously reported in the context of general motor control and timing, could play a determinant role in dyadic entrainment.

Investigating the link between perception of rhythmic timing and inhibitory control

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Rhythm and timing skills have been linked to inhibitory control in both expert musicians and clinical populations, including individuals with Attention Deficit/Hyperactivity Disorder (ADHD). Previous research suggests beat-based and interval-based timing are supported by basal ganglia and cerebellar pathways, respectively; these pathways are also important for inhibitory control and are implicated in ADHD. However, individual differences in beat-based and interval timing and inhibitory control have not been examined in the general population. We used an online data collection platform to administer beat alignment and interval discrimination tests as well as auditory stroop and go/no-go tasks in a community sample of young adults (n=110, age

18-35 years, including a range of ADHD symptomatology assessed via self-report). Performance on the beat-based and interval-based tasks was not correlated. Both rhythm tasks were correlated with performance on the auditory go/no-go task. Regression analysis revealed that the two rhythm tasks contribute uniquely to go/no-go performance. These outcomes are consistent with the hypothesis that beat-based and interval timing rely on distinct mechanisms, both of which are important for inhibitory control. This study provides a basis for further investigation of rhythm processing and inhibitory control in clinical populations.

Neural correlates of action-based auditory predictions

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Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Sensory consequences of actions are predicted by the brain via an internal forward model to prepare sensory cortical areas, referred to as motor prediction. In a similar vein, the predictive coding framework suggests that perception is based on internal models making predictions about sensory events, using statistical probabilities of stimuli. We used a self-paced, two-choice random generation task, that infrequently induced a deviant outcome from the voluntary action. Participants repeatedly pressed right or left buttons that were normatively associated with a 70 ms long 1 kHz and 2 kHz tone, respectively. Occasional deviants occurred, that inverted the learned button-tone association. Participants were instructed that their button presses should be random, at a regular but self-paced tempo of one press per 1-2 s. They were informed that the tones were task-irrelevant. We analyzed intracranial EEG data recorded from 10 adult patients with drug resistant epilepsy undergoing presurgical monitoring via implanted stereotactic electrodes. Electrode coordinates and anatomical labels were obtained from MRI and CT images using iElectrodes toolbox. Initial results indicate that unexpected action outcomes modulated high frequency band activity (HFA, 75-145 Hz) in distributed brain regions, including temporal and prefrontal cortices. Since HFA has been linked to increased neural spiking activity, we suggest that these brain regions respond to violations of action prediction outcomes.

The Sound of Teaching Music: Experts' sound modulation for novices

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Gather.town: Room 8 Code 15

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

It has been shown that experts modulate their performance of actions for teaching purposes, performing slower and exaggerated movements when demonstrating novel actions to novices. Much less is known about teaching of artistic expressions through performance modulations. This study investigated whether and how expert pianists modulate their playing to demonstrate to students piece-related musical expressions requiring specific techniques, compared to performing the piece with the same notated expressions but without didactic intentions. Expressions in the piece concerned either articulation (i.e., legato and staccato) or dynamics (i.e., forte and piano). The pianists played either with the goal to perform the piece to an audience or with the goal to teach students how to play the piece expressively. Results showed that expert pianists made systematic and fine-grained sound modulations in order to teach expressive techniques to novices: When playing with the intention to teach articulation, they produced shorter staccato. When teaching dynamics, they produced louder forte and softer piano. Moreover, they exaggerated dynamics at structurally important points to create a larger contrast between forte and piano. These findings suggest that ostensive action modulations are performed not only to guide learners' attention but to highlight the most relevant aspects of the actions to be learnt.

Sensorimotor synchronization in blind musicians: does lack of vision influence non-verbal musical communication?

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Gather.town: Room 8 Code 16

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Musical communication can be considered as a form of social interaction and it requires a certain degree of inter-individual cortical synchronization (D'Ausilio et al., 2005). Scientific literature has shown that visual experience is necessary for social interaction (Nogueira Campos 2019) and visual impairment negatively influence nonverbal communication both in children and adults (Doherty-Sneddon, 2003), (Iverson and Goldin-Meadow, 1997). In this study, we investigated the role that visual experience plays in the context of musical interaction. In particular, we tested a mixed interaction context (e.g. visually-blind performers) to identify the patterns of synchronization. We recorded motion tracking data to analyze the interaction between two musicians in three different contexts with the same cellist as soloist accompanied by a 1) blind pianist, 2) sighted pianist, 3) sighted but blindfolded pianist. The recor-

dings comprised a upper-body motion captures and audio data. A model of nonverbal patterns was presented and a human evaluation realized. Results are presented by highlighting the important applications of non-verbal communication studies for music therapy, for example to understand underlying brain mechanisms and identify the most effective therapeutic intervention.

How is nonverbal communication between jazz musicians affected by improvisation?

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Gather.town: Room 8 Code 17

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Nonverbal communication during joint performance can act as a means of information transfer between musicians. Past work in our lab has shown that the body sway of performing musicians reflects information transfer, which subsequently predicts ratings of performance quality. Here, we expand on this work by examining body sway communication during jazz improvisation. Musicians may rely on nonverbal communication to a greater degree during musical uncertainty than when notes are pre-determined by a score. Using motion capture, we are recording body sway of professional jazz duos performing in two conditions: improvisation and a matched non-improvisation control. We are also manipulating which musician takes the lead on different trials. We are using Granger causality to analyze the predictive relationships (bidirectional communication) in the performers' motion time series to determine the strength and direction of information flow between performers. Additional judges are rating performance quality. We expect that (1) there will be higher total information transfer during improvisation, (2) lead musicians will influence following musicians more than vice versa, and (3) overall information transfer will predict ratings of performance quality. It is expected that this study will reveal the cognitive and motor process that enable musicians to coordinate with each other spontaneously during improvisation. Data collection is ongoing and will be complete before June 2020.

Enhanced nociceptive-evoked responses indicate metaplasticity in healthy musicians

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Gather.town: Room 8 Code 18

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

There is an increasing concern that repetitive movements in musicians may trigger maladaptive neuroplasticity that facilitates the appearance of pathological conditions such as focal dystonia or chronic pain. In fact, approximately 80% of musicians experience prolonged pain syndromes across their lifespan, a prevalence four times higher than general population. Recent behavioral and resting state fMRI data have indicated increased pain sensitivity and insular connectivity in healthy musicians compared to non-musicians, suggesting that musical training may alter pain processing. However, to date, no study described the underlying neural mechanisms of this interaction. The present work investigated whether musical training may facilitate changes in the nociceptive pathways, assessed by event-related potentials (ERPs). Twenty healthy musicians and 20 healthy non-musicians were included. ERPs and perceptual thresholds (PTs) were recorded in response to intra-epidermal electrical stimulation on the right hand, which predominantly activates nociceptive Aδ fibers. Results showed enhanced N2-P2 peak-to-peak amplitude in healthy musicians compared to non-musicians. This supports the notion that heightened and continuous integration of sensorimotor information across the lifespan of musicians may facilitate not only musically relevant cortical mechanisms but also other sensory modalities, such as priming the responses conveyed within the nociceptive pathways (i.e., metaplasticity).

How do you feel the beats: An EEG study of beat imagination

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Gather.town: Room 8 Code 19

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

Feeling the beat is a universal experience when listening to music, but the neural mechanism is a matter of debate. Using EEG, we examine the connectivity between motor and auditory related cortical components during beat listening, imagining and production. The experiment consists of an auditory and motor localizer task and a main task. In each trial in the main task, participants (a preliminary sample of n=9) first listened to 12 unaccented beats. Then they listened to accented beats that create either a binary or a ternary meter. Next, they imagined binary or ternary metrical accents atop physically unaccented beats. Finally they tapped out the pattern of their imagined beats. We ran an independent components analysis (ICA) and identified the auditory related ICs which account for the highest percent variance of the signal (pvaf) for each participant. To select the most related motor ICs, we compared pvaf vs. cerebromuscular coherence methods. A medium to high effect size of Spearman correlation showed that both methods identified similar ICs for 7 out of 9 subjects. Measuring directional motor/auditory connectivity using the direct, directed transfer function in SIFT toolbox revealed two-way causal flow between the top motor and auditory IC across all listening phases in the main task. These preliminary results suggest a coordination between motor and auditory systems for comprehending the regular beats, favoring an embodied view of active perception.

Marimba, Mallet and Mind - Enhancing the Marimba Sound by Ki-aikido Approach

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Gather.town: Room 8 Code 20

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

This study highlights the potential benefits of applying physico-mental strategies from the Japanese martial art Ki-aikido in the approach to teaching and playing percussion instruments, aiming at enabling the player to produce a more varied spectrum of sounds. Two groups of percussion students played an exercise on marimba before and after either a Ki-aikido or a control instruction. To measure possible group differences in sound quality, recordings of the performances were subjectively rated by ten marimba experts who were blinded to the type of intervention. Furthermore, the amplitude in two prominent partials were inspected and compared between groups using Fast Fourier Transform (FFT). Between-group analyses were robust and showed a significant effect of the Ki-aikido intervention, indicated by a change in the harmonic distribution in the instrument's timbre. By contrast, subjective ratings by marimba experts were less consistent and showed no effect of the intervention. The study highlights the potential of taking physico-mental strategies into consideration in the general approach to teaching and production of sound on percussion instruments. More research into the field is encouraged.

Individual and collective technology-aided musical learning: Comparing synchronization, turn-taking, and imitation.

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Gather.town: Room 8 Code 22

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

We assessed the performance accuracy of 54 novices (40 females, 14 males; mean age 23.1 years; SD = 4.9) who learned to play short musical pieces on the piano. Aided by easily-manipulated instructional videos on a computer, participants engaged in three learning conditions: synchronisation (playing the same musical pattern at the same time), turn-taking (playing different musical patterns one after the other), and imitation (playing the same musical pattern one after the other). As participants were assigned to either a solo (n=18) or a duo (n=36) learning group, three types of novice-novice-computer interactions were tested and compared to analogous novice-computer interactions. In both solo and duo settings, tempo and pitch accuracy of post-training performances were better when learning was based on synchronisation or turn-taking, compared to imitation. We conclude that novices benefit from situations where active participation is prioritised, and where learning resources can be fluidly integrated across biological (i.e., peers) and hybrid (i.e., participants and computer) systems. These results are consistent with cross-disciplinary research on the role of embodied action and co-presence for musical learning and mental life more generally, suggesting that peer-to-peer interaction in novices can be as valuable as individual learning if based on active participation and cooperation.

Decoding music education with dyslexic students: What can teachers learn?

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Gather.town: Room 8 Code 23

Subtheme B - Auditory, Motor and Sensory Integration, Embodied Learning

The purpose is to improve and enhance the quality and accessibility of instrumental music teaching for dyslexic students. Nurturing and empowering the student's voice in the learning process is prioritised in order to counteract risk factors of 'learned helplessness', low motivation and challenges posed by possible comorbidities. With a focus on examining how to utilise dyslexic strengths, technological applications, alternative notation systems, evidence-based strategies and the learning environment, the aim is to generate a robust evidence base and resources for music educators, music exam boards, parents and students. Combining analysis of the latest findings from neurobiological, cognitive and pedagogical studies with evidence-based analysis of piano lessons and collaboration between student, teacher and parents allows for a convergence of theory and informed practice. My focus in this poster will be to demonstrate how specific teaching strategies can inform the teacher of the dyslexic student's specific learning style, zone of proximal development, and most importantly their strengths: visuospatial abilities, creativity, problem solving, verbal communication and resilience. These have proved an effective method of putting the student at the centre of the learning process, increasing self-determination, informing the lesson planning and structure with the ultimate goal of making music education more accessible to the dyslexic student.

Neural Entrainment to Perceptually Ambiguous Polyrhythms Depends on the Metrical Context

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Gather.town: Room 9 Code 1

Subtheme C - Neural Correlates of Music Perception and Performance

How we interpret a musical rhythm depends, among others, on the context in which the rhythm is presented. In an EEG experiment, we used two different metrical contexts to manipulate interpretations of a polyrhythm as indicated by steady-state evoked potentials (SSEPs), a measure of neural entrainment. Sixteen participants listened to a 32-sec perceptually ambivalent 3:4 polyrhythm consisting of simultaneously presented isochronous triple-beat and quadruple-beat

drum sounds. This polyrhythm was preceded by an 8-sec rhythm consisting of snare drum, bass drum, and hihat with either a triple or a quadruple meter establishing two different contexts. EEG signals of the FCz electrode were averaged and transformed into the frequency domain. Amplitudes in the frequency spectra at the polyrhythm's triple beat (1.5 Hz) and quadruple beat (2 Hz) were normalized with surrounding frequency bins and compared against zero in one-sample t-tests. When preceded by a triple meter context, the polyrhythms elicited SSEPs at 1.5 Hz ($t(15) = 4.05$, $p = .001$) and 2 Hz ($t(15) = 5.86$, $p < .001$), corresponding to triple and quadruple parts of the polyrhythm, respectively. In the quadruple meter context, however, SSEPs were only present at 2 Hz ($t(15) = 6.16$, $p < .001$) and not at 1.5 Hz ($t(15) = 1.35$, $p = .199$). We conclude that the different metrical contexts established different models influencing the interpretation of a subsequent polyrhythm, as indicated by changes in neural entrainment.

Neural Correlates of Motor Coordination During Rhythmic Tension

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Gather.town: Room 9 Code 2

Subtheme C - Neural Correlates of Music Perception and Performance

Entraining to a musical beat by means of body movement is a way to reinforce the musical meter. While foot-tapping during music-making is a common habit, vocalizing a beat while clapping a rhythm has a destabilizing effect. In previous studies, we have shown the dynamically changing roles of voice, hands and feet during intrapersonal simultaneous performance of rhythm and meter. Results suggested the existence of a bodily hierarchy going from voice -> right hand -> left hand -> right foot -> left foot, implying a preference for performing the rhythm using a limb listed before the limb keeping the beat. The vertical component of the hierarchy (voice -> hands -> feet) dominated the horizontal (right -> left). While performance generally increased with musical expertise, the hierarchical pattern was consistent across participants. However, musicians were less affected by performing against the hierarchy than non-musicians. The notion of a bodily rhythm/meter hierarchy raises several questions about brain dominance and the lateralization of rhythm and meter. Therefore, we used fMRI to assess the neurological foundation of the hierarchy. 25 musicians tapped and vocalized rhythm and meter simultaneously in the MR-scanner using combinations of voice, hands and right foot. Their rhythmic expertise was assessed behaviorally by measures of tapping accuracy and the Musical Ear Test. We here show the neural correlates of this rhythmic hierarchy and its relation to rhythmic expertise.

Modelling Jazz in the Brain: predicting transitions of brain dynamics between memory and improvisation modes

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Gather.town: Room 9 Code 3

Subtheme C - Neural Correlates of Music Perception and Performance

Creativity depends on the dynamic interplay between brain networks underlying different cognitive processes. Specifically, a coupling between memory and executive control facilitates the generation of new ideas. In music improvisation, memory retrieval reveals crucial in the recalling of prior knowledge and the flexible rearrangement of information to create novel and aesthetically pleasant sequences. To this date, no study has explored how the brains of creative people are capable of maintaining efficient dynamics between memory and novel sequence creation. Here, we propose to combine structural and functional neuroimaging data of 16 skilled jazz musicians with whole-brain computational modelling to shed new light into the local dynamics supporting rich and coordinated state transitions between familiar and creative modes of music production. Our results from network-model perturbations show that a transition from memory to free improvisation occurs when the BOLD noise level of brain regions involved in cognitive processes important for creativity is increased. Interestingly, a transition between creativity to a memory-based state happens upon increasing the synchronicity (i.e. lower dynamic expansion) of regions involved in memory retrieval, planning, motor, executive and emotion control. Our study may provide important contributions to the development of more targeted strategies to compensate for memory and creativity deficits, common in many neuropsychiatric conditions.

Beat subdivisions and musical training explain differences in neural entrainment and tapping performance

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Subtheme C - Neural Correlates of Music Perception and Performance

The subdivision benefit refers to an improvement in tapping accuracy when an isochronous beat is divided into equal intervals. However, it remains unclear if the subdivision benefit (i) is an emergent property of the neural system, (ii) depends on the kind of subdivision, and (iii) relates to formal training in music. We assessed the EEG responses of 31 participants (16 musicians) in the frequency domain while they repeatedly listened to an isochronous beat, a particular subdivision of this beat (duplet, triplet, quadruplet or quintu-

plet), the beat again, and the same subdivisions while tapping to their underlying beat. We found that the neural entrainment to the beat and its 1st harmonic is increased during listening across all subdivisions, indicating a general tendency to reinforce the beat, perhaps to minimize complexity towards a 1:2 ratio. Behavioral responses revealed that tapping was less consistent and precise for quintuplets than for the other subdivisions. In addition, musically-trained participants tapped more consistently than musically-naïve participants for all subdivisions. Finally, tapping enhanced the neural entrainment to beat-related frequencies, yet with greater amplitudes in musicians. Together, these results suggest that subdivisions enhance neural synchronization to the frequencies of the beat and its 1st harmonic ("duplet"-related), and that formal training in music enhances both the tapping to the beat and the corresponding neural entrainment.

Sensory versus culturally shaped expectations in the neural processing of music

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Subtheme C - Neural Correlates of Music Perception and Performance

When listening to music, we constantly attempt to predict the sounds that will follow. For example, quite often we end up humming, singing along or tapping our foot to the beat, and find pleasure in listening to pieces we know very well. However, the nature and brain basis of musical predictions or expectations remain poorly understood. Concretely, we do not know the extent to which these expectations arise from adaptation to the sensory properties of sounds or from a more cognitive and culturally shaped learning of the statistics of musical pieces and styles. Here, we employed computational modelling and MEG data to investigate the neural correlates of melodic expectations. We compared the performance of a cognitive model of music statistical learning (IDyOM) and simpler metrics of acoustic similarity between tones (e.g. pitch distance, cosine similarity) in predicting neural responses to sounds, in listeners with different cultural background and musical expertise. For this, an encoding model based on regularized linear regression was used. Our results show that, across listening conditions, datasets and types of listeners, acoustic similarity models outperform cognitive models. This suggests that sensory expectations play a prominent role in shaping neural responses to musical sounds.

Perturbing whole-brain dynamics of the psychedelic state with music

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Subtheme C - Neural Correlates of Music Perception and Performance

Across cultures and throughout history, music has been intimately linked with psychedelics, suggesting that music serves a fundamental purpose. However, there is a lack of understanding of the brain in the psychedelic state and the mechanisms through which music interacts with it. Here, we hypothesised that psychedelics cause a fundamental reorganisation in the dynamical system of the brain and that music perturbs brain dynamics within this altered state. In this fMRI study, healthy participants (N=20) were given either LSD or placebo and listened to naturalistic ambient music or were instructed to rest inside the scanner. In order to estimate brain dynamics of psychedelics and music through time-resolved whole-brain connectivity patterns, we applied a Hidden Markov Model (HMM) to the fMRI-time series. The HMM estimated a temporal sequence of hidden brain states, i.e. whole-brain networks that recur over time, as well as transition probabilities between these states. Using this approach, we found spatial state maps specific to LSD and placebo, as well as distinct temporal transition paths between brain states distinguishing music listening from resting. Our model thereby describes how the whole brain reorganises into fundamentally different spatiotemporal patterns under LSD, which are then shaped into a unique structure of transitions by music. This view supports the essential role of music to purposely "guide" the psychedelic trip by shaping brain dynamics.

The CI MuMuFe - a new MMN paradigm for measuring music discrimination in electric hearing

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Subtheme C - Neural Correlates of Music Perception and Performance

Cochlear implants (CIs) allow good perception of speech while music listening is unsatisfactory. This study aimed to investigate CI-users' discrimination thresholds for changes in salient musical features. 11 adult CI-users and 14 normal-hearing (NH) controls took part in the study. We recorded EEG, applying a new multifeature Mismatch Negativity (MMN)-paradigm, which presented 4 music deviants at 4 levels of magnitude in a novel ´no-standard´ configuration. A supplementary test measured behavioral discrimination

of the same deviants and levels. The MMN-paradigm elicited significant MMN responses to all levels of deviants in both groups. Furthermore, the CI-users' MMN-amplitudes and latencies were not significantly different from those of NH controls. Both groups showed MMN strength that was in overall alignment with the deviation magnitude. In CI users, however, discrimination of pitch levels remained undifferentiated. On average, CI users' behavioral performance was significantly below that of the NH group, mainly due to poor pitch discrimination. The study indicates that CI-users may be able to discriminate subtle changes in basic musical features both in terms of automatic neural responses and of attended behavioral detection. The new CI MuMuFe paradigm provided reliable results, suggesting that it may serve as a relevant tool in future CI research. For clinical use, future studies should investigate the possibility of applying the paradigm also at the individual level.

Temporal power spectral changes in electroencephalography during passive listening to improvisation of melodic scales

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Subtheme C - Neural Correlates of Music Perception and Performance

Indian music has a pre-determined structure for improvisation, that includes alaap. Alaap is elaboration of melodic scale without lyrics or tempo. Electroencephalographic(EEG) changes with passive listening to improvisation of melodic scales is not well documented. The objective was to evaluate the temporal sequence of EEG power with passive listening to improvisation of melodic scales of Indian music. A randomized triple blind study on healthy individuals (aged 18-30 years) was done with 3 music intervention groups and one control group (n=35 each), was done. After collection of baseline data, EEG(19 channel) was recorded, in eyes closed condition. This was followed by passive listening task, that included instrumental music(flute) improvisation in scales namely, Ahir Bhairav(A), Kausi Kanada(B) and Bhimpalas(C). Control group was kept in silence, with each condition for 10 minutes (pre, during, post). EEG data was analysed and standard frequency bands power was binned. All 3 scales resulted in increase in different frequencies, suggesting a 'mind wandering/ drawn into music' state. Alpha power reduced with time, in all three groups. Gradual rise in theta activity (attentional and emotional functions) was seen with scale B, suggesting positive valence. As a melodic scale unfolds, the response of the brain, also changes. Vigorous EEG analysis techniques to study temporal changes using microstates, may aid in confirming the present results.

Family GAMEs: a longitudinal study exploring the effect of infants' and their parents' rhythm skills on childhood speech/language development

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Subtheme C - Neural Correlates of Music Perception and Performance

Rhythm and speech/language skills have been found to be associated in multiple past studies. In addition, both rhythm and speech/language skills show moderate heritability. In Family GAMEs (Grammar And Music Exercises for the whole Family), a longitudinal study involving 80 infant-parent dyads, we aim to explore whether children's rhythm skills as measured during infancy and/or their parents' rhythm skills predict children's speech/language skills at 3 and 4 years of age and/or the presence of speech/language disorders at age 4. In the first, ongoing phase of the project, we measure rhythm processing in 6-12-month-old infants and their parents with a dynamic attending EEG task. Preliminary results (n = 32 infant-parent dyads) show efficient beat processing on average in both infants and their parents, establishing feasibility of the paradigm for measuring rhythm skills. We also assess rhythmic processing in parents behaviorally with a rhythm discrimination task. Infants' vocabulary is measured at 12, 18 and 24 months with the MacArthur-Bates Communicative Development Inventories. In the second and third phases of the project, children's broader speech/language abilities and nonverbal IQ will be measured with standardized tests. This poster will introduce relevant background information, provide a scoping review of the research strategy for the Family GAMEs study, and summarize the results of predictive relations of interest in the first phase of the project.

Prediction under uncertainty: Dissociating sensory from cognitive expectations in highly uncertain musical contexts

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Subtheme C - Neural Correlates of Music Perception and Performance

Predictive models in the brain rely on the continuous extraction of regularities from the environment. These models are thought to be updated by novel information, as reflected in prediction error responses such as the mismatch negativity (MMN). However, even though in real life individuals often face situations where uncertainty prevails, it remains unclear whether and how predictive models emerge in high-uncertainty contexts. Recent research suggests that uncertainty affects the magnitude of MMN

responses in the context of music listening. However, musical predictions are typically studied with MMN stimulation paradigms based on Western tonal music, which are characterized by relatively high predictability. Consequently, here we developed a novel MMN paradigm to investigate how the high uncertainty of atonal music modulates predictive processes as indexed by the MMN and behavior. Using MEG in a group of 20 subjects without musical training, we demonstrate that the magnetic MMN in response to pitch, intensity, timbre and location deviants is evoked in both tonal and atonal melodies, with no significant differences between conditions. In contrast, in a separate behavioral experiment involving 39 non-musicians, participants detected pitch deviants more accurately and rated confidence higher in the tonal, than in the atonal musical context. These results indicate that contextual tonal uncertainty modulates processing stages where conscious awareness is involved, even though deviants robustly elicit low-level pre-attentive responses such as the MMN.

Neural alpha oscillations during turn-taking piano duet index creative thinking when preparing for improvisation and engagement to the partner's action

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Subtheme C - Neural Correlates of Music Perception and Performance

Musical improvisation requires a complex organization of brain functions in order to generate musical ideas, translate them into actions, and integrate auditory and tactile feedforward/feedback for future planning. In addition, ensemble performance involves real-time coordination using a joint-action scheme. This study investigates how alpha oscillations index creative ideation and attention to one's partner during a turn-taking duet improvisation. Simultaneous EEG were recorded from two pianists while they alternated playing a scored or improvised melody, for a total of 4 phrases. Alpha power for each phrase was analyzed depending on whether a pianist was a starting or joining player. Prior to playing, both players showed a larger alpha ERD for improvisation than score, reflecting additional cognitive processes for preparation for the former. Furthermore, when listening to one's partner, alpha ERS occurred only if the partner played the score, indicating less attention paid to the partner's actions. Interestingly, when the joiner listened to the first phrase played by the starter, alpha ERD was significantly stronger than when they listened to the second phrase played by the starter, indicating higher engagement of the joiner, perhaps because they must fit their part to the new melodic context set by the starter. Our results suggest that a player's role in the musical structure as well as source of musical content both affect attentional engagement between duet partners.

Mapping the tonal hierarchy in the brain

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Subtheme C - Neural Correlates of Music Perception and Performance

The tonal hierarchy is a cognitive structure that underlies the organization of pitch in Western music. In a given key, certain notes are perceived to have a better fit compared to other notes, and goodness of fit ratings are consistent across individuals enculturated to Western music. The amplitude of the N1 has been identified as a neural marker for melodic expectancy. Out-of-key notes evoke a larger N1 compared to in-key, more expected notes, however a direct relationship between evoked responses and goodness of fit ratings for both in- and out-of-key notes has not been reported. Here, we attempted to discover the neural correlates of the tonal hierarchy using the probe tone method while recording EEG. Thirty-two participants listened to 576 trials (12 keys, 12 probe tones, 4 times) consisting of a seven-note context, an arpeggio, and a probe tone, one of the twelve notes of the chromatic scale, while watching a silent movie. Participants also rated probe tone fit for 48 trials, or four major keys. Peak amplitude and latency of the P1, N1 and P2 ERP components were analyzed as well as the mean amplitude of difference waves corresponding to an early positive wave, the ERAN and a late positive wave. Using linear modeling, we found that P2 latency was the best predictor of behavioral ratings, where longer latencies were associated with more unexpected notes. This finding calls into question the previously established relationship of the N1 amplitude with melodic expectancy.

A study of rhythmic auditory-motor behaviour with focal TMS of the human brain: the distinct role of the dorsal and medial premotor cortices

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Subtheme C - Neural Correlates of Music Perception and Performance

The translation of a rhythmic auditory input into a temporally-ordered chain of motor events is a musical competence of uncertain neural bases, but, according to neuroimaging data, likely relying on premotor areas of human brain. The present study aims at exploring the role of the supplementary motor area (SMA) and the dorsal premotor cortex (dPMC) in rhythmic auditory-motor behaviour. We used event-related online focal transcranial magnetic stimulation (TMS) to stimulate the SMA and the dPMC of the left hemisphere in 18 healthy participants, without professional musical experience, during a task of motor reproduction of auditory rhythmic patterns. TMS was applied in the delay time between listening and repeating the sequence to the SMA, dPMC or a sham spot (control condition). An optical tracking system was used to capture

the movement of the hand while performing the task. We found that SMA stimulation induced an overall strengthening of motor performance duration, without altering the internal proportions of the rhythmic sequence. Conversely, dPMC stimulation altered the proportion between the duration of single acoustic events, but not the overall duration. Interestingly, the effect of TMS was evident only in non-syncopated sequences. We hypothesize a contribution of premotor cortices to 2 different aspects of rhythm processing: the relation between acoustic events is represented in the dPMC; in contrast, the SMA is involved in less specific aspects of motor performance

The neural correlates of statistical deviance detection within an auditory statistical learning paradigm

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Gather.town: Room 9 Code 15

Subtheme C - Neural Correlates of Music Perception and Performance

How does the brain respond to prediction errors within a patterned sequence of sounds? The brain perceives the regularities occurring in the environment and forms expectations regarding future events. Statistical learning is one of the mechanisms underpinning this phenomenon. In the current functional magnetic resonance imaging (fMRI) study we employed a block-design to investigate the neural correlates of statistical deviance detection within an auditory statistical learning paradigm. Participants were exposed to auditory streams of regular sound triplets (standards), interspersed with irregular sound triplets (deviants). Our initial results reveal distinct neural activity patterns in response to deviant (compared to standard) triplets in both temporal and frontal cortex, indicating an important non-sensory component. Our study lies at the intersection of deviance detection and statistical learning and sheds light on the cortical hierarchy and resolution of prediction errors.

Explaining Timbre Experiments in Human Listeners using Computational Models of the Early Auditory System

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Subtheme C - Neural Correlates of Music Perception and Performance

How are timbral features represented in the early auditory system? We approach this question by observing the output of computational models of the auditory nerve and midbrain, two main sites in the sub-cortical auditory system. These models can simulate the activity of neurons in response to any sound waveform. Here, we examined model responses to stimuli that were matched to those used in previous perceptual studies. The first perceptual study estimated the threshold for timbral brightness discrimination and showed interference effects between fundamental frequency and spectral centroid perception (Allen and Oxenham, 2014, JASA 1371:1379). Additional studies demonstrated differences in timbral brightness for different musical instrument stimuli (Lakatos, 2000, Perception & Psychophysics, 1426:1439; McAdams et al., 1995, Psychological Research, 177-192). Our results suggest that pitch and timbre interference may have a neural basis at the level of the midbrain, and nonlinear transformations in the inner ear may be influential for the neural representation of brightness. In our simulations, an unexpected connection arises between timbral brightness, spectral irregularity, and the brain's internal representation of temporal modulations.

A new pictorial tapping technique for measuring individual differences in preferred rate

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Gather.town: Room 9 Code 17

Subtheme C - Neural Correlates of Music Perception and Performance

The current study is an attempt to develop a novel measure of individual preferred rate. Participants tapped out simple musical rhythms that they only saw pictorial representations of but had critically never heard. This technique ensures that we were measuring internally-generated tempo rather than a tempo primed by the experimental procedure. Each of the 18 rhythms had a clear duple or triple meter according to Povel and Essens's model (1985) and required a tap on each downbeat. Participants practiced producing each rhythm for as long as needed. Once they were satisfied, we recorded seven repetitions of the rhythm produced continuously with no gap between repetitions. We compared each production with the corresponding to-be-produced prototype rhythm and estimated an individual's preferred rate at the quarter-note level by "fitting" the prototype to the production in the frequency domain. We tested the effects of rhythm identity, rhythm length, meter, and serial order on produced rate to rule out influences of structural properties of the rhythms on the produced rates. Serial order had a significant effect, where tapping rate increased over the experiment as participants acclimated to the task. No rhythmic features contributed to produced rate. Thus, we propose that this pictorial tapping technique is sensitive to individual differences in the rate at which participants prefer to produce metrically structured musical rhythms.

Replicability of Sight-over-sound Effect in the Judgement of Brass Ensemble Competition in Japan

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Gather.town: Room 9 Code 18

Subtheme C - Neural Correlates of Music Perception and Performance

How people use auditory and visual information to judge musical performance? Contrary to the belief that audition should be more important than vision in the judgement of musical performance, the visual judgement was shown to be more accurate than audition (Tsay, PNAS, 2013; Mehr et al., PLoS ONE, 2018). In this study, we tested if the "sight-over-sound" effect was replicable when judging the performance in brass ensemble competition in Japan. Thirty-three people participated in this study (22.0 ± 4.29 years of age, 11 females). All participants had experience to play in a brass band (8.67 ± 4.40 years of experience) but had no experience as an instructor. The 93.9% of participants reported subjectively that sound should be more important than vision in the ensemble judgement. The participants were randomly assigned to one of the three judgement conditions: 1) Audio-only, 2) Visual-only and 3) Audio-Visual conditions (11 participants each). The one-way ANOVA showed no significant difference in the judgement accuracy among the three groups ($F(2,30)=0.12$, $p=0.89$). The one-sample t-tests revealed that the judgement accuracy was significantly higher than the chance level in the Audio-only condition and AudioVisual condition but not in Visual condition (40.0%, $t(10)=2.85$, $p=0.02$; 40.9%, $t(10)=2.66$, $p=0.02$; 38.2%, $t(10)=0.83$, $p=0.43$, respectively). Our results suggest that sight-over-sound effect is not replicable in the judgement of brass ensemble competition in Japan.

Social Connectedness in Livestream Concerts: The Role of COVID-19, Agency, Presence, and Social Context

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Subtheme C - Neural Correlates of Music Perception and Performance

Musical life became disrupted in 2020 due to the COVID-19 pandemic. Many musicians and venues turned to online alternatives, such as livestreaming. In this study, three livestreamed concerts were organized focusing on separate, yet interconnected concepts (i.e. agency, presence, social context), to ascertain which components of livestream concerts facilitate social connectedness. Crucially, the impact of COVID-19 and related anxieties on feelings of social connection are considered, as the main focus of this study was to investigate enhancement of social connectedness during a time of real-life social distancing, and to investigate people's musical behavior in such times. Results from 89 participants showed that a greater negative impact of the COVID-19 pandemic on people's lives increased feelings of social connection with the artist. Shared agency, physical and social presence were associated with decreased experience of negative emotions, such as loneliness. Shared agency was found to impact social connectedness during concerts, but this effect was mainly driven by presence. Both physical and social presence impacted social connectedness, and were correlated with reductions in negative feelings. Overall, the findings suggest that in order to reduce feelings of loneliness and anxiety, concert organizers and musicians could adjust livestream formats to increase feelings of physical and social presence and subsequently foster social connectedness.

Distinct neuromuscular and anatomical constraints on the finger dexterity in pianists

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Gather.town: Room 9 Code 22

Subtheme C - Neural Correlates of Music Perception and Performance

The finger dexterity enables skilled motor actions in musical performance. While skilled musicians acquire the dexterity through extensive musical training, it has not been elucidated what neural and musculoskeletal adaptation subserves acquisition and sophistication of the finger dexterity. Here, we addressed this issue by comparing each of the dexterity, corticospinal excitability of multiple muscles, muscular activity, and anatomical features of the fingers between the pianists and non-musicians. As a measure of the dexterity, we assessed the individuated movements of each of the index and ring fingers at the maximum speed. Transcranial magnetic stimulation (TMS) was applied over the primary motor cortex to assess the corticospinal excitability of multiple finger muscles prior to both active and passive production of the individuated movements. The results showed no difference in the individuated movements of both the index and ring fingers between the two groups. However, when moving the ring finger, the pianists exhibited smaller passive motions at its adjacent fingers as compared to the non-musicians. The TMS measurement further showed lower corticospinal excitability and muscular activity of the little finger muscle when moving the ring finger in the pianists than the non-musicians. These findings indicate reduction of both anatomical constraint and corticospinal excitability of the fingers in the pianists, which can underlie their sophisticated finger dexterity.

Oscillatory neural activity underlying enhanced synchronization with musical training

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Gather.town: Room 9 Code 23

Subtheme C - Neural Correlates of Music Perception and Performance

Previous research has shown that musical training enhances the ability to successfully synchronize with an auditory stimulus across production rates (Scheurich et al., 2018; Scheurich et al., 2019). However, the neural mechanisms underlying this enhancement are still not well understood. This study investigated whether greater stability of oscillatory neural activity across rates may support greater auditory-motor synchronization consistency with musical training. Due to restrictions imposed by COVID-19, the current sample includes three musicians and three nonmusicians. While recording EEG, participants tapped a familiar melody at a comfortable rate and then synchronized their tapping with a metronome set at each individual's comfortable rate as well as slower rates. Recurrence Quantification Analysis (RQA) was used to examine the stability of oscillatory neural activity at each tapping rate. Behaviourally, musicians showed greater synchronization consistency across rates than nonmusicians. RQA indicated greater stability of oscillatory neural activity (larger meanline) across rates for musicians than nonmusicians. Importantly, synchronization consistency was correlated with the stability of oscillatory neural activity across all participants: as synchronization consistency increased, so did neural stability. These findings suggest that musical training enhances synchronization by increasing stability of oscillatory neural activity at the rate of production.

Impact of false feedback on auditory intensity judgments in musicians and non-musicians

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Gather.town: Room 9 Code 24

Subtheme C - Neural Correlates of Music Perception and Performance

Perception of the intensity of auditory events can be explained using predictive processing. Prediction errors form as a consequence of the difference between the prediction and the actual percepts. Professional musicians have large prior experience with sound stimuli and are able to make more accurate and precise predictions based on auditory information than non-musicians. The aim of the project is to study the differences between musicians and non-musicians in an intensity judgment task after receiving accurate or inaccurate feedback. A group of 20 expert drummers and 20 non-musicians is being studied. The subjects are required to judge the intensity of different drum sounds. The sounds are of the same drum played with different intensities and taken from a drum sample library. After each trial participants receive feedback about the accuracy of judgment they made. The feedback is either accurate (consistent with actual drumming intensity) or false (random). Intensity and certainty ratings are being evaluated, as well as participants response times. The study is currently underway, the results will be presented during Neuromusic VII.

Associations between neural and behavioral measures of rhythm processing and self-reported musicality in adults

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Gather.town: Room 9 Code 25

Subtheme C - Neural Correlates of Music Perception and Performance

Previous research has shown that when adults listen to rhythmic stimuli and are asked to imagine a beat, their neural response to the imagined beat matches their brain's response to a beat that is physically accented (Iversen et al., 2009). In the present study, we aim to further investigate beat processing in adults with EEG. In a passive listening paradigm, a simple rhythm is presented repeatedly with a physical accent either (1) in the whole block (physical beat condition) or (2) only for the first ten trials of the block (induced beat condition). Neural responses to the beat are measured only after the tenth trial in each block. We also assess adults' rhythmic skills with a rhythmic discrimination task with simple (beat-based) and complex (syncopated) rhythms as well as self-reported musicality with the Goldsmiths Musical Sophistication Index (Gold-MSI) (Müllensiefen et al., 2014). Preliminary data show (1) a similar neural response to the physical and induced beat on average (n=14), but (2) a different pattern of neural response to induced beat in participants with high vs. low musicality, and (3) a significant positive correlation between musicality and discrimination performance for simple rhythms (n=34; 27-47 years, M=36.5 years; 32 females). These results suggest evidence for beat processing even without a physical beat or explicitly prompted imaginary beat and suggest self-reported musicality is associated with beat processing measured both behaviorally and via EEG.

Relationship Between the Beat Synchronization Ability and Cortical Thickness in Patients with Schizophrenia

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Gather.town: Room 9 Code 26

Subtheme C - Neural Correlates of Music Perception and Performance

Approximately 60% of patients with schizophrenia (SZ) were regarded as amusia according to the Montreal Battery for Evaluation of Amusia

(MBEA) (Hatada et al., 2014). A recent neuroimaging study showed that a lower score on the MBEA was associated with a reduced cortical thickness in the temporal and inferior frontal areas in patients with SZ (Fujito et al., 2018). However, the synchronization ability to musical beat and its relation with cortical thickness remain unknown in this population. Here, we investigated the cortical thickness and beat synchronization ability of 31 patients with treatment-resistant schizophrenia (TRS), 27 non-TRS patients, and 27 healthy controls (HCs). Music Tapping Test (MTT) in the Harvard Beat Assessment Test (Fujii & Schlaug, 2013) was used to assess the beat synchronization ability. MRI images were acquired with 3T GE scanner and the cortical thickness was analyzed with FreeSurfer software. We found that the cortical thinning of the left and right medial orbitofrontal cortex (mOFC) was related to the scores on the MTT in SZ (left mOFC, $r = -0.242$, $p < 0.001$; right mOFC, $r = -0.453$, $p < 0.001$, respectively). The cortical thickness in the right mOFC was positively correlated with the beat synchronization ability in HCs ($r = 0.463$, $p = 0.023$). Thus, the right mOFC may be involved in the beat synchronization ability in HCs and may also be responsible for its disorders in patients with SZ.

Brownian noise enhances the learning process

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Gather.town: Room 10 Code 1

Subtheme E - Music and Memory

The formula Einstein discovered analyzing the brownian motion proved the existence of atoms, molecules and their irregular restless movements. According to Tomatis, the noise produced by the molecules might be the first stimulus ever perceived by the fetus through the skin first and then through the ears, making it essential for the development of the human being. The brownian formula, transposed into sound, generates a noise having higher intensity at lower frequencies: the brownian noise. Since the intervals of neuron firings are highly affected by different sorts of noise and according to the principle of stochastic resonance, by which noise can amplify the information transfer in neural networks, brownian noise might improve the way brain behaves about attention and information storage in short and long-term memory. The method I developed is meant to study guitarists while learning two melodies, one with brownian noise coming out a subwoofer and one without. The results are collected considering how long it takes to play each melody correctly and how many errors are performed a couple of minutes after learning, at the end of the class and after one week. Although the speed of learning seems to be slightly slowed down by the noise, the melody originally played with noise shows a gradual decrease in the number of errors over time, highlighting that the brownian noise enhances the long-term memory. Further researches can be carried out using different tasks and persons.

Spatiotemporal brain dynamics of musical patterns recognition

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Gather.town: Room 10 Code 2

Subtheme E - Music and Memory

Pattern recognition is a key topic in neuroscience and psychology and has been widely explored, especially in visual and spatial domains. However, little is known about how the brain recognizes patterns that acquire meaning through their development over time, such as musical sequences. Therefore, by recording magnetoencephalography data of 70 participants, we investigated the spatiotemporal fast-scale brain dynamics during the recognition of Johann Sebastian Bach's original and varied musical patterns. Recognition was accompanied by a network of active and synchronous brain areas comprising primary auditory cortex, hippocampus, cingulate gyrus, frontal operculum, orbito-frontal cortex, insula and basal ganglia. Furthermore, even if the retrieval of both Bach's original and varied patterns recruited similar networks, Bach's originals presented a stronger activity and synchronization within the brain, following the temporal evolution of the musical pattern. This brain ignition emerging for Bach's original vs variation was reflected especially within hippocampus, cingulate gyrus, medial orbito-frontal cortex, frontal operculum and basal ganglia. This study shed new light on the dynamics of brain connectivity underlying memory processes and meaning creation for auditory patterns evolving over time. Additionally, in this work, we highlighted the crucial role of fast-scale phase synchronization analysis to understand complex cognitive processes related to music recognition.

Functional and structural connectivity in human auditory networks and the origins of variation in the transmission of musical systems

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Gather.town: Room 10 Code 3

Subtheme E - Music and Memory

Music performers differ in their ability to acquire and transmit music. Some performers can reproduce a song as originally composed ("transmitters"), while others tend to alter it in the course of repetitions as a consequence of memory erosion ("innovators"). Our work addresses for the first time the neural origins of this form of variation. In one experiment, we collected auditory resting-state fMRI, diffusion-weighted data and behavioral measurements from a large cohort of human participants (N=51). First, we show that the degree of interhemispheric resting-state functional connectivity between core auditory areas of the superior temporal gyrus and between those areas and prefrontal cortices predicts, several

weeks after scanning, how individuals will learn, transmit, and regularize the structure of an artificial musical system. Second, using diffusion tensor imaging (DTI) we show a relationship between the same behavioral measures and structural features of the corpus callosum. Our work introduces neuroimaging in cultural transmission research and points to specific neurophysiological mechanisms and brain structures underlying variation in the social learning, transmission and structural modification of musical systems.

The influence of classical flute training on speech perception and musical interpretations of words

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Gather.town: Room 10 Code 4

Subtheme F - Music and Language

Perception is influenced by one's experience and musical training has been shown to enhance speech perception in domains such as word memory, prosody and tone recognition. However, musical experience is hard to generalize, as, in practice it is specific to each instrument. In this presentation, we focus on the Western Concert Flute whose production method shows many similarities to spoken phonemes, as tonguing technique is characterized by specific consonants. How does the instrument specific experience of classical flute training affect speech perception and in turn how will the way speech is perceived be reflected in musical interpretations of spoken words? We conducted two experiments focusing on instrument specificity and flute players. In our first experiment, the perception of whistled speech phonemes (a natural form of modified speech) was used to understand the influence of musical experience. The results showed significant differences between musicians and non-musicians, and also between flutists and other musicians, notably in terms of consonant recognition. In a second experiment, we targeted these same phonemes in a spoken word context and asked musician participants to propose musical interpretations of these words. In line with the previous results, the flutist participants proposed remarkably strict consonant – attack analogies. This leads us to conclude that due to their playing technique and articulation, flute players have a close relationship with consonants both in terms of musical interpretation and speech perception.

Speech in noise perception following six months of musical training: behavioral and brain morphological adaptation

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Gather.town: Room 10 Code 5

Subtheme F - Music and Language

Musical expertise has often been suggested to be a contributor to speech intelligibility. The associations, however, are mostly correlative. The present randomized controlled trial aimed to investigate a potential causal transfer from musical training to speech in noise perception. Therefore, 156 healthy, normal-hearing elderly were recruited and randomly assigned to either piano playing or music listening/musical culture groups. Before and after a six month intervention the speech reception threshold was assessed using the International Matrix Test. To evaluate changes in speech in noise performance, we used a Bayesian multilevel model approach. Both groups improved their speech in noise perception under binaural conditions; a left ear improvement was only observed in the piano group. Moreover, the improvements were mainly found in women. Additionally, we investigated brain morphometric changes using voxel-based morphometry in regions of interest which are involved in the processing of speech and auditory features (e.g. spectrotemporal analysis). We will relate behavioral adaptations to grey matter volume changes. The results will be discussed with respect to functional lateralization hypotheses of auditory cortices.

The effect of mental practice on musical memory performance

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Gather.town: Room 10 Code 7

Subtheme E - Music and Memory

Mental practice (MP), in the music field, refers to the ability to mentally rehearse music without any muscular movements or acoustic feedback. Specifically, many studies presented evidence for the combination of MP and physical practice (PP) as the best technique in order to enhance performance. In contrast, in our work, we studied the effects of MP and PP on memory. To do so, musicians at different levels of expertise were recruited and divided into two groups. In a one-week music practice protocol, guitarists were asked to study a new musical piece using either

a combination of MP and PP or PP alone. We asked participants to play the musical piece and write it in musical notation at three different times: Day 1, Day 7, and in a follow-up session ten days after the one-week protocol was completed. Our results showed that the combination of MP and PP improves the recollection of a selected piece compared with PP alone. Interestingly, we observed that the difference in memory performance was stronger in the follow-up session than on Day 7. Based on our results, we suggest that MP and PP can be used together in the music education field in order to improve long-term retention and to reduce physical workload, and thus reduce playing-related overuse injuries in musicians. We further propose that MP should be taught systematically in music academies.

Neural dynamics of improved bimodal attention and working memory in musically trained children

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Gather.town: Room 10 Code 8

Subtheme E - Music and Memory

Attention and working memory (WM) are core components of executive functions. We hypothesized that the brain networks underlying bimodal auditory/visual attention and WM would be boosted in children who regularly learn and play a musical instrument. Girls and boys aged 10 to 13 with and without musical training completed an attention task while their brain activity was measured with fMRI. Participants were presented with a pair of bimodal stimuli (melody and figure) and were asked to pay attention only to the auditory, only to the visual, or to both at the same time. The stimuli were afterwards tested with a memory task in order to confirm attention allocation. Both groups had higher accuracy on items that they were instructed to attend, but musicians had an overall better performance on both memory tasks across attention conditions. In line with this, musicians showed higher activation than controls in cognitive control regions such as the fronto-parietal control network during all encoding phases. In addition, facilitated encoding of auditory stimuli in musicians was positively correlated with years of training and higher activity in the left inferior frontal gyrus and the left supramarginal gyrus, which support the phonological loop. Therefore, our results help to better understand the neural dynamics that underlaid the improved performance of musically trained children on our attention and WM task.

Cognitive and neural mechanisms underlying the mnemonic effect of songs after stroke

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Gather.town: Room 10 Code 9

Subtheme E - Music and Memory

Sung melody provides a mnemonic cue that can enhance the acquisition of novel verbal material in healthy subjects. Recent evidence suggests that also stroke patients with mild aphasia, can learn and recall novel narrative stories better in sung format compared to spoken. The present study explored the cognitive mechanisms underlying this effect by determining whether learning and recall of novel sung vs. spoken stories show a differential pattern of serial position effects (SPEs) and chunking effects in non-aphasic and aphasic stroke patients (N=31) studied 6 months post-stroke. The structural neural correlates of these effects were also explored using voxel-based morphometry (VBM) and deterministic tractography (DT) analyses of sMRI data. Non-aphasic patients showed more stable recall with reduced SPEs in the sung than spoken task, which was coupled with greater volume and integrity of the left arcuate fasciculus. On the other hand, the aphasic patients showed a larger recency effect (better recall of the last part of the story) and enhanced chunking in the sung than spoken task. Neurally this sung>spoken recency effect in aphasic patients was coupled with greater grey matter volume in a bilateral network of temporal, frontal, and parietal regions and also greater volume of the right inferior fronto-occipital fasciculus (IFOF). The results provide novel cognitive and neurobiological insight on how a repetitive sung melody can function as a verbal mnemonic aid after stroke.

Memory for nostalgic stimuli across the lifespan: An examination of aging and familiarity ratings using naturalistic stimuli presented across three modalities

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Gather.town: Room 10 Code 11

Subtheme E - Music and Memory

Although music has been shown to successfully prompt memory retrieval in healthy individuals as well as people with memory disorders, it is unclear whether music confers a unique advantage for this purpose. A possible explanation is the strong emotional and nostalgic grip of musical stimuli. We examined whether musical stimuli (jingles) uniquely promote memory retrieval and induce nostalgia compared to verbal (slogans) and visual (logos) stimuli in healthy individuals across the lifespan. Young adults (n=27, 20 female, M=21.4±1.69 years) and seniors (n=11, 7 female, M=72.1±4.87 years) rated the familiarity and emotional impact of stimuli randomly presented from these isolated modalities. Logistic regression yielded a main effect of modality with

higher average familiarity ratings for logos ($p = .002$) and slogans ($p = .021$) compared to jingles. There was also a main effect of age such that young adults provided significantly higher familiarity ratings than seniors overall ($p < .001$). Moreover, we observed an interaction between age and modality. Young adults provided significantly lower familiarity ratings for slogans, compared to logos ($p = .036$). More familiar advertisements were also rated as more nostalgic ($p < .001$). These results demonstrate the role of age, nostalgia, and modality in memory. Additionally, they provide impetus for further inquiry into the interaction of these factors during memory retrieval across the lifespan.

Exploring the effects of emotions evoked by music on visuospatial working memory and physiological measures

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Gather.town: Room 10 Code 12

Subtheme E - Music and Memory

Throughout human history, music might have played different roles, but its efficiency in modulating our emotional states is undeniable. Furthermore, studies have suggested that working memory (WM) is responsible for processing emotions, and depending on the type and intensity of emotion, it could perturb WM capacity. However, little is known about the effects of emotions evoked by music through a validated procedure on WM performance. For this reason, we developed a paradigm called emotional induction through music (EIM) including carefully selected musical excerpts to investigate the impact of positive and negative EIM on visuospatial WM performance. Using a repeated-measures design, 78 participants received positive, negative, and neutral EIM followed by a visuospatial WM task. Results revealed that participants' visuospatial WM performance was inferior after being negatively induced compared to when they were positively induced. Furthermore, we also observed increased skin conductance level during positive EIM in comparison to baseline and a lower heart rate throughout positive EIM in contrast to baseline. Overall, these findings suggest that music evoking sad or unpleasant emotions could disrupt attentional processes decreasing visuospatial WM performance. These findings may have important practical implications since there are several moments where we engage in cognitively demanding activities while listening to music that could promote happy or sad emotions.

What makes music memorable? Relationships between acoustic musical features and music-evoked emotions and memories in older adults

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Gather.town: Room 10 Code 13

Subtheme E - Music and Memory

Previous music information retrieval (MIR) studies have suggested that the emotional experience of music is influenced by a combination of musical features. Here, our aim was to explore the relationship between music-evoked emotions and music-evoked memories and how musical features can predict them. Healthy older adults ($N = 113$, age ≥ 60 years) rated a total of 140 song excerpts (folk songs and popular songs from 1950s-1980s) on five domains measuring experienced valence, arousal, emotional intensity, familiarity, and autobiographical salience of the songs. 24 musical features were extracted from the songs using MIR methods. Principal component analyses resulted in six musical components, which were then used to predict the behavioural ratings in multiple regression analyses. All correlations between behavioural ratings were positive ($r = 0.46–0.92$). Emotional intensity showed the highest correlation to both autobiographical salience and familiarity. Three musical components measuring salience of the musical pulse, relative strength of high harmonics, and fluctuation in the frequencies between 200-800 Hz predicted both music-evoked emotions and memories. Especially emotional intensity mediated the effect of the musical components on music-evoked memories. The results suggest that music-evoked emotions are strongly related to music-evoked memories in healthy older adults and that both music-evoked emotions and memories are predicted by the same core musical features.

Decrypting the fingerprints of jazz improvisation

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Gather.town: Room 10 Code 16

Subtheme E - Music and Memory

In some musical genres, such as non-Western styles and in particular, in jazz, skilled improvisers can spontaneously produce new arrangements of melodic, rhythmic and harmonic patterns to create novel and emotionally rewarding musical sequences 'on the fly'. Until date, little is known about the music signatures that portray the different stages of a jazz performance. In this study, we analysed MIDI data from 16 skilled jazz pianists while playing by memory (Memory) and by two different modes of improvisation: freely (iFreely) and by melody (iMelody). To investigate differences in the metric fingerprint between the conditions, we developed a new interdisciplinary (Matlab/Python-based) framework - NeMuLink - to characterise the patterns of music features,

such as the total number of played notes, pitch-class distribution, distribution of interval sizes, entropy and pitch predictability. We found significant differences in metric structure, robustness and predictability of music fingerprints, which illustrate distinctive jazz playing phases (Memory, iMelody and iFreely). Our study supports the potential of jazz improvisation as a versatile and dynamic form of domain-specific creativity, composed by well-defined phases with distinct metrics signatures, blending to produce a novel piece with high aesthetic value.

Specialized and general human cortical encoding mechanisms across music and speech perception

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Gather.town: Room 10 Code 17

Subtheme F - Music and Language

It remains unknown to what extent music perception relies on general sound-encoding mechanisms that are shared with speech versus those that are specialized for music alone. While music and speech signals have overlapping acoustic properties, such as envelope, pitch, or pitch-change, music can be characterized by unique perceptual features that capture the statistical structure of tonal music, which listeners have learnt through long-term exposure. Here, we hypothesize that shared acoustic representations exist in the auditory cortex across music and speech. In contrast, we hypothesize that the high-level representation of musical structure is encoded in specialized populations that are relatively unresponsive during speech perception. We recorded electrocorticographic (ECoG) data from 6 patients during passive listening to natural instrumental music and speech. Consistent with previous work, we found subsets of electrodes throughout the Superior Temporal Gyrus (STG) that were either co-activated by music and speech, or selective to a single domain. We then applied temporal receptive field modelling to examine the encoding of different stimulus representations in the neural responses to music. In addition to acoustic features, we employed a well-known statistical model of music trained on a large corpus of Western tonal melodies (IDyOM; Pearce, 2005) to code the note-level Surprisal and Entropy as predictors. We found that largely distinct subsets of electrodes encoded acoustic vs. statistical (surprisal/entropy) information. Encoding of acoustic information did not systematically vary with electrode selectivity. In contrast, encoding of statistical features occurred exclusively on music-selective electrodes, with the degree of encoding scaling with the degree of selectivity. Finally, focusing on one acoustic feature – pitch-change – that was highly overlapping across music and speech, perceptually relevant in both domains, and well represented in the acoustic and neural signals, we found shared (domain-independent) encoding of information at the single electrode level. Together, these findings suggest that the STG contains general auditory populations intermixed with those specialized for processing high-level information in meaningful channels of communication such as music.

Improving reading skills at school: a rhythmic-musical intervention

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Gather.town: Room 10 Code 20

Subtheme F - Music and Language

Our work is based on previous evidence of the role of music in phonological awareness and in particular in how a specific learning disorder, such as dyslexia, is usually coupled with difficulties in relation to different musical skills such as temporal processing, synchronization of action to sound, discrimination of heights and the ability to segment and group rhythm patterns.. We test previous findings (Flaugnacco, 2016) concerning rhythmic skills improvements in relation to enhancing reading abilities through the use of body music, activities centered on rhythm and the use of symbolic language.
Our study reports the result of a training which is being offered for 2 years to 106 Italian 6-8 years pupils. Results are compared with results by a control group in-cluding 60 primary school pupils. In order to test the training effectiveness, psychological (Zoccolotti Test, MT Reading Test) and musical test (Stambak Test) bat-teries are being administered as baseline and at the end of the training (May 2020).
Different results are found. Previous data (2019) show that after training, the music group performed better than the control group in terms of rhythm. There are also significant improvement in particular on the speed of reading ability and on denomination tasks, while data on accuracy are less encouraging although are expected to improve by the end of the new training (May 2020)
The findings show music training as beneficial in school early intervention.

Perception of lexical tone and intonation in Mandarin by English speakers with and without autism spectrum disorder (ASD)

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Gather.town: Room 10 Code 21

Subtheme F - Music and Language

Pitch plays an important role in music and language, especially in tone languages such as Mandarin where the same segments can signify different meanings depending on lexical tones. Research has shown that English-speaking musicians can better discriminate Mandarin tones compared to non-musicians, although neither group learned the language. Given the often observed enhanced musical abilities in individuals with Autism Spectrum Disorder (ASD), this study examined whether English speakers with ASD would show superior performance on Mandarin tone and intonation discrimination compared to typically developing (TD) controls. The experiment consisted of a lexical tone discrimination task and an intonation discrimination task, in which participants were required to judge whether pairs of Mandarin tones or statements and questions (in either natural speech or its

gliding tone analogue) sounded the same or different. Preliminary results from 15 ASD and 8 TD participants showed comparable performance between the two groups on both lexical tone and intonation discrimination, and both groups performed better at discriminating gliding tones than natural-speech sentences. While awaiting more data to consolidate the above results, our findings suggest that, unlike musicians, individuals with ASD may not have enhanced abilities to process pitch in a non-native language. More research is needed to examine the relationship between musicality, pitch, music and language processing in ASD.

Mental representations of speech and music pitch contours in Autism Spectrum Disorder: Evidence from Mandarin Speakers

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Gather.town: Room 10 Code 22

Subtheme F - Music and Language

Numerous behavioural and neurophysiological studies have investigated pitch processing across different auditory domains in individuals with Autism Spectrum Disorder (ASD) and have produced mixed results. Using a novel reverse-correlation paradigm, we examined the mental representation of pitch contours in speech, non-speech, and music in 31 Mandarin-speaking individuals with ASD and 33 matched controls. The results indicate that the two groups exhibited similar morphology (i.e.,representations) for the speech kernels, although the ASD participants showed smaller filter gain (i.e., less sensitivity) than the controls for the non-speech kernels. However, for music, the ASD group showed a more consistent mental representation of a well-known melody compared to controls. Analysis of internal noise (a measure of the robustness of participant responses to external variability) showed the two groups did not differ significantly in internal noise, suggesting the group differences in filter gain for non-speech and in mental representation of pitch contour in music translate genuine qualitative differences in processing. These findings uncover for the first time how ASD affects mental representations of pitch patterns in speech, non-speech, and music, reveal intact speech pitch processing but superior melodic contour processing in Mandarin-speaking individuals with ASD. Further studies on individuals with ASD from other language backgrounds are needed to consolidate these results.

Impaired linguistic prediction but intact musical prediction in autism spectrum disorder: evidence from Mandarin speakers

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Gather.town: Room 10 Code 23

Subtheme F - Music and Language

Individuals with autism spectrum disorder (ASD) have been associated with impaired prediction, which affects the adaptation to the changing world. However, it is unclear whether this deficit is domain-general or -specific. Language and music provide an excellent way to investigate prediction, as both domains involve structured temporal sequences in which expectations are based on implicit learning of combinatorial principles. This study examined prediction in music and language in 31 Mandarin speakers with ASD and 33 matched controls. Participants were asked to produce the final note/word after hearing an unfinished melody/sentence in a melodic cloze task and a sentence completion task. Results indicated comparable performance between the two groups on the melodic cloze task, while controls produced more words that belonged to the most frequent responses than individuals with ASD. The predictive constraints of the melodic/sentence stems (i.e., probabilities of responses based on normative data) showed a positive effect on the produced final notes/words, with more frequent responses being produced following high-probability stems than low-probability stems. These findings suggest that the impairment in linguistic prediction in ASD may not be due to generalised problems with prediction in any type of complex sequence processing. Future studies are required to investigate how and why such a dissociation may occur in ASD and its implications for theories of prediction.

Speech-on-Speech Perception of Musicians and Non-Musicians: the Role of Prosodic Cues

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Gather.town: Room 10 Code 24

Subtheme F - Music and Language

In the current study, we investigate the role of prosodic cues in speech-on-speech perception in musicians and non-musicians. Earlier studies have shown that musically experienced listeners may have an advantage in speech-on-speech performance in behavioral tasks (1,2). Previously, we have also shown in an eye-tracking study that musical experience has an effect on the timing of resolution of lexical competition when processing quiet vs masked speech (3). In particular, musicians were faster in lexical decision-making when a two-talker masker was added to target speech. However, the source of the difference observed between groups remained unclear. In the current study, by employing a visual world paradigm, we aim to clarify whether musicians make use of durational cues that contribute to prosodic boundaries in Dutch, in resolving lexical

competition when processing quiet vs two-talker masked speech. If musical training preserves listeners' sensitivity to the acoustic correlates of prosodic boundaries when processing masked speech, we expect to observe more lexical competition and delayed lexical resolution in musicians. We will compare gaze-tracking and pupil data of both groups across conditions.

Combining Bouba-Kiki effect and musical timbres: An ongoing research in multimodal integration using eye-tracker

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Gather.town: Room 10 Code 26

Subtheme F - Music and Language

It is not uncommon for certain words to be systematically associated with specific visual forms. Likewise, it is also not uncommon for music to evoke visual imagery. Here we investigate how modern music relates to visual forms based on the Bouba-Kiki Effect. We designed an experiment where we cluster 11 visual forms by the subjective rating of the participants while listening to 11 auditory stimuli. Then we collected eye-tracking data during a listening task where volunteers indicated the visual shape that best represented the auditory stimulus. 06 volunteers participated in the eye-tracking step (mean age: 31.17, sd: 7.57). We used K-means to cluster (N=4) the visual forms by the subject ratings. Chi-squared test determined whether shapes were taken randomly. It was very unlikely to have arisen by chance: cluster 1, $p < 2.2e-16$; 2, $p = 9.365e-09$; 3, $p = 1.202e-04$ and 4, $p = 4.086e-06$). Timbre features and visual shapes association was observed. Soft sounds were related to round shapes and smaller pupil dilation profiles while harsh sounds were associated with sharp ones with larger pupil dilation outlines. Studies investigating audiovisual modalities are scarce, notably on modern music. These studies found so far suggest that certain features of the stimuli, regardless of their modalities, seem to share neural resources in some stage of their processing. Further studies would be necessary to test this hypothesis. Our results might also encourage artists on collaborative art

Vowel Perception in Congenital Amusia

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Gather.town: Room 10 Code 27

Subtheme F - Music and Language

Congenital amusia has long been said to affect only the musical domain, however several studies now show that amusics also have impaired perception of intonation and linguistic tones. In this study we show that amusia also influences linguistically relevant cues other than pitch by investigating the perception of the German front high vowels. These are differentiated by length and formant frequency and we assessed amusics' (N=11) and controls' (N=11) behavioral and electrophysiological responses, more specifically the MMN. For the behav. study, we employed an ABX task and the stimuli were presented with varying interstimulus intervals (ISI). For the EEG study, the stimuli were presented in a multideviant oddball paradigm in 4 blocks, resulting in 12 MMNs. Behav. results: An lmer model revealed main effects of group $t(20)=2.26$, $p=0.035$, ISI $t(2436)=5.73$, $p < .0001$ and cue $t(2436)=4.60$, $p < .0001$. Amusics performed worse than controls, the short ISI as well as duration (vs. formants) was overall harder. We used an lmer model for the MMN data as well, finding significant main effects for group $t(323.7)=-2.45$, $p=0.024$ with amusics having a smaller MMN than controls and also cue. Our study shows that amusia negatively affects vowel perception and has therefore more far reaching consequences for speech perception than previously assumed. Not only was the behavior of amusics affected, we also showed differences in the MMN, reflecting differences in early auditory change detection.

The music that people use to sleep: universal and subgroup characteristics

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Gather.town: Room 11 Code 1

Subtheme G - Music and Emotion

Music is known to affect widespread networks in the brain, thereby modulating many emotions. An estimated 25% of the population utilise this effect of music by, for example, using music to relax before bed. Although music-based sleep interventions use music that is soft, has simple repetitive rhythms and melodies and has minimal percussive instruments, little research has been done to determine what type of music is used before sleep by the general population. In this study, we investigate what musical features characterise music used for sleep by extracting the musical features of a large number of tracks (N = 225,927) from sleep playlists retrieved from the global streaming platform Spotify. We show that sleep music is softer and slower than general music and is most often acoustic and instrumental. We also demonstrate that sleep music can be clustered into six distinct subgroups. While some subgroups reflect the general musical features of sleep music, three subgroups are louder, more energetic and have a higher tempo. This large variation might be due to individual differences in musical preference, familiarity and the reason why individuals listen to music before sleep. Using the largest sleep music dataset to date, this study found that sleep music is soft, slow, acoustic and instrumental and contains a lot of variation. This study increases our understanding of human behaviour and can be used in the design of future music-based sleep interventions.

Acquired musical anhedonia – Measuring the emotional sensitivity to music after focal brain damage

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Gather.town: Room 11 Code 2

Subtheme G - Music and Emotion

Acquired musical anhedonia is the selective loss of emotional responses to music following brain damage.It is assumed that also a small group in the general healthy population has musical anhedonia.Those affected derive no pleasure from listening to music although they have normal hearing capacities and find pleasure in other leisure activities.To date,there are only a few studies investigating musical anhedonia, suggesting that the disorder could be caused by a disconnection between fronto-temporal brain regions and the reward system.Although there are many stroke patients with lesions involving these brain areas,only a handful of case studies have reported musical anhedonia after focal brain damage.One reason for the lack of reports may be an insufficient sensitivity of impaired emotional reactions to music after stroke in non-musicians.Thus, we hypothesize that the number of patients with acquired musical anhedonia may be much higher than assumed previously. Here,we investigate the emotional abilities of 30 stroke patients with chronic left or right fronto-temporal lesions and 30 healthy controls.In a music task,participants evaluate valence and arousal experienced during different film music excerpts.Physiological parameters (skin conductance, heart rate, respiration) are recorded simultaneously.We aim at identifying the frequency of acquired musical anhedonia in stroke patients and at revealing lesion-dependent varieties in the sensitivity to different musical emotions.

Empathy but not musicality is at the root of musical reward: A behavioral study with adults and children

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Gather.town: Room 11 Code 3

Subtheme G - Music and Emotion

Music is one of the most rewarding and pleasurable human experiences, entailing high emotional involvement. However, the determinants of the variation in individual sensitivity to musical reward are not yet fully unravelled. Recently, empathy has been identified as a determinant of musical affect, including enjoyment of sad music. Additionally, higher musical expertise leads to enhanced arousing and pleasurable responses to music, whereas aging decreases overall individual sensitivity to musical reward. Hence, we conducted a study to explore the relationships between musical reward, empathy trait and musical competence across two different age groups. 48 children (mean age 10.5) and 42 adults (mean age 25) were included in the study. Consistent with our expectations, musical reward was positively correlated with empathy in both adults and children, but not with musical competence. However, a deeper analysis revealed that when inserted in a model including empathy, also musical competence emerges as a predictor of musical reward, although this result is only obtained among adults. Taken together, our study is the first to provide behavioural evidence that empathy is directly involved in musical reward mechanisms. In turn, musical competence associates with an individual's musical reward experience only when controlling for empathy. On a broader view, this study contributes to shed new light on the determinants of the emotional responses to music.

Assessing properties of music for sleep and other purposes

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Gather.town: Room 11 Code 4

Subtheme G - Music and Emotion

People use music for many different purposes, including to help with sleep (Trahan et al., 2018). Whilst many studies lend support to music's efficacy as a sleep aid, there remain several issues to be clarified, including better specification of the types and characteristics of music that can help with sleep (Jespersen et al., 2015). The aim of this study was to examine what musical properties distinguish music for sleep from music for other purposes through an investigation of Spotify playlists. 90 playlists were gathered using search terms corresponding to categories of music for sleep, relaxing, and energising (30 in each category). 12 audio features for the first 50 tracks in each playlist were extracted from the Spotify Data Catalogue through the Spotify Web API, resulting in a dataset of 4,500 tracks. Statistical analysis found significant differences between each category for all features except acousticness between sleep and relaxing playlists, and duration between energising and relaxing playlists. Splitting playlists in the 'sleep' category between Spotify playlists and those from other users revealed further significant distinctions, possibly reflecting differences in a curated approach to sleep music as oppose to personal selection. This work provides useful reference for profiling musical properties of sleep music and making comparisons with other studies. Further work is now needed to relate these musical properties to listener preferences and responses.

Impaired integration of auditory and visual cues in emotion recognition in autism spectrum disorder: Evidence from Cantonese speakers.

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Gather.town: Room 11 Code 5

Subtheme G - Music and Emotion

Sensitivity to emotional meaning in speech and music forms the basis of the integration of auditory cues in cross-modal emotion recognition. Relating to the emotion recognition and multisensory integration difficulties in ASD, this study examines the extent to which facial emotion recognition is facilitated through the process of integrating auditory emotional cues in ASD. Under a cross-modal affective priming paradigm, participants identified emotions in faces/face-like objects (targets) after hearing a spoken/sung word (primes) with either congruent or incongruent emotions. Results from 21 Cantonese speaking adults with ASD and 17 controls showed that emotion recognition from faces was significantly facilitated by both spoken and sung primes for both groups. The magnitude of the priming effects on emotion recognition from face-like objects was however found to be greater for the control group in comparison to the ASD group. A significant association between group and error patterns corresponding to the auditory primes was nevertheless revealed across target types, such that controls were more likely to make a response that matched the auditory prime than the ASD group. Altogether, it was found that controls were influenced by incongruent auditory cues to a greater extent than the ASD group. Thus, controls, but not individuals with ASD, integrated auditory and visual cues for emotion recognition, particularly with face-like objects.

Listening Niches on Spotify

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Gather.town: Room 11 Code 6

Subtheme D - Music and Development

On-demand access to millions of songs on streaming services suggests listening niches may have changed in recent years. Many previous studies have used top Billboard Hits, but it is unclear if this approach is well-suited to current listening habits. In this study, 62 university students (37 women, 21 men, and 4 gender-nonconforming; mean age = 19.7) voluntarily provided their 25 top Spotify-streamed songs from three periods of time: the past 4 weeks, 6 months, and since subscribing, as well as their use of Spotify-curated playlists. All songs were coded for release year and genre. Males and females listened on average 19.4 hours per week and listened alone 93% of the time. However, gender had a number of effects. Females subscribed at a younger age and made greater use of Spotify-curated playlists, particularly Release Radar, which suggests newly released songs of artists they already listen to. Females also listened to more recently released music (average release 2015.1) than males (average release 2007.8). Females listened more to alternative/indie and pop genres than males, whereas males listened more to dance/electronic and rap/hip-hop (especially when they were younger) and to a wider variety of genres overall. These differences are consistent with previous studies. Unlike previous studies, however, there was no suggestion that they listened preferentially to the music of their parents' generation which may be related to the large percentage of time they listen alone.

Why don't they like sad songs?

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Gather.town: Room 11 Code 7

Subtheme G - Music and Emotion

Not all of us can find enjoyment in listening to a sad song. In a previous study, we have identified a group of participants that did not seem to enjoy sad pieces: Cochlear Implant users. The cochlear implant, CI, is a medical device developed to help people with severe-to-profound hearing loss regain the ability to perceive speech. However, this device is not well suited to convey musical information, such harmony and mode. Surprisely, our data shows that despite not being able to discriminate major from minor, CI users correctly identify the happy piano pieces from the sad ones. Additionally, their report a clear preference for the former one. Given their lack of tonal perception, it was hypothesized that CI listeners base their emotional judgment only on the tempo. However, statistical analysis revealed only a weak effect of this musical parameter. In the following study, normal-hearing, NH, listeners were asked to rate similar musical pieces played only on two congas to allow emotional judgment only purely temporal information. Results show that their ratings were very similar to the piano pieces' ratings from CI listeners. As the tempo only explains a small part of the variability, other temporal aspects such as the rhythmic pattern, syncopation, and pulsation were used to model the music emotion judgment. We conclude that although CI users have difficulties perceiving modes, they can rely on subtle temporal cues to extract music's emotional context. We also argue that without harmonic information, musical enjoyment will rely mostly on the rhythmical structure of the piece.

The role of opioid transmission in music-induced pleasure

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Gather.town: Room 11 Code 8

Subtheme G - Music and Emotion

Previous studies conducted in rodents indicate a key role of the opioid circuit in mediating hedonic reactions to primary rewards. Based on this evidence, it has been suggested that opioid transmission may be essential to experience pleasure with music as well. Yet, there is no direct evidence linking both. We addressed this problem through a double blind within-subject pharmacological design in which opioid levels were up- and down-regulated by administering opioid agonist (oxycodone) and antagonist (naltrexone), respectively, while healthy participants (n=21) listened to music. The monetary-incentive delay (MID) task was included to control for the effectiveness of the treatment and the specificity of the effects. Our results revealed that while the pharmacological intervention did modulate the reward responses associated with the MID bidirectionally, the reward-related responses elicited by music remained unaltered. Interestingly, participants felt the music to be more relaxing and, accordingly, showed significantly lower tonic physiological responses to music following oxycodone than naltrexone administration. These findings suggest that opioid transmission may underlie the relaxing properties of music, yet not the pleasure derived from it. This result carries important implications for our understanding of the complex interplay between different neurotransmitter systems in abstract pleasures such as music, and opens new perspectives for musical interventions.

Musical stimuli for emotion evaluation

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Gather.town: Room 11 Code 9

Subtheme G - Music and Emotion

Music is often used for inducing emotions in various contexts. The creation of musical stimuli that induce different emotions contributes to the development of research that investigates the relationship between these emotions and other cognitive functions. This research aims to evaluate the effectiveness of musical stimuli composed to elicit happy, fear / anger, sadness and peace. The 116 musical stimuli were elaborated with characteristics that induce these four basic emotions. Stimuli were tested in a sample of 100 individuals aged 18 to 40 years, of which 50 musicians and 50 non-musicians. Participants answered how they felt when they heard the stimulus and what were their emotional valence (positive to negative) and excitability (low to very stimulating) levels. Based on the analysis, Among the 116 stimuli, the 40 most reliable stimuli for inducing their emotion were selected (10 of each emotion), based on our analysis. We also found that fear / anger stimuli were better perceived by musicians than non-musicians and that this difference may reflected a judgment of stimulus excitability. The validation of stimuli created for research allows reducing the sources of error related to their composition and parameters, increasing the reliability of the results.

Deficits in cognition and emotion perception in patients with Depression.

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Gather.town: Room 11 Code 10

Subtheme G - Music and Emotion

Aim:The study aimed to examine the deficits in cognition and emotion perception in patients with mild-moderate depression. Method: The sample comprised of patients diagnosed with mild or moderate depression (DP) (n=19) and matched healthy controls (HC) (n=18). The sample was evaluated on tests selected from NIMHANS Neuropsychological test battery (Rao et al., 2004) to measure cognitive functions, and on social cognition rating tool in Indian settings (SOCRATIS) (Mehta et al., 2011) to measure social cognition. Emotion perception in domains of faces and verbal prosody was measured using the NIMHANS Emotion Perception Test (Rani et al., 2009), and musical emotion perception using a set of 32 musical excerpts (Van Tritch, et al., 2010). Results and conclusions: DP showed significant deficits in theory of mind and domains of neuro-cognition such as working memory, response inhibition and verbal learning and memory as compared to HCs ($p<0.05$). On emotion perception tests, DP underperformed on identification and discrimination tasks compared to HC. They also rated intensity of happiness significantly lesser than HC group on musical emotion perception ($p<0.05$). Correlation analysis showed a significant relationship neurocognitive functions, emotion perception and social perception index. (0.48**). This study has its implications in understanding the nature of neurocognitive and emotion perception deficits in depression. The strengths and limitations of the study will be presented

The effects of emotionally congruent vs. emotionally incongruent music on pain perception after an anger induction event.

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Gather.town: Room 11 Code 11

Subtheme G - Music and Emotion

Emotion and attention influence pain perception, and unpleasant emotions have been shown to in a subsequent pain test decrease the pain threshold. Expressing negative emotions has been shown to increase the pain threshold in both acute and chronic pain. Because listening to music is often described as an intimate experience where music can express personal emotional states, we here investigated music listening as an intervention for anger management and thus indirectly also for a moderation of pain. Specifically we examined if the negative effect of unpleasant emotions on pain perception is modulated by listening to emotionally congruent music. Female participants (N = 40, mean age= 26.3) performed cold pressure tasks in order to monitor changes in pain perception following anger induction and subsequently a music listening session. Participants were randomly assigned to listen to either emotionally congruent (angry) or emotionally incongruent (happy) music. Results show that while the anger induction task increased pain sensitivity, listening to emotionally congruent music increased pain tolerance more strongly than emotionally incongruent music ($U = -1.871$; $p = 0.033$). Findings suggest that it seems more beneficial to listen to music expressing a current negative emotion while in pain than listening to incongruent happy music as a distractor. Applying music to aesthetically experience the expression of anger might be a useful strategy for people developing chronic pain.

The negative power of music – the impact of disliked music on psychophysiology

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Gather.town: Room 11 Code 12

Subtheme G - Music and Emotion

Many studies have demonstrated the positive effects of music, namely focusing on behavioral and bodily responses when participants listen to self-selected pleasant and liked music. However, just as listeners can have strong attitudes to liked music, they can also have strong attitudes to disliked music. The current study tackles the question of whether a negative attitude to music has an impact on psychophysiological reactions. Forty participants were selected who reported experiencing highly unpleasant feelings when listening to three self-selected disliked musical pieces. Firstly, each participant listened to all the (disliked) pieces provided by the other participants, in order to select three additional pieces on which the participant took a neutral stance. At least one piece disliked by one person found a 'neutral' match with another. Secondly, participants listened to these six pieces while psychophysiological measures were recorded. Linear mixed models with fixed effect of Condition (disliked and 'neutral' music) and random effect Condition (slope) and Participant (intercept) as well as random intercept of musical piece revealed that in disliked compared to neutral pieces, significantly higher heart rate, increased skin conductance and facial electromyography activity was elicited. This shows that, independent of the music itself, the response relies on a strong attitude towards the music – be it either positive or negative – compared to an indifferent attitude.

Musical Experience is related to the Time Course of Changes in Levels of the Immune Response Marker Interleukin-6 after Exposure to Acute Social Stress

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Gather.town: Room 11 Code 13

Subtheme G - Music and Emotion

Acute social stress is associated with changes in cortisol levels, and reports indicate that musical experience is related to the level and duration of this stress response. Although the stress- and immune-responses are known to interact, little is known about the relationships between musical experience and the immune system's response to stress. To investigate these relationships, perceived chronic stress, depressive symptoms, and diagnoses of mental disorders were assessed by self-report in musicians and non-musicians prior to exposure to the Trier Social Stress Test (TSST). Salivary cortisol and the immune response marker interleukin-6 (IL-6) were measured immediately before, and 30, 60, and 90 minutes after TSST onset. In comparisons with non-musicians, musicians reported less perceived chronic stress, depressive symptoms, and diagnoses of mental disorders. After adjusting for total salivary protein concentrations, non-musicians showed a decrease in IL-6 between 0 and 30 minutes after TSST onset, whereas musicians showed a decrease from 60 to 90 minutes. Cortisol levels increased after TSST, but levels did not differ between musicians and non-musicians at any timepoint. Adjusting levels of target proteins to total protein concentrations is rarely reported, but the current findings suggest it is important as this adjustment influenced both group differences and the time courses of effects. Overall, these results indicate that acute social stress decreases levels of a marker of immune response and does so later among musicians than among non-musicians. Our results also suggest that amateur musicians have lower perceived chronic stress, and fewer depressive symptoms and diagnoses of mental disorders than non-musicians

Musicians and non-musicians have different inverted U-shaped liking responses to harmonic complexity in single chords.

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Gather.town: Room 11 Code 14

Subtheme G - Music and Emotion

Recent research suggests there is an inverted U-shaped relationship between structural complexity in music and aesthetic or reward responses. However, it is unclear how musical background affects this U-shape. Does musicianship lead to overall increased responses, or does it change the shape of the U? And what is it about musicianship that modulates responses? Here we show results from a study in which musicians and non-musicians listened to and rated individual chords varying in four levels of harmonic complexity, indexed by acoustic roughness. In addition, we recorded personality measures (Big Five), genre preferences (STOMP), melodic discrimination abilities (MET), musical reward experiences (BMRQ) and musical engagement (Gold-MSI). Results show that the rating profiles were affected by musical training. Specifically, the inverted U peaked at low complexity for non-musicians, compared to medium for musicians. This effect was not influenced by personality, genre preferences, melodic discrimination or music reward experience. Instead, it was associated with years of musical training, hours of weekly practice and musical engagement. Our results suggest that it is the active engagement afforded by music performance, rather than personality or stylistic preference, that drives musicians' preference for medium complexity chords. Active engagement may thus be an important modulator of aesthetic responses to the structural complexity of music.

Uncertainty Resolution and Anticipation of Pleasure in Chord Progression: An EEG Study

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Gather.town: Room 11 Code 15

Subtheme G - Music and Emotion

A recent neuroimaging study has shown that not only surprise but also uncertainty and its resolution play a crucial role in musical pleasure and reward (Cheung et al., Curr Biol, 2019). Although the early right anterior negativity (ERAN) has been a well-known measure of surprise and syntactical errors (e.g., Koelsh, Front Psychol, 2011), little is known about the electroencephalography (EEG) response underlying uncertainty and its resolution. In this study, we tested if ERAN could be observed when uncertainty resolves. In the "standard" condition, four chords (I, IV, IIm7, and V7) were repeated four times. In the "deviant" condition, the third chord (IIm7) in the fourth block was replaced with a deviant chord (IV#dim) to enhance uncertainty. The participants tended to rate the deviant condition as more pleasant than the standard condition ($t = 1.5$, $p = 0.07$, paired t-test), suggesting that resolving the uncertainty increased the pleasure. Although ERAN was not observed at the third chord where the deviation was made, a negative ERP was observed about 70 ms before the last chord was provided. We suggest that this component, which is similar to stimulus preceding negativity, may reflect the anticipation of uncertainty resolution and pleasure in a chord progression.

How does musical training affect socio-emotional abilities in children? A longitudinal study

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Gather.town: Room 11 Code 16

Subtheme G - Music and Emotion

Musical training provides a powerful framework for examining neurocognitive plasticity. Most research to date compares musicians and non-musicians, remaining unclear whether expertise-related advantages reflect predispositions or the training itself. Also, most studies on musical training effects are focused on language and domain-general abilities. Whether and how musical training affects socio-emotional skills remains unclear. We are conducting a longitudinal study with 6- to 8-year old children to examine how musical training affects socio-emotional abilities. This study includes pre-test, training for 9 months, and pos-test, in three conditions: musical training ($n = 43$), sports training ($n = 43$), and no training ($n = 33$). They had no previous experience of music/sports training. Children were tested with cognitive, motor, music and socio-emotional measures (including emotion recognition in faces and voices), and underwent structural and functional magnetic resonance imaging. Preliminary analyses on the pre-test data show that music skills are correlated with emotion recognition abilities, even when cognitive and sociodemographic variables are held constant. This suggests that there are associations that arise from preexisting factors and not from training in music. We also found correlations between cognitive performance and music and socio-emotional skills, which underline the importance of accounting for domain-general factors when examining musical training effects.

Time perception in film is modulated by sensory modality and arousal

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Gather.town: Room 11 Code 17

Subtheme G - Music and Emotion

Time perception is often distorted in cinematic experiences, but little research has used film - a naturalistic multimodal stimulus - to study how we perceive the passing of time. Here, we explore the effect of sensory modality and arousal

on our perception of time in film. Using psychometric and psychophysiological methods, we investigate emotional responses to and time estimates of film extracts in three conditions: audiovisual (with music), visual (without music), and auditory (music on its own). Participants were presented with 27 film clips (9 in each condition) from nature documentaries, fiction, animation, and experimental films, and were asked to judge clip duration and to report subjective arousal and valence. Results reveal duration estimates varied with sensory modality. Clip durations were judged to be shorter than actual durations in all conditions, with visual-only clips judged to be longer than auditory-only and audiovisual clips. Consistent with previous research, arousal positively impacted time perception. The effect of arousal on duration perception was strongest when the clips were presented in the audiovisual modality. We discuss the results in relation to multimodal perception, attention, and the known effects of music in cinema.

Music to help you fall asleep: effects and mechanisms

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Gather.town: Room 12 Code 1

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Sleep problems are highly prevalent in modern society with about one third of the general population experiencing insomnia symptoms. Music has been proposed as an efficient sleep aid, but no studies have differentiated between sleep initiation and maintenance problems nor investigated the underlying mechanisms. In this study, we will evaluate if listening to music can improve sleep quality in adults with sleep-onset insomnia and test the underlying mechanisms. We hypothesize that music can improve subjective and objective sleep quality in adults with sleep-onset insomnia, and that music-induced arousal reduction underlies the effect. To test these hypotheses, we will conduct a randomized controlled trial with one intervention and one control group, combined with neuro-physiological assessment of arousal response to the intervention music. All participants will receive sleep hygiene instructions. In addition, participants in the music group will be asked to listen to music for 30 minutes at bedtime every night during the four-week intervention period. Participants are given a choice between five music playlists of different genres but with similar structure of the musical parameters. We will assess participants' neuro-physiological responses to the intervention music before and after the intervention period to evaluate if these can predict the clinical outcome. Increased knowledge of the mechanisms will enhance efficient and flexible use of music as intervention for insomnia

Musical Rhythm and Pleasure in Parkinson's Disease

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Gather.town: Room 12 Code 2

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Parkinson's disease (PD) is a neurological condition resulting from dopaminergic dysfunctions in the basal ganglia (BG) of the brain, with devastating consequences for motor and cognitive functioning. The method 'rhythmic auditory cuing' has shown to improve motor deficits in PD patients, by stimulating the BG. However, this method may be limited by a rather simple rhythmic complexity, restricting its benefits in the motor domain. Thus, a more complex stimulus may lead to a richer set of predictions, and promote a better guidance for the temporal model of a movement. Syncopation is a form of rhythmic complexity related to pleasure and synchronized body-movement, referred to as groove. While healthy adults experience a pleasurable desire to move to stimulating music (medium syncopation), we do not know if PD patients respond in the same way. Does PD affect the pleasure experienced from rhythmically complex music? Can musical complexity be used to treat deficiencies in PD, and what level of rhythmic complexity would be most effective? Participants listened to short musical sequences that varied in rhythmic complexity (low, medium, high), and rated experienced pleasure and desire to move on a 5-point Likert scale. PD patients without dopamine agonist (DA) medication rated higher scores on pleasure and desire to move for the low rhythmic complexity, while PD patients under DA medication and HC preferred medium complexity for pleasure and desire to move.

Auditory biofeedback through real-time generated music in balance and gait training for stroke patients

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Gather.town: Room 12 Code 3

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

With its universal appeal, music has proven potential as a motivating and enjoyable medium for the delivery of feedback information to enhance engagement and performance during repetitive motor tasks in stroke rehabilitation. Wearable sensor hardware and real-time music generation technology can productively lend themselves to movement rehabilitation for this patient group. The presented work integrates principles of neurologic music therapy and auditory biofeedback in a lightweight proof-of-concept system to assess the utility of individualized musical biofeedback during balance and gait training. The sensor hardware comprises one multi-axis IMU weighing 120g, mounted on the trunk or lower

limb. Inertial data is transmitted to a computer application for processing, flexible mapping and music synthesis. There are multiple interactions targeting static and dynamic tasks for balance training, providing feedback on trunk inclination and movement smoothness through a series of musical feedback strategies. In gait training, the system can provide feedback on stride periodicity or phase in addition to rhythmic cueing through music. Data from initial testing with physiotherapists and six sub-acute stroke patients suggested that the patients were able to comprehend and enjoy most interactions, though the feedback strategies had varied and sometimes insufficient perceptual salience. Future iterations will focus on improving the feedback strategies and further tests will be reported.

Imagine, sing, play!- Combined mental, vocal and physical practice improves musical performance

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Gather.town: Room 12 Code 4

Subtheme J - Music Intervention Programs – Community and Education

Classical musicians face a high demand for flawless performance, leading to highly intensified practice activity. Whereas the advantage of using mental strategies are well documented in sports research, few studies have explored the efficacy of mental imagery and overt singing on musical instrumental learning. In this study, 50 classically trained trumpet students played short unfamiliar pieces. Performances were recorded before and after applying either A) physical practice (PP), B) mental imagery (MP), C) overt singing with optional use of solfege (SOL), or D) a combination of A, B and C (COM) for three minutes. In a control condition, participants read a non-related article. Three experts independently assessed pitch and rhythm accuracy, sound quality, intonation, and musical expression in all recordings. In addition, semiautomatic detection of pitch and rhythm errors was applied as a supplementary measure. We found higher gains in the overall performance as well as in pitch accuracy for the physical practice (A) and combined practice (D), compared to no practice. Furthermore, only the combined strategy (D) yielded a significant improvement in musical expression. Pitch performance improvement was positively correlated with previous solfege training and frequent use of random practice strategies. Duration and onset of music training, amount of daily practice and accumulated hours of music training had no significant effect on performance scores. The findings point to positive effects of applying practice strategies that complement conventional physical practice. The study may generalize to other forms of learning, in which cognitive processes and motor skills are involved.

Exploring the mechanisms of music-induced plasticity in childhood acquired brain injury

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Gather.town: Room 12 Code 6

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

An improved understanding of the biology of the injured brain suggests that the human brain is capable of significant reorganization through the phenomenon of neuroplasticity. These advances indicate that neuroplasticity varies according to the time since injury, etiology and the age of the injured person. However, there is a mistaken perception that young brains make better functional recoveries than adult brains. The past two decades have shown an increase in music therapy interventions in neurorehabilitation, as well as an interest for exploring the mechanisms of music-induced plasticity. In the clinical practice, there is an important interplay between the functional rehabilitation goals, while remaining child-centered and meeting the emotional needs of the child and his/her family. Moreover, there is a strong indication that plasticity in both children and adults following brain injury can be enhanced through the repetition of meaningful action. Consequently, the methods focusing on passive stimulation were replaced with active learning and exposure to new experiences. Still, patient heterogeneity remains the major challenge to progress in this area of research. As music-based interventions in this field become more aligned with goal-oriented research and practice, there is a need for clinicians and researchers to develop relevant and effective therapeutic interventions for pediatric population.

Early steps to facilitate use of music in medicine in slovenia

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Gather.town: Room 12 Code 8

Subtheme J - Music Intervention Programs – Community and Education

BACKGROUND: A plan to sensitize medical community and general public to consider music as a relevant agent in health care. METHODS: Dedicated national radio interviews on topics between music and medicine with guests from Slovenia and abroad (HR, IT, CZ, NO, GB, FR, CH). A questionnaire for medical doctors on domaines where music could be introduced in research/ practice with chance to improve patient care. Planning scientific and professional events. RESULTS: The topics addressed: Entry to sound and music in child development; From music education to animation and musicotherapy; Music therapy in the department od paediatric haemato-oncology and in demented elderly; Beginnings of music therapy in Central European social psychiatry; The healing power of music; Mozart' Sonata K448 in people with epilepsy during SEEG; GOSH experience of a hospital radio. Further interviews to follow until end June. A neuroscience symposium will close this phase in

September. End June 2021 the project's interim results will be presented. DISCUSSION on best practices/pitfals in introducing music to medicine welcome

The role of school and family background in youth involvement in music

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Gather.town: Room 12 Code 10

Subtheme J - Music Intervention Programs – Community and Education

Music plays an important role in the lives of adolescents but at the same time, when music becomes a school subject to be studied, it seems to not attract interest and inspire enthusiasm in young people. The school has a great responsibility because for many young people it is the only place to meet music. Also the relationship between family and interest in music plays in youth an important role. The purpose of the present research is to describe and analyze the relationship between family background, music education in school and interest in music among young people. In order to define habits and skills acquired about practice and listening to music by the students, two research tools have been developed: a questionnaire and a standardized test. The data analysis describes the musical education in school from two different views: the description of the students' musical behavior inside and outside of the school and, on the other hand, the relationship between acquired musical skills and musical behavior and activities. An hypothesis of the study is that playing a musical instrument develops interest and involvement in music so another object of this research is to compare the musical skills of students who are learning a musical instrument with students who don't have this possibility. The students' scores in music tests show a clear diversification of skills acquired by students, in relation to socio-cultural variables and family and show that playing a musical instrument is the most effective way to develop interest and, therefore, encourage mastery of skills that can be used outside the classroom.

Community Music Programming Enhances Executive Function and Self-Efficacy in Children Ages 9-14 Years

Winston, J.L., Raturi, V., Cavalli, A., Muise, I.R, & Colombo, P.,
Tulane University, New Orleans, LA, USA

Gather.town: Room 12 Code 11

Subtheme J - Music Intervention Programs – Community and Education

There is growing evidence that music training can enhance cognitive abilities and socioemotional outcomes in children and adults. As part of an ongoing longitudinal study, differences in executive function and perceived self-efficacy were measured in school-aged children enrolled in a tuition-free community music program. The executive function test battery included the Tower of Hanoi, Berg Card Sort, Corsi Block Span, and Trail Making Tests. Perceived self-efficacy was measured with a 21-item scale that included items probing self-regulatory, social, and academic efficacy. For each analysis, age was included as a covariate to control for developmental improvements in performance. Children enrolled in the program for two or more years achieved more categories on the Berg Card Sort than those enrolled for less than one year or 1-2 years. Children enrolled for 1-2 years scored higher on regulatory self-efficacy than children enrolled for less than one year. These results suggest that participation in a community music program facilitates development of cognitive flexibility and regulatory self-efficacy in school-aged children.

Short-Term Music Training on Auditory Processing in Older Adults

Hennessy, S., Wood, A., Habibi, A.
University of Southern California, USA

Gather.town: Room 12 Code 12

Subtheme J - Music Intervention Programs – Community and Education

Perceiving speech in noise (SIN) is important for health and well-being and decreases with age. Musicians show improved SIN abilities and reduced age-related auditory decline, yet it is unclear whether short term music engagement has similar effects. This ongoing randomized-control-trial employs a pre-mid-post design to investigate whether a 24-week music intervention in non-musician adults aged 50-65 with subjective hearing loss improves SIN abilities, auditory encoding and attention measured respectively by early auditory evoked potentials (N1 P2) in a syllable-in-noise task, and later P3 in an oddball task, and well-being. Age and gender-matched adults were randomized to a choir or control group. Weekly, choir participants sang in a 2-hr ensemble with 1-hr home vocal training; controls listened to a 3-hr playlist, attended concerts, and socialized online with fellow participants. At pre-test, groups did not differ in audiometric thresholds, behavioral SIN, or well-being. After 12 weeks, behavioral SIN improved across groups. No group-by-time interactions were observed in audiometric thresholds, music-in-noise, or well-being. EEG analysis is ongoing. Results suggest that short-term music engagement in older adults improves SIN abilities, but improvements may not be specific to music learning. Analysis after 24 weeks will explore changes to auditory processing over time. EEG analysis will assess the respective contribution of top-down and bottom-up processes on such change

Music, dance and imagination: a pilot training in young adults with tourette syndrome

Zanaboni, D.C., Rago, S., Cancer, A., Antonietti, A.
Catholic University of the Sacred Heart, Italy

Gather.town: Room 12 Code 13

Subtheme K - Music Intervention Programs - Neurodevelopmental disorders

Tourette syndrome (TS) is a childhood-onset neuropsychiatric disorder characterized by tics. Tics are motor or sound, repetitive, arrhythmic, and semi-voluntary movements. Tics' decrease is prompted by specific factors, such as relaxation, concentration, musical activities, and voluntary/finalistic movements. Creative skills – which are enhanced in TS patients as compared to healthy controls – can be supported by their motor energy and channeled in multiple activities, such as the ones proposed in the current study. In the last decades music has been used as a rehabilitative tool, which – in case of TS – could lead to mood improvement and fluid and rhythmic voluntary movements in place of tics. "Imagine, Tourette!" is the name of a musical dancing training, involving 8 TS patients (4 experimental subjects and 4 controls; 20 to 35 years old; 6 males and 2 females). The experimental group was enrolled in motor tasks based on music, whereas the control group in the same motor tasks without the musical component. The hypothesis of the study was that music can reduce tics' severity and increase mood more than the mere execution of the motor tasks. Results confirmed the hypothesis: The experimental group exhibited a higher level of tic reduction than controls and 3 out of 4 experimental subjects improved their mood. This training was an attempt of connecting the typical TS creativity to musical rehabilitation with the aim of improving quality of life in TS people.

Vocal music listening enhances post-stroke language network reorganization

Sihvonen, A.J.1,2, Ripollés, P.3, Leo, V.1, Saunavaara, J.4, Parkkola, R.4,5, Rodríguez-Fornells, A.6,7,8, Soinila, S.4,5, Särkämö, T.1
1 University of Helsinki, Finland, 2 University of Queensland, Australia, 3 New York University, USA, 4 Turku University Hospital, Finland, 5 University of Turku, Finland, 6 L'Hospitalet de Llobregat, Spain, 7 University of Barcelona, Spain, 8 Institució Catalana de Recerca i Estudis Avançats, Spain

Gather.town: Room 12 Code 15

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Daily vocal music listening aids stroke recovery and improves post-stroke language outcomes. However, little is known about the neural mechanisms driving this effect. Using data from a single-blind RCT including acute stroke patients (N=38), we set out to compare the effects of daily listening to vocal music, instrumental music, and audiobooks on functional and structural connectivity changes within the language network, and their correlation to improved language skills during the first three post-stroke months. Deterministic tractography analyses indicated that the vocal music group increased structural connectivity in the left frontal aslant tract (FAT) more than the audiobook group from acute to 3-month stage. The increased structural connectivity correlated with improved language skills. Analyses for functional neuroplastic changes showed that vocal music group increased stimulus-dependent activity in the frontal termination points of the left FAT during vocal music listening and resting-state fMRI engagement in the left postcentral areas within the language network compared to the audiobook group from acute to 3-month post-stroke stage. The level of resting-state engagement correlated with improved verbal memory. These results implicate that the beneficial effects of vocal music listening on post-stroke language recovery are underpinned by neuroplastic changes within the language network and extend our understanding of music-based interventions in stroke rehabilitation.

Effects of neurological music therapy on cognitive and emotional recovery after traumatic brain injury: a randomized controlled trial

Siponkoski, S.T.1, Martinez-Molina, N.1, Kuusela, L.2, Laitinen, S.3, Holma, M.4, Ahlfors, M., Jordan-Kilkki, P.5, Ala-Kauhaluoma, K.6, Melkas, S.2, Pekkola, J.2, Rodriguez-Fornells, A.7,8,9, Laine, M.10, Ylinen, A.2,11, Rantanen, P.12, Koskinen, S.1, & S
1 University of Helsinki, Finland, 2 Helsinki Central University Hospital 3 Espoo hospital, Finland, 4 Musiikkiterapiaosuuskunta InstruMental, 5 Dialogic Partner Oy, Finland, 6 Ludus Oy Tutkimusjakuntoutuspalvelut, Finland, 7 Bellvitge Biomedical Research Institute, L'Hospitalet de Llobregat, Spain, 8 University of Barcelona, Spain, 9 Catalan Institution for Research and Advanced Studies, Spain, 10 Åbo Akademi University, Finland, 11 Tampere University Hospital, Finland; 12 Kanta-Häme Central Hospital, Finland;

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Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Traumatic brain injury (TBI) causes severe cognitive deficits, especially in executive function (EF), as well as problems in mood and emotional self-regulation. Neurological music therapy may potentially aid both aspects of recovery, but experimental evidence for this is scarce. We performed a cross-over randomized controlled trial where 40 patients with moderate-severe TBI received a 3-month neurological music therapy intervention (2 times/week, 60 min/session), either during the first (AB, n = 20) or second (BA, n = 20) half of a 6-month follow-up period. Outcome was assessed with neuropsychological test and questionnaires performed at baseline and 3-month and 6-month stages. Results of neuropsychological tests showed that overall EF (Frontal Assessment Battery) and set shifting ability (Number-Letter Task) improved more in the AB than BA group from baseline to 3-month stage, the positive effect on EF being maintained also in the 6-month follow-up. In both groups, set shifting improved in the intervention vs. control period. Questionnaire results showed that the Self-Monitor subscale of Behaviour Rating Inventory of Executive Function (BRIEF) improved more in the AB than BA group from baseline to 3-month stage. No changes in mood or quality

of life were observed. Our results suggest that neurological music therapy can enhance executive functioning as well as facilitate awareness of the impact of one's behavior in interpersonal relationships in daily life.

Cognitive function and brain atrophy predict the efficacy of physical exercise with music of healthy elderly people and dementia: Mihama-Kiho Scan Project

Tabei, K.1,6, Satoh, M.1, Ogawa, J.2, Tokita, T. 3, Nakaguchi, N.4, Nakao, K.5,8, Kida, H.1,7, Tomimoto, H.1
1 Mie Univ, Japan ; 2 YAMAHA Music Foundation, Japan ; 3 Dept Health and Welfare, Mihama Town Hall, Japan; 4 Dept Health and Welfare, Kiho Town Hall, Japan; 5 Kinan Hospital, Japan; 6 AIIT, Tokyo Metropolitan Univ, Japan; 7 Iryohojinshadan Shokenkai Oami Zaitaku Shinryojo, Japan; 8 Shiokawa Hospital, Mie, Japan

Gather.town: Room 12 Code 17

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

In healthy elderly people and dementia, physical exercise with music (ExM) induces positive effects on cognitive function (Satoh et al., 2014; 2017) and leads to extensive neuroanatomical changes (Tabei et al., 2017). However, the neuropsychological factors influencing interventions of ExM, as well as the neural basis of its efficacy, remain unknown. The participants of healthy elderly people were followed up to 1 year; 51 underwent an intervention involving ExM. After 1 year, the participants were dichotomized into the improvement subgroup (IG) or no-improvement subgroup (no-IG) on the basis of their MMSE. The no-IG performed worse than the IG on the word fluency and visuospatial test at baseline. Voxel-based morphometry (VBM) demonstrated that no-IG showed more gray matter tissue loss in the left inferior frontal gyrus and medial frontal gyrus. The patients with mild to moderate dementia were followed up to 6 months; 25 underwent an intervention involving ExM. After 6 months, the participants were dichotomized into the IG or no-IG on the basis of their MMSE. The no-IG performed worse than the IG on the logical memory at baseline. VBM demonstrated that no-IG showed more gray matter tissue loss in the anterior cingulate gyrus. Our findings suggest that some characteristics of pre-intervention cognitive dysfunction and regional brain atrophy may aid clinicians in determining the efficacy of ExM in healthy elderly people and dementia.

Musical Attention Control Training for patients with acquired brain injury – a feasibility study

Werner, J.1, Obrig, H.1,2 , Villringer, A.1,2, Engel, A.1,2
1 University Hospital Leipzig, Germany, 2 Max Planck Institute for Human Cognitive and Brain Sciences, Germany

Gather.town: Room 12 Code 18

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

This study aimed at implementing and evaluating a music-based group therapy developed on the basis of the Musical Attention Control Training of Neurologic Music Therapy (Thaut & Hoemberg, 2014). 34 neurologic patients with acquired brain injury who suffered from attention deficits revealed by the initial standardized neuropsychological assessment were included. All patients were tested for attention abilities, interference control and mood before and at the end of their therapy. All patients received a multidisciplinary therapy within a day clinic setting (4-8 weeks) while half of the patients (n=17) received an additional Musical Attention Control Training (6-13 sessions twice a week, 50 minutes, 2-9 patients in a group). Before and after each session patients evaluated several parameters (e.g., mood, attention). Each session included training of specific attention functions (e.g., focusing, divided attention, flexibility, interference control) using structured rhythm exercises, melodic tasks and rhythmical exercises to patients' favorite songs. The implementation of the musical attention training was successful and subjective evaluations of patients showed improvements of mood and attention while patients enjoyed the training. Results on neuropsychological tests revealed for all patients an enhancement of several attention functions and mood, but only the music training group had significant better interference control showing evidence for a specific training effect.

Music intervention affects infants' early sensory encoding of nonnative speech

Zhao, T.C.1, Llanos, F.2, Pettet, M.1, Chandrasekaran, B.3, Kuhl, P.K.1
1 University of Washington, 2 University of Texas Austin, 3 University of Pittsburgh

Gather.town: Room 12 Code 19

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Infants' sensitivity to nonnative speech contrasts decline between 6-12 months, a period considered as the 'sensitivity period' for phonetic learning. Previous research suggests that music intervention during this period can enhance neural discrimination of a nonnative speech contrast (Zhao & Kuhl, 2016). However, it is largely unknown whether such music intervention can affect early sensory encoding of acoustic features of nonnative speech. We targeted the frequency-following response (FFR), a robust indicator of early sensory encoding of sound, to a nonnative Mandarin lexical tone. Seven-month-old infants were semi-randomly assigned to a music intervention group or a control group. Both groups'

FFRs were measured longitudinally at 7 and 11 months of age. In addition, music intervention group underwent a 12-session lab-controlled music intervention starting at 9 months of age. Neural pitch tracking accuracy and biometric decoding accuracy extracted from the FFR were evaluated as dependent variables. For the control group, neural pitch tracking accuracy significantly declined while biometric decoding accuracy increased from 7 to 11-months, both supporting the idea that perceptual narrow is already altering early sensory encoding of speech (Zhao et al, in prep). On the contrary, both metrics from the music intervention group did not change between the two ages, thus suggesting a 'maintenance' of early sensory encoding. Taken together, current music intervention indeed affected early sensory encoding of speech by preventing perceptual narrowing related alteration. Future research is warranted to elucidate the relation between early sensory encoding and later neural discrimination of both nonnative and native speech.

Groove and instructions to synchronize influence gait in Parkinson's disease during music-based auditory cueing

Ready, E., Holmes, J., & Grahn, J.
Western University, Canada

Gather.town: Room 12 Code 21

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Rhythmic auditory stimulation (RAS) is an auditory cueing strategy used to mitigate gait impairments in Parkinson's disease (PD), but it has highly variable outcomes. When music is used as the cue, 'groove' (i.e., degree of desire to move with the music) and instructions to synchronize with the perceived beat significantly alter temporal gait parameters in healthy adults. The current study examined how groove and synchronization influence gait parameters in PD. 21 people with idiopathic PD (Hoehn & Yahr stages 2-3) were tested on medication. Participants were randomized to one of two instruction conditions: free walking (instructed to walk comfortably) or synchronized walking (instructed to synchronize with music). All participants walked 8 passes across a 16-foot pressure sensor walkway in silence to determine baseline gait parameters. Participants then walked to high- and low-groove music that was 10% faster (beats per minute) than individual baseline cadence (steps per minute). Step length, stride width, stride velocity, cadence, and double support time (DST) were analyzed. High groove music elicited faster gait, longer steps, higher cadence, and lower DST than low groove music. Instructions to synchronize with cues were associated with an overall higher velocity than instructions to walk comfortably. These findings suggest that accounting for groove and task instructions during RAS may be relevant to clinical outcomes.

Enriched music-supported therapy in the improvement of motor function and quality of life of chronic stroke patients

Segura, E., Grau-Sánchez, J., Sánchez-Pinsach, D., Duarte, E., Arcos, J. L., Rodríguez-Fornells, A.
University of Barcelona and Bellvitge Biomedical Research Institute (IDIBELL), Spain, University of Barcelona and Bellvitge Biomedical Research Institute (IDIBELL), Spain, IIIA-CSIC, Artificial Intelligence Research Institute, Spain, Hospitals del Mar i l'Esperança, Parc de Salut Mar, Spain, IIIA-CSIC, Artificial Intelligence Research Institute, Spain, University of Barcelona, Bellvitge Biomedical Research Institute (IDIBELL), and Catalan Institution for Research and Advanced Studies (ICREA), Spain

Gather.town: Room 12 Code 22

Subtheme L - Music Intervention Programs – Neurology and Neurorehabilitation

Music-supported therapy (MST) is a rehabilitation program to improve the motor function of the upper extremity through playing musical instruments. However, recent trials in acute and chronic patients using MST failed to find a clear benefit of this rehabilitation approach when compared to other conventional rehabilitation programs. Considering this, a modified version of the MST protocol has been created (hereafter, referred as enriched MST, eMST). The new eMST includes two approaches: (i) a home-based self-training program using an app for electronic tablets and (ii) weekly group sessions of musical playing strengthening the motivational and emotional components of music playing. A parallel randomized controlled trial is being conducted where chronic stroke patients are randomized into the eMST program group or a control group receiving the Graded Repetitive Arm Supplementary Program (GRASP). A total of 60 patients receive 30 individual home one-hour sessions within 10 weeks in both interventions. In addition, the experimental group receives 10 group one-hour sessions in groups of 3 people. The participants' quality of life and upper limb motor function are evaluated before and after the intervention (an in a follow-up at 3 months). We will report a preliminary result of the ongoing randomized controlled trial. We expect to find a significant improvement of the upper limb motor function and the quality of life in the group receiving eMST compared to the control group.

Classroom music and movement instruction benefits only children's musical skills: A two-year comprehensive study

Lukács, B.1, Maróti, E.2 , Asztalos, K.3, Honbolygó, F.1
1 Research Centre for Natural Sciences, Hungary, ELTE Eötvös Loránd University, Hungary, 2 Budapest University of Technology and Economics, Hungary, 3 Liszt Ferenc Academy of Music, Hungary

Gather.town: Room 12 Code 23

Subtheme J - Music Intervention Programs – Community and Education

A growing body of research suggests that music interventions during childhood improve a wide range of sensory, cognitive, motor, and social skills. However, the effects of general classroom-based music education on normative development has rarely been examined. Based on the close interrelations of auditory, cognitive, and motor development in childhood, we investigated the long-term impacts of embodied music learning on the development of 6–7-year-old children in the school context. The education models of Active Music Learning (AML) were provided to three first-year classes: an intensive music and a mathematics class applied predefined movements, whereas another intensive music class used movement improvisations in music lessons. As a control group, we studied a class with the traditional Kodály music curriculum. Eighty children were tested three times over two school years. Results showed that pre- to posttraining improvements in rhythmic entrainment, literacy, intelligence, creativity, executive functions, and empathy were comparable in all classes. However, AML methods significantly enhanced children's harmony-, tempo discrimination and audio-visual connection skills. Further, we observed greater gains in pitch and melody discrimination in the intensive AML classes. These findings suggest that the long-term benefits of implementing body movements into classroom music interventions may be limited to musical development and not extend to other non-musical domains.

Music as Therapy: a Future Intervention Tool for Children with Reading Difficulties

Zavogianni, M.I.1, Kelić, M.2, Honbolygó, F.3
1 Research Center for Natural Sciences, Hungary & University of Pannonia, Hungary, 2 University of Rijeka, Croatia & SUVAG Polyclinic, Croatia, 3 Research Center for Natural Sciences, Hungary & Eötvös Loránd University,Hungary

Gather.town: Room 12 Code 25

Subtheme K - Music Intervention Programs - Neurodevelopmental disorders

Background Studies have shown that music training can enhance linguistic processes (e.g., categorical perception, phonological awareness) and cognitive functions involved in reading (Flaugnacco et al, 2015; Habib et al., 2016). Methods This project aims to develop a music training and measure its effects. In the pre-training phase, we will recruit 10-year-old children with reading difficulties from schools in Hungary and behavioral and ERP experiments will be conducted. In the training phase, we will apply a music training we are currently developing. During the post-training phase, we will assess the effectiveness of our training conducting the experiments of the pre-training phase. Results and Discussion We are expecting that our training, which is based on the association of speech and music elements, will show the importance of music transferring effects to cognitive functions of language such as reading. Results will be discussed in the light of the previous music training studies and acoustical and phonological processing in dyslexia. References Flaugnacco, E., Lopez, L., Terribili, C., Montico, M., Zoia, S., & Schön, D. (2015). Music training increases phonological awareness and reading skills in developmental dyslexia: a randomized control trial. PloS one, 10(9). Habib, M., Lardy, C., Desiles, T., Commeiras, C., Chobert, J., & Besson, M. (2016). Music and dyslexia: a new musical training method to improve reading and related disorders. Frontiers in Psychology, 7, 26.

Best posters in a flash 1

Theta-gamma phase amplitude coupling in human hippocampus supports auditory short-term memory retention.
Borderie Arthur
Gather.town: Room 4 Code 26

Neural entrainment to vibrotactile beats in hearing and deaf participants
Gilmore Sean
Gather.town: Room 3 Code 27

Are poor language skills associated with narrow entrainment region?
Gordon Reyna L., Ladanyi Eniko
Gather.town: Room 1 Code 16

Instability of Tone Production: A Means for Objectivizing Embouchure Dystonia
Lee André
Gather.town: Room 6 Code 7

Memory in time: Neural tracking of low-frequency rhythm dynamically modulates memory formation
Patel Aniruddh
Gather.town: Room 4 Code 15

Music intervention affects infants' early sensory encoding of nonnative speech
Zhao Christina
Gather.town: Room 12 Code 19

Best posters in a flash 2

Neural spiking in the human medial temporal limbic system to emotions expressed in music
Fernandez Natalia
Gather.town: Room 5 Code 14

Musical abilities in children with developmental cerebellar anomalies
Guinamard Antoine
Gather.town: Room 3 Code 2

Train the brain with music – Can one year of musical intervention lead to structural connectivity changes in healthy elderly?
Jünemann Kristin
Gather.town: Room 1 Code 6

Rehabilitative effects of choir singing on verbal, emotional and social functioning in chronic post-stroke aphasia: a randomized controlled cross-over trial
Pitkäniemi Anni
Gather.town: Room 6 Code 23

Adapting to the sound of music - development of music discrimination skills in recently implanted CI users
Seeberg Alberte
Gather.town: Room 7 Code 2

A study of rhythmic auditory-motor behaviour with focal TMS of the human brain: the distinct role of the dorsal and medial premotor cortices
Signoriello Elisabetta
Gather.town: Room 9 Code 14

"CONNECTING WITH MUSIC" INTERLUDES

The Neurosciences and Music VII conference is arranged in cooperation with the host institutions Center for Music in the Brain (MIB) and The Royal Academy of Aarhus/Aalborg (RAMA) and takes place in the Academy's premises within the Aarhus Music Hall. RAMA offers a large variety of music education programmes, including classical, jazz/pop and electronic music. The vision for The Neurosciences and Music VII is that the diverse musical expertise of the Academy can be represented as part of both the scientific and the social program. Inbetween the symposia, the participants will thus experience brief musical encounters under the overarching title "Connecting with music", involving both teachers and students from the Academy's different programs.

FRIDAY, 18 JUNE 2021

18.40-19.00
Connecting with music 1
Assoc. Professor Lena Gregersen and Song, Dance and Playing student group

In this session Assoc. Professor Lena Gregersen and a group of rhythmic music and movement students will perform a singing, dancing and playing interlude. The students follow an educational programme in which, apart from their main instrument, they study the combined skills of song, dance and play, a discipline that is much inspired from Latin-American and African music traditions and a speciality in Aarhus, not found in other institutions. The interlude will incorporate solo and group vocal performance, drum and percussion ensembles and dancers, all in an intriguing and complex context. During the interlude, the performers will interact with the audience and provide them with a chance to form part of the performance.

SATURDAY, 19 JUNE

14.15-14.30
Connecting with music 2
Prof. Jim Daus Hjernoe in vocal interaction with audience

Professor in choir conducting and head of RAMA Vocal Center Jim Daus Hjernøe has developed a set of hand signs that can be used for interacting with the singers and to create live arrangements and compositions on the fly. The method is called Vocal Painting or VOPA and can be used at all levels of singing competence from school children over amateur choirs to professional singers at the highest level. In this interlude, Professor Hjernøe will demonstrate the concept by leading the conference participants through a unique impromptu shared singing experience.

SUNDAY, 21 JUNE

13.30-14.00
Connecting with music 3
RAMA Big Band
conducted by Professor Jens Christian Jensen

The RAMA Big Band consists of players from both the jazz/pop and the classical departments of RAMA. Professor Jensen is an expert within composition, arranging and conducting of large ensembles and often designs concerts that widely expand the traditional boundaries of Big Band music. Jensen has, among many other things, successfully fused jazz-style arrangements with Middle eastern, Chinese and Electronic music traditions. At this occasion the Jensen will lead the RAMA Big Band through a suite of recently developed compositions and arrangements, featuring some of RAMA's jazz/pop vocal students.

16.45-17.00
Connecting with music 4
El Sistema inspired children's orchestra Musik-Sak led by Rebecca and Gabriella Fuglsig

In this interlude, the El Sistema-inspired children's ensemble MUSIK-SAK from Aarhus Music School will play a short concert. The goal of the Musik-Sak project is to bring together children across cultural, religious and socio-economic differences and to provide the opportunity to be part of a creative community within the framework of the classical orchestral music tradition.

MONDAY, 22 JUNE

10.25-10.45
Connecting with Music 5
Triple bass concert, featuring Morten Ramsbøl, Bjørn Petersen, Mads Bærentzen & Peter Vuust

In this musical interlude, the audience will have the rare opportunity to hear not one, not two but three double basses playing at the same time. Leader of Center for Music in the Brain, Professor Peter Vuust, Associate Professor @ MIB and RAMA Bjørn Petersen and Professor of Jazz Double Bass at University of Music and Performing Arts in Graz, Austria, Morten Ramsbøl here join forces with their instruments. The bass players are accompanied by Aarhus Jazz Orchestra pianist Mads Bærentzen in a program of children's songs and jazz classics.

15.30-16.00
Connecting with music 6
A cappella choir Vocal Line led by Associate Professor Jens Johansen.

Vocal Line is a contemporary a capella choir from Aarhus, Denmark, consisting of 30 singers and conducted by Jens Johansen. The choir dates back to 1991 and has as its stated goal and purpose to be the front runner in the development of rythmical a cappella choir music nationally as well as internationally. At the concert Vocal Line will present songs from their latest album "True North".

GENERAL INFORMATION

VENUES

- **AARHUS MUSIC HALL**
  Thomas Jensens Allé 2, 8000 Aarhus C
  Lille Sal: *workshops, symposia*
  Caféen (The Café): *lunches and coffee breaks*
  Area around Filuren: poster session
  "Klubscenen" (226) and rooms 222 and 224: *jam sessions*
- **AARHUS CITY HALL**:
  welcome reception
  Rådhuspladsen 2, 8000 Aarhus
- **"CENTRALVÆRKSTEDET" (THE RAILWAY REPAIR CENTER)**:
  conference dinner
  Værkmestergade 9, 8000 Aarhus C
- **"DEN GAMLE BY" (THE OLD CITY MUSEUM)**:
  music and light supper
  Viborgvej 2, 8000 Aarhus C

ENROLMENTS

Enrolment fees include:

- Live and recorded sessions available for 6 months
- Keynote lecture
- Symposia
- Live and online interactive poster sessions
- Certificate of attendance
- Live and online networking sessions with speakers and attendees
- Proceedings
- Lunches and coffee breaks (only for on site participants)

POSTERS

Over 270 posters are exhibited at Aarhus Music Hall and online on Gather.town
Detailed information is available online and at the conference Secretariat and on www.neuromusic.org.

AUDIENCE AND OFFICIAL LANGUAGE

The Conference is intended for professionals involved in the study of the relations between neurosciences, music and development.
The Conference is also accessible to undergraduate students.
The Conference is held in English.

CERTIFICATES AND CREDITS

Certificates are available online on your account menu (after log in and access from the User Menu).

PROGRAM CHANGES

The Organization reserves the right to modify the program according to scientific or organizational considerations.

SOCIAL PROGRAM

- COFFEE BREAKS AND LUNCHES
Caféen (The Café) - Aarhus Music Hall
Thomas Jensens Allé 2, 8000 Aarhus C

- SOCIAL EVENTS

Friday, 18 June 2021
WELCOME RECEPTION
AT AARHUS RÅDHUS (AARHUS CITY HALL)
Rådhuspladsen 2, 8000 Aarhus
18.00-18.10
Welcome by the Municipality of Aarhus
18.10-18.30
Welcome by Mariani Foundation and Hosting Committee

Saturday, 19 June
19.00-22.30
CONFERENCE DINNER AT "CENTRALVÆRKSTEDET" (The Railway Repair Center)
Værkmestergade 9, 8000 Aarhus C

Sunday, 21 June
20.00-23.00
JAM SESSION AT THE ROYAL ACADEMY OF MUSIC
Musikhuset Aarhus (The Concert Hall Aarhus)
Skovgaardsgade 2, 8000 Aarhus C

Jazz/Blues led by Mikkel Vuust (dms)
"Klubscenen" (room 226) which will be equipped with rhythm group instruments, microphones and percussion.
Rooms 222 and 224 are reserved for spontaneous sessions (vocal or other).
Both are equipped with a grand piano.

Monday, 22 June
18.30-22.00
MUSIC, EXHIBITIONS AND LIGHT SUPPER AT "DEN GAMLE BY" (The Old City Museum)
Viborgvej 2, 8000 Aarhus C
19.30-22.00

1. **Jazz at Bent J jazz bar**, featuring Mikkel Vuust, Frederik Vuust and Peter Vuust
2. **Aarhus fortæller (The Aarhus Story)**
   800 m2 underground museum on the history of Aarhus
3. **Remember the 1970's?**
   Entire neighbourhood based on the year 1974 with apartments, shops, a jazz bar and much more.

Fondazione
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neurologia infantile

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