neuro music news

n° 339 – 24 June 2021

Special edition
Neuromusic VII Best Posters

Here below we present the **12 best posters** selected among over 250 submitted at the international conference **"The Neurosciences and Music VII - Connecting with music across the lifespan"**, that took place in Aarhus (Denmark) and online a few days ago (June 18-21, 2021). The selection rewarded the most innovative research.
At the meeting, the Scientific Committee also launched the **"Mariani Young Investigator Award - dedicated to Maria Majno"** sponsored for 2021 by RITMO (Centre for Interdisciplinary Studies in Rhythm, Time and Motion), University of Oslo. The first recipients were the authors of the two highest ranked posters: **Antoine Guinamard** from Lille and **Kristin Jünemann** from Hannover.

*In questo numero presentiamo la scelta dei **12 "best poster"** fra gli oltre 250 presentati al convegno internazionale **"The Neurosciences and Music VII - Connecting with music across the lifespan"**, che si è tenuto ad Aarhus in Danimarca e online pochi giorni fa (18-21 giugno 2021). La selezione ha premiato gli ambiti di ricerca più innovativi.*
*Nei "best poster" si è parlato di memoria e, in particolare, del ruolo dell'accoppiamento di fase e ampiezza theta e gamma nel mantenimento della memoria di lavoro (**Borderie et al**), e del ruolo della pulsazione sincrona presentata in modo naturalistico nel favorire la memoria episodica (**Patel et al**).*
*Sono state esplorate le abilità uditive musicali in portatori di impianto cocleare (**Seeberg et al**) e il livello di entrainment per stimoli vibrotattili nei non udenti (**Gilmore et al**). Di entrainment si è parlato anche in relazione ai disturbi del linguaggio (DLD), in quanto l'efficienza sia grammaticale che ritmica del linguaggio risulta essere proporzionale all'ampiezza della regione di entrainment in bambini con DLD (**Gordon et al**). Le abilità di discriminazione precoce dei suoni del linguaggio sono solitamente forgiate dalla lingua nativa e intorno ai 6-12 mesi si osserva una specializzazione con una perdita delle abilità di discriminazione fine dei suoni non nativi, questo fenomeno può essere ritardato con un intervento musicale (**Zhao et al**).*
*Altri argomenti trattati sono: il ruolo della corteccia supplementare motoria nel comportamento ritmico (**Signoriello et al**); l'individuazione di un criterio diagnostico oggettivo nella diagnosi della distonia dell'imboccatura (**Lee et al**); le risposte intracorticali nelle aree limbiche a contenuti musicali emotivi (**Fernandez et al**); gli effetti riabilitativi del canto in coro sul funzionamento verbale, emotivo e sociale nell'afasia cronica, studio randomizzato controllato (**Siponkoski et al**).*

Il Comitato Scientifico ha inoltre istituito il premio **"Mariani Young Investigator Award - dedicated to Maria Majno"***, sponsorizzato nel 2021 dal centro RITMO* (Centre for Interdisciplinary Studies in Rhythm, Time and Motion) dell*'Università di Oslo. Il premio è stato assegnato ai primi due best poster in classifica. Il primo, presentato da* ***Guinamard et al*** *(Lille), era incentrato sullo studio delle abilità di percezione e produzione ritmica nei bambini con anomalie evolutive del cervelletto (DCA); il secondo, presentato da* ***Jünemann et al*** *(Hannover), riguardava la possibilità di modificare la connettività cerebrale nell'anziano dopo un anno di training musicale.*

Neuromusic VII Best Posters Abstracts

Musical abilities in children with developmental cerebellar anomalies

Guinamard A, Clément S, Goemare S, Mary A, Riquet A, Dellacherie D
University of Lille, France; University Hospital of Lille, France
"Mariani Young Investigator Award - dedicated to Maria Majno"

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 thirtyseven 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.

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
"Mariani Young Investigator Award - dedicated to Maria Majno"

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.

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

Borderie, A[1,2], Caclin A[3], Tillmann B[3,4], Albouy P[1,2]

1 Laval University, Quebec, Canada; 2 BRAMS Music and Sound Research, Montreal, Canada; 3 CRBLM, Montreal, Canada; 4 Lyon University, France

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-becompared 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.

Neural entrainment to vibrotactile beats in hearing and deaf participants

Gilmore S, Pham PN, Russo F

Ryerson University, Toronto, Canada

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.

Are poor language skills associated with narrow entrainment region?

Gordon RL, Ladanyi E, Novakovic M, Scartozzi E, Fromboluti EK, McAuley JD
Vanderbilt University Medical Center, Nashville, USA; Northwestern University, Chicago, USA

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.

Instability of tone production: A means for objectivizing embouchure dystonia

Lee A, Furuya S, Morise M, Iltis P, Altenmüller E
Technical University of Munich, Germany; Sophia University, Tokyo, Japan

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.

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

Patel AD, Hickey P, Merseal H, Race E
Dept. of Psychology, Tufts University, USA

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.

Music intervention affects infants' early sensory encoding of nonnativespeech

Zhao TC[1], Llanos F[2], Pettet M[1], Chandrasekaran B[3], Kuhl PK[1]
1 University of Washington, USA; 2 University of Texas, Austin, USA; 3 University of Pittsburgh, USA

Infants' sensitivity to nonnative speech contrasts decline between 6-12months, 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.

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

Fernandez NB[1], Bobin M[1], Trost WJ[1], Frühholz S[1,2]
1 University of Zürich, Switzerland; 2 University of Oslo, Norway

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.

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

Siponkoski S-T[1], Pitkäniemi A[1], Laitinen S[2], Särkämö E-R[3], Pentikäinen E[1], Sihvonen AJ[1,4], Martinez Molina N[1], Pekkola J[1,5], Eloranta H[6], Schlaug G[7], Melkas S[5], Särkämö T[1]

1 University of Helsinki, Finland; 2 Espoo Hospital, Finland; 3 Private choir conductor, Finland; 4 University of Queensland, Australia; 5 Helsinki University Central Hospital; 6 Uusimaa Stroke Association & Aphasia Centre, Finland; 7 University of Massachusetts Medical School, USA

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 groupbased singing in aphasia. Using a cross-over RCT design, 50 stroke patients with chronic nonfluent 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 homebased 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 groupbased 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.

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

Seeberg A[1], Andersen AS[1], Højlund A[2], Haumann N[1], Faulkner K[3], Brattico E[1], Vuust P[1], Petersen B[1]

1 Center for Music in the Brain, Denmark; 2 Center of Functionally Integrative Neuroscience, Denmark; 3 Oticon Medical, Denmark

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.

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 E, Marchiotto F, Lega C, Cattaneo L
University of Verona; University of Trento; University of Milano Bicocca, Italy

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 auditorymotor 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 Pierfranco and Luisa Mariani Foundation
Since its beginnings in 1985, the Mariani Foundation has established itself as a leading organization in the field of paediatric neurology by organizing a variety of advanced courses, providing research grants, and supporting specialized care. The Foundation works in close cooperation with major public healthcare institutions, complementing their scientific programs and other activities. In 2009 it became the first private entity in Italy to join the founding members of the National Neurologic Institute "Carlo Besta" in Milan. In addition to its services, the Foundation aims, through its continuing medical education courses and publications, to spread knowledge in the field of paediatric neurology in order to help treat or alleviate a large number of paediatric neurologic disorders.

In the year 2000, the Mariani Foundation has added a new and important dimension to its activities: fostering the study of the multiple links between the neurosciences and music, including music education and early intervention. This significant commitment has inspired the series of "Neurosciences and Music" conferences, held in Venice (2002), Leipzig (2005), Montreal (2008), Edinburgh (2011), Dijon (2014), Boston (2017) and Aarhus (2021). All these meetings have led to the publication of major volumes in the Annals of the New York Academy of Sciences.

"Neuromusic News"
Direttore responsabile Luisa Bonora
Pubblicazione periodica. Registrazione n. 318 Tribunale di Milano del 10-06-2011

Edited by Fondazione Mariani
Contributors: Luisa Lopez, Giuliano Avanzini, Maria Majno and Barbara Bernardini
Editorial coordinator: Renata Brizzi
For further information: neuromusic@fondazione-mariani.org