Tenth anniversary symposium

of the international laboratory for Brain, Music, and Sound Research

October 21 – 23, 2015

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Symposium program & schedule

Wednesday, October 21, 2015

Location: **BRAMS Laboratory, UdeM**
1430 boul. Mont Royal
Outremont, QC H2V 4P3

17:00 – 19:00 **BRAMS tour and reception**

Thursday, October 22, 2015

Location: **Université de Montréal, Amphithéâtre Ernest-Cormier (room K-500)**
Pavillon Roger-Gaudry, 2900, boul. Édouard-Montpetit

09:00 – 09:45 **Registration**

09:45 – 10:00 **Welcome Address**

Maryse Lassonde, *Directrice scientifique et membre du conseil d'administration du Fonds de recherche du Québec – Nature et technologies (FRQNT)*

Laurent Lewis, *Vice-doyen, Faculté des Arts et des Sciences, UdeM*

♫ Irene Feher (mezzo-soprano) & Christine Beckett (keyboard)

10:00 – 11:00 **Barbara Canlon**, Karolinska Institute / *Introduction by Philippe Fournier*
The auditory system through the ages

♫ Christine Beckett (keyboard)

11:15 – 12:00 **Speed data presentation by BRAMS members – I**

Presenters: **Isabelle Peretz, Karim Jerbi, Caroline Palmer, Marc Schoenwiesner, Sandra Trehub, Pierre Jolicoeur, Virginia Penhune, Krista Hyde** / Gong chair: Christine Beckett

12:00 – 14:00 **Posters & Lunch**

♫ Brian Matthias (harpsichord), Floris van Vugt (Oboe) & Anna Zamm (Flute)

14:00 – 15:00 **Frederik Ullén**, Karolinska Institute / *Introduction by Isabelle Royal*
Musical expertise – from neuroimaging to behavior genetics

♫ Simon Jutras (classical guitar)

15:15 – 16:00 **Speed data presentation by BRAMS members – II**

Presenters: **Robert Zatorre, Alexandre Lehmann, Marcelo Wanderley, François Champoux, Sylvie Hébert, Jorge Armony, Denise Klein, Nathalie Gosselin** / Gong chair: Christine Beckett

♫ Anastasia Sares (flute), Pauline Tranchant (flute) & Dominique Vuvan (accordion)

16:00 – 16:30 **Break**

16:30 – 17:30 **Public keynote – Antonio Damasio**, University of Southern California
Notes on Feeling, Music and the Human Brain

♫ Vanessa Asher (flute)

17:30 – 19:00 **Cocktail**

♫ Samuel Brassard (bass), Noam Guerrier-Freud (drums) & Olvier Salazar (keyboard)

Friday, October 23, 2015

Location: **McGill University, Jeanne Timmins Amphitheatre**
Montreal Neurological Institute (MNI)

09:45 – 10:00 **Welcome Address**

Viviane Poupon, *Executive Director, Partnerships, MNI*

Maria Majno, *Vice President, Mariani Foundation for Pediatric Neurology, Milan, Italy*

09:30 - 10:30 **Uri Hasson**, Princeton University / *Introduction by Anna Zamm*
Coupled neural systems in conversation

♫ Taryn Boudreau (clarinet) & Samuel Hogue (violin)

10:30 - 10:45 **Break**

10:45 - 11:45 **Nina Kraus**, Northwestern University / *Introduction by Emily Coffey*
Unraveling the biology of auditory learning: What have we learned from music?

♫ Nicolò Bernardi (violin), Brian Matthias (harpsichord), Floris van Vugt (oboe) & Lucia Vaquero (cello)

11:45 - 12:00 **Break**

12:00 - 13:00 **Round table: "The Next Ten Years"**
Chair: **Virginia Penhune**
Panel: **Barbara Canlon, Antonio Damasio, Andrea Halpern, Uri Hasson, Nina Kraus, Isabelle Peretz, Frederik Ullen, Robert Zatorre**

♫ Nicolò Bernardi (violin), Brian Matthias (harpsichord), Floris van Vugt (oboe) & Lucia Vaquero (cello)

Closing Comments

1:00 - 14:00 **Lunch**

♫ Thomas Christie (guitar) & Tyler Lewis (Guitar)

Erasmus Mundus session

14:10 - 14:30 **Rudolf Rübsamen**, Leipzig University, Germany
Inhibition increases sub-millisecond encoding precision of second order neurons in the auditory brainstem

14:30 - 14:50 **Manolo Malmierca**, University of Salamanca, Spain
Stimulus-specific adaptation in the auditory brain: Functional mechanisms

14:50 - 15:10 **Josef Rauschecker**, Georgetown University, U.S.A.
Harmonic and sequence processing in nonhuman primates: Precursors of music

15:15 - 15:30 **Break**

15:30 - 15:50 **Larry Roberts**, McMaster University, Canada
What we are learning about plasticity, attention, and neural coding in tinnitus

15:50 - 16:10 **Mari Tervaniemi**, University of Helsinki, Finland
Music and the brain - life span approach

16:10 - 16:30 **Barbara Tillman**, Lyon Neuroscience Research Center, France
Auditory rhythmic stimulation influences language processing

18:00 - 01:00 **Party/Reception**
Espace Marie-Chouinard, 4499 av. de l'Esplanade


Professor
Groove
funk hip-hop
soul - 9 pm
8 pm
Casino
Neuronale
recycled brain signals
neuromagnetic beats
6 pm
BRAMS talents
FRIDAY OCT 23, 2015
Éspace Marie-Chouinard
4499 avenue De L'Esplanade
MONTREAL, QC H2W 1T2
Brams
International Laboratory for
Brain, Music and Sound Research
10
years
SYMPOSIUM

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Abstracts

1 – Philippe ALBOUY

Affiliation: Montreal Neurological Institute, McGill University

Email: philippe.albouy@mail.mcgill.ca

Abstract Title: Selective modulation of theta oscillations using rhythmic TMS boosts auditory working memory performance.

Abstract Authors: Philippe Albouy (1,2,3), Sylvain Baillet 3, Robert J. Zatorre (1,2)

1) Cognitive Neuroscience Unit - Montreal Neurological Institute, McGill University

2) International Laboratory for Brain, Music and Sound Research (BRAMS)

3) McConnell Brain Imaging Center – NeuroSPEED team - Montreal Neurological Institute, McGill University

Abstract Text:

Substantial efforts in neuroscience have been made to understand how humans process complex stimulus patterns. In the auditory domain, in addition to the subdivisions of the auditory cortex, long-range brain connections are involved in the processing of auditory information. More specifically, multiple brain oscillatory components can be considered as signatures of these distributed processes, as endogenous oscillations correlate with, and can predict, behavioral performance. Although a large body of brain-behavior correlation data is convincing that brain oscillations subserve various cognitive processes, their causal relationship with behavior needs to be clarified: Do neuronal oscillations condition behavior and performance, or is it vice-versa? Our study investigated this causal relationship in the context of auditory working memory, first identifying a relevant oscillatory signature, and then modulating it with TMS.

In a first phase, we asked healthy participants to perform two same-different melodic discrimination tasks during an MEG recording. The first task involved a simple pitch judgment (simple melodies). The second task required participants to manipulate auditory information in memory while performing pitch judgment (inverted melodies). Our MEG results revealed the emergence, during the retention period, of a parietal theta oscillation (in the left Intra Parietal Sulcus: IPS) that predicts participants' performance on the inverted melody task. In contrast this oscillatory activity was not observed for the simple task. We then used rhythmic Transcranial Magnetic Stimulation bursts over the left IPS during task performance (on trial-by trial basis) to directly modulate this MEG -identified θ-oscillation. With TMS bursts tuned to participants' preferred theta-frequency (θ-TMS), performance was increased as compared to baseline on the inverted melody task, which requires manipulation of auditory information in memory. In contrast, such stimulations decreased performance on the simple pitch task. To test the specificity of the effects, participants performed the same tasks with arrhythmic stimulations over the left IPS. Interestingly no change in terms of behavioural performance was observed after such stimulations for both tasks. Our results demonstrate for the first time that the modulation of endogenous oscillations during task performance can modulate participants' behavioral performance. This approach suggests that brain oscillations can serve as specific signal markers and targets for controlled interventions into brain activity and (dys)functions, using safe, non-invasive brain stimulation.

2 – Miriam ALBUSAC-JORGE

Affiliation: Brain, Mind and Behavior Research Center/Musicology Department, University of Granada (Spain)

Email: albusac@ugr.es

Abstract Title: Does music training change the Default Mode Network?

Abstract Authors: Albusac-Jorge, Miriam; Zatorre, Robert J.; Verdejo-Román, Juan; Giménez-Rodríguez, Francisco J.; Pérez-García, Miguel.

Abstract Text:

Default Mode Network (DMN) is a well-known system, which is included in the resting state brain networks. It has been studied extensively since Marcus Raichle first described it in 2001. DMN is characterized by regions that remain consistently active and synchronized at rest (with high levels of communication between them), and yet they are inactivated during tasks that demand attention. In this research, the interest is focused on deactivation patterns while performing tasks.

Still very little is known about changes in large-scale brain networks as a result of long-term learning of activities, which require high-level cognitive skills. Some studies have been conducted on functional connectivity at rest as well as deactivation patterns, using samples having a great expertise in a domain, like chess, with findings that suggest a change in DMN. While musical performance requires high cognitive abilities and extensive training, the question arises: Does music training change the Default Mode Network?

In order to answer this question, a preliminary study was carried out using fMRI. The sample (n=13) included musicians (experimental group; n=6) and non-musicians (control group; n=7).

Participants were asked to perform two tasks: music and linguistic (control) tasks. In the first, two melodies were heard. Participants had to decide whether both melodies were the same or different. If the melodies were different, they differed only in a note. The second task had a similar structure, but used syllable sequences (without semantic content). It is also well known that with higher difficulty in the task, the suppression of DMN increases. Therefore, each of the tasks had three levels of difficulty, based on a previous behavioural study.

Behavioral results showed the expected patterns: better performance in the musicians for the melodies but no differences between groups for the syllables.

We expected to find differences between groups in deactivation for the musical task, as well as differences depending on the degree of difficulty of the task. Both groups demonstrated deactivation in the areas typically thought to be part of the DMN. However, preliminary results seem to point to less DMN deactivation in musicians within the music task, although the task performance was very successful. In addition, this deactivation level appears to be influenced by the level of difficulty. Easy melodies deactivated DMN more in non-musicians than in musicians, i.e, the network appears more strongly in non-musicians. Something similar happens with the medium difficulty melodies. In the most difficult condition is where the deactivation was most similar between groups. Although these results are preliminary, they suggest that musical training changes the DMN, resulting in less deactivation to perform the task more successfully.

3 − Anna-Katharina R. BAUER

Affiliation: Neuropsychology Lab, Department of Psychology, University of Oldenburg, Germany

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Abstract Title: Phase entrainment of slow neural oscillations enhances performance over time

Abstract Authors: Anna-Katharina R. Bauer, Manuela Jaeger, Jeremy D. Thorne, Stefan Debener

Abstract Text:

Natural auditory stimuli are characterized by rhythmic patterns, as for example in speech or music, to which neural oscillations can be synchronized. The neural synchronization to environmental rhythms is thought to shape human perception, by optimizing cortical excitability to be high and low when critical events are expected. Accordingly, the detection probability of near-threshold auditory targets has been shown to co-vary with the phase of neural δ-oscillations that were entrained by a periodic stimulus. While the concept, of entraining brain rhythms to an external periodic force has had an upsurge in research interest over the past years, little is known about the development of entrainment over time. In a human electroencephalography (EEG) study, we investigated whether exposure to several seconds of uninterrupted periodic auditory stimulation results in behavioral benefits and neural entrainment effects. Listeners were asked to detect short silent gaps that were equally distributed with respect to the phase angle of a 3 Hz frequency-modulated tone (carrier frequencies: 800 Hz, 1 kHz, and 1.2 kHz). Two stimulus durations were compared, an early (3.67s, 11 cycles) and a late condition (7.67s, 23 cycles), the latter containing a four seconds time period prior to gap occurrence, which allowed us to study the maturation of entrainment. Gap detection performance and reaction times were correlated with stimulus phase. The results confirmed that behavioral performance was strongly modulated by the phase angle of the stimulus. Furthermore, performance scores were higher and reaction times faster for the late condition, suggesting “stronger” phase entrainment over time. The phase angle corresponding to peak performance was correlated between early and late conditions, indicating stable phase entrainment over several seconds. Importantly, we ensured that the current results were not an artifact of stimulus acoustics. Fourier analysis of the EEG showed spectral peaks at 3 Hz and the 6 Hz harmonic, indicating that neural oscillations were also entrained by the 3 Hz frequency-modulated tone. Subsequent analysis of inter-trial phase coherence (ITPC) revealed a single peak in the 3 Hz frequency band. Importantly, the onset phase of the frequency-modulated stimulus was randomized from trial to trial. The observed effects of neural entrainment were only present when the neural signals were realigned in phase so that the stimulus phases were consistent over trials. This study demonstrates that uninterrupted phase entrainment over several seconds leads to enhanced behavioral performance and stronger phase entrainment. Overall we suggest that entrainment is gradually evolving over time and thereby optimizes our perceptual processing.

4 – Valetin BEGEL

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Abstract Title: Battery for the Assessment of Auditory Sensorimotor Timing Abilities (BAASTA): a rehabilitation perspective

Abstract Authors: Valentin Begel (1), Nicolas Farrugia (5), Charles-Etienne Benoit (1,3,5), Laura Verga (5), Eleanor Harding (5), Sonja A. Kotz (5), & Simone Dalla Bella (1,2,3,4)

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Abstract Text:

Impairments of timing abilities are characteristic of different neurological and psychiatric disorders such as Parkinson's disease, attention deficit hyperactivity disorder (ADHD) or schizophrenia. They can also occur in healthy individuals suffering from beat deafness. These deficits manifest in terms of impoverished timed performance and/or poor time perception. The characterization of timing skills inthese impaired populations is valuable for the understanding of the disorders and can pave the way to targeted rehabilitation perspectives. To this goal, we introduce here the Battery for the Assessment of Auditory Sensorimotor and Timing Abilities (BAASTA), a new tool for the sytematic assessment of rhythm perception and auditory-motor synchronization skills. The battery includes a large array of perceptual and sensorimotor tasks. Perceptual tasks include the comparision of two durations, the discrimination between regular and irregular metronome or musical sequences and judging if a tone is aligned with the beat of music. Sensorimotor tasks include unpaced tapping and paced tapping with metronome and music. The battery has been tested in two Experiments. In Experiment 1 the BAASTA was validated in a group of 20 nonmusicians. Three perceptual tasks of the battery were further tested in another group of 30 participants to validate the results of the maximum likelihood procedures (MLP) against standard staircase methods. The BAASTA is sensitive for the characterization of individual differences within a population in terms of sensorimotor and perceptual timing skills. Given the existing links between timing skills, motor control and cognition, its use could help develop an individualized approach to rehabilitation of motor abilities and cognition in a variety of disorders.

5 – Amélie BERNARD

Affiliation: McGill University

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Abstract Title: Tracking speech-sound regularities at multiple levels: syllable-position and co-occurrences

Abstract Authors: Amélie Bernard, Kristine H. Onishi

Abstract Text:

Languages display language-specific regularities in the positioning of their sounds. For example, in English NG occurs at the end but not the beginning of syllables, but the NG sound can occur at the beginning of syllables in other languages (e.g., Vietnamese). Adults are sensitive to the sound-sequence patterns (phonotactics) of the languages they know and can rapidly learn novel patterns, but little is known about how these patterns are represented. In the current work, we investigated the level(s) at which adults represent phonotactic patterns.

In Training, adult participants heard multiple repetitions of words like baFPek and kuZDev that contained constraints on the medial consonants (capitalized in the examples). These constraints could be represented as (1) constraints on syllable-position (F, Z as syllable codas; P, D as syllable onsets) or as (2) co-occurrences (F co-occurring with P; Z with D). In test, participants heard novel words (that were not heard in Training) and were asked whether the word has been heard before during the study. All test words were novel, and thus should not be recognized. However, if participants learn the constraints present in the training items, they might more often falsely recognize words that maintain (rather than violate) the constraints from the training items.

False recognition was higher for novel words that maintained than violated syllable-position constraints, when the local co-occurrences were maintained (Experiment 1: more false alarms to kiFPeb than kiPFeb) and when they were not (Experiment 2: more false alarms to kiFDeb than kiDFeb). False recognition was also higher for novel words that maintained than violated local co-occurrences, when syllable-position constraints were maintained (Experiment 3: more false alarms to kiFPeb than kiFDeb), but failed to differentiate items differing in local co-occurrence patterns when syllable position constraints were violated (Experiment 4: similar false alarm rates to kiPFeb and kiDFeb).

Participants were thus able to track constraints at both the syllable and the local co-occurrence levels. Moreover, across participant groups, syllable-level representations were available, and, if syllable-level constraints were maintained, co-occurrence level information was available. In ongoing work we examine whether both levels of representation were simultaneously available by presenting the test items from Experiments 1-4 in a single experiment (Experiment 5). Our results suggest the simultaneous availability of hierarchical phonotactic representations in which co-occurrence information is nested within syllable-position information.

6 – Daphné BERTRAND-DUBOIS

Affiliation: Département de psychologie, Université de Montréal

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Abstract Title: The effect of speech processing on spontaneous resting-state brain activity: an MEG study

Abstract Authors: Daphné Bertrand-Dubois, Florence Martin, Hannu Laaksonen, Ana-Sofia Hincapié, Hélène Giraud, Véronique Boulenger and Karim Jerbi

Abstract Text:

For many years, spontaneous brain activity has been considered to reflect an idling brain state of little interest. In fact, it has even been referred to as background or baseline noise. This has changed dramatically over the last ten years with the discovery of characteristic large-scale functional activation patterns that occur spontaneously in the brain. Functional and structural imaging studies have shown that these so-called resting-state networks are tightly linked to the structural organization of the brain, that they are altered in various brain disorders, and in some cases, they appear to be modulated following sensory, motor or cognitive processes. Whether auditory and, in particular, speech-related processing affect the brain's baseline activity remains poorly understood. Here we examined whether the properties of resting-state brain activity are modified after a sustained speech perception task. To this end we compared the oscillatory and network brain dynamics measured with magnetoencephalography (n=23) during 3 minutes of rest before versus 3 minutes of rest after a speech perception task. This was carried out by assessing a combination of local oscillatory power in various frequency bands (theta, alpha, beta and gamma), various long-range frequency-domain interaction measures (weighted phase-lag index, imaginary coherence, etc.) as well as graph-theoretical metrics. We found statistically significant changes in various measures and we interpret the results by linking these changes to the functional networks involved in speech processing and to previous findings in the literature. Ongoing and future research paths are discussed.

7– Federica BIANCHI

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Abstract Title: Cortical pitch representations of complex tones in musicians and non-musicians

Abstract Authors: Federica Bianchi, Jens Hjortkjaer, Sébastien Santurette, Hartwig Siebner, Robert Zatorre, Torsten Dau

Abstract Text:

Musicians typically show enhanced pitch-discrimination ability compared to non-musicians, consistent with the fact that musicians are more sensitive to some acoustic features critical for both speech and music processing. However, it is still unclear which mechanisms underlie this perceptual enhancement. In a previous behavioral study, musicians showed an increased pitch-discrimination performance for both resolved and unresolved complex tones suggesting an enhanced neural representation of pitch at central stages of the auditory system. The aim of this study was to clarify whether musicians show (i) differential neural activation in response to complex tones as compared to non-musicians and/or (ii) finer fundamental frequency (F0) representation in the auditory cortex. Assuming that the right auditory cortex is specialized in processing fine spectral changes, we hypothesized that an enhanced F0 representation in musicians would be associated with a stronger right-lateralized response to complex tones compared to non-musicians.

Fundamental frequency (F0) discrimination thresholds were obtained for harmonic complex tones with F0s of 100 and 500 Hz, filtered in either a low or a high frequency region to vary the resolvability of audible harmonics. A sparse-sampling event-related functional magnetic resonance imaging (fMRI) paradigm was used to measure neural activation in all listeners while performing the same pitch-discrimination task for conditions of varying resolvability. The task difficulty was individually adjusted according to the previously obtained F0 discrimination thresholds.

Preliminary results from 6 listeners (3 musicians and 3 non-musicians) showed that the behavioral discrimination thresholds of musicians were, on average, lower than the thresholds of non-musicians by about a factor of 2.3, independent of harmonic resolvability. A group analysis on the 6 listeners revealed no differential neural activation for resolved vs unresolved conditions, suggesting that cortical responses did not increase with increasing stimulus resolvability, when adjusting for the task difficulty across conditions and participants. A significant effect of processing demand, i.e., task demand estimated from both stimulus resolvability and task difficulty, was observed in both auditory cortices, with a larger neural activation in the right auditory region. Additionally, no differential activation was observed in the musicians vs. the non-musicians.

Overall, these preliminary findings suggest an involvement of a postero-lateral region in both auditory cortices during a pitch-discrimination task with conditions of varying processing demand. Cortical responses were larger in the right than in the left auditory cortex, suggesting an increasing activation of the right-lateralized pitch-sensitive cortical areas with increasing task-processing demand.

8 – Rachel BOUSERHAL

Affiliation: Ecole de Technologie Supérieure (ETS)

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Abstract Title: Modeling Speech Production in Noise for the Assessment of Vocal Effort for Use with Smart Hearing Protection Devices

Abstract Authors: Rachel E. Bouserhal, Tiago H. Falk, Jeremie Voix

Abstract Text:

A Radio Acoustical Virtual Environment (RAVE) is being developed to address issues occurring when communicating in noise while wearing Smart Hearing Protection Devices (S-HPD). RAVE mimics a natural acoustical environment by transmitting the speaker's voice signal only to receivers within a given radius, the distance of which is calculated by considering the speaker's vocal effort and the level of background noise. To create a genuine RAVE, it is necessary to understand and model the speech production in noise while wearing HPDs. Qualitative open-ear and occluded-ear models of the vocal effort as function of background noise level, exist. However, few take into account the effect of communication distance on the speech production process and none do so for the occluded-ear. To complement these models, experimental data is collected to be used to generate quantitative open-ear and occluded-ear models, representing the relationship between vocal effort, communication distance, and background noise level. Data from a pilot study on N=12 are presented. Results show a significant increase in both vocal level and pitch as the background noise and communication distance increase.

9 – Daniel CAMERON

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Abstract Title: Motor system excitability increases before the beat in auditory rhythms

Abstract Authors: Daniel J Cameron, Tzu-Cing Chiang, Jessica A Grahn

Abstract Text:

Humans synchronize movements with the perceived, regular emphasis (the beat) in musical rhythms. Neural activity during beat perception is dynamic, time-locked, and heavily based in the motor system. Neural oscillations synchronize to regularities, such as the beat, in auditory rhythms (Fujioka, et al., 2012; Nozardan, et al., 2011). Beat perception also causes motor system excitability fluctuations, as shown by applying transcranial magnetic stimulation (TMS) over primary motor cortex, causing motor-evoked potentials (MEPs) in muscles (the amplitude of which index motor system excitability). In one study, MEP amplitude at the onset of the beat was greater when musicians heard music rated high on 'groove' vs. low on 'groove' (Stupacher, et al., 2013). In another study, MEP amplitude was greater when listeners heard rhythms with a strong beat vs. rhythms with a weak beat, but only for MEPs elicited at 100 ms before the beat, not for MEPs generated at other, random, time positions relative to the beat. Thus, the modulation of motor system excitability by beat perception may be specific to particular time positions on or before the beat (Cameron, et al., 2012).

Here, we sought to characterize the time course of motor system excitability during beat perception. Participants (n=16) sat relaxed while listening to beat-based and non-beat-based auditory rhythms (35s, in three tempi, presented in random order). TMS was applied to left primary motor cortex at specific time positions (asynchronies) before the beat (0, 5, 10, 15, or 20% of the inter-beat interval). MEP amplitudes were recorded with electromyography from right hand (first dorsal interosseous muscle).

Mean normalized MEP amplitudes were greater during listening to beat-based vs. non-beat-based rhythms. However, no effects of or interactions with stimulation-beat asynchrony were found.

Thus, motor system excitability is increased during beat perception, and this excitability extends to 20% of the time period before the beat.

10 – Kuwook CHA

Affiliation: Montréal Neurological Institute, McGill University

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Abstract Title: Does functional connectivity do anything in spectrotemporal encoding in human auditory cortex?

Abstract Authors: Authors: Kuwook Cha (1, 3, 4), Robert Zatorre (1, 3, 4), Marc Schoenwiesner (2,3,4)

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(4) Center for Research on Brain, Language and Music (CRBLM), Montréal, QC, Canada H3G 2A8

Abstract Text:

Studies on intrinsic functional connectivity (FC) in sensory cortices have shown that intrinsic FC is specific to sensory input feature space such as frequency (tonotopy), somatotopy, visual field location (retinotopy), and orientation tuning. Given that FC is well-reflective of anatomical connectivity, one can ask weather this pattern of FC is an epiphenomenon of shared noise by anatomical networks or it rather has a functional role in stimulus encoding. We show that incorporation of voxelwise functional connectivity in the auditory spectrotemporal encoding model improves prediction of voxel-wise activity in response to natural sounds and decoding (identification) of natural sounds.

We used a well-known spectrotemporal response field model, as the 'tuning' model, to predict fMRI voxelwise cortical activity in human auditory cortex, and built the 'full' model by incorporating FC which determines the weight of contribution of residual activity (trial-to-trial error in response to the same stimulus) of other voxels to a predicted voxel. We obtained auditory cortical activity in response to 60 natural sounds to estimate the parameters and predict/decode the activity in 10-fold cross-validation. Intrinsic FC was computed by correlating residual activity.

We found that (1) intrinsic FC is specific to stimulus feature encoding space (tonotopy, spectral density and temporal modulation), and (2) the full model outperforms the tuning only model in activity prediction and decoding of stimuli heard by the listener. Also, when FC was shuffled or set as flat (hence, no intrinsic pattern), this effect was degraded. Furthermore, this pattern was consistent when FC was computed in resting-state.

Our results support the hypothesis that correlation in intrinsic or residual activity has informational contribution to sensory processing rather than it only reflects spurious covariance of noise shared by anatomical connectivity.

11 – Vanessa Tsz Man CHAN

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Abstract Title: Auditory Perception and Executive Functions in Simultaneous Interpreters

Abstract Authors: Chan, Vanessa Tsz Man; Alain, Claude

Abstract Text:

Music and language have been proposed to share processing resources in the brain, an extension of that being expertise in one of these two skills may enhance processing of the other. This study aimed to use an experience-dependent linguistic expert – simultaneous interpreters – to address whether linguistic expertise enhances auditory processing outside of the linguistic domain, particularly in measures where musical expertise has been shown to improve performance. Simultaneous interpreters and non-interpreter controls were compared on several measures, spanning fine temporal and spectral discrimination, speech-in-noise perception, memory for pitch, visual working memory and cognitive flexibility. No significant differences were found between simultaneous interpreters and controls on any of the tested measures. The current findings are discussed in light of previous studies demonstrating advantages in executive function in simultaneous interpreters. Possible causes for the discrepancy between the existing research and this study are also discussed, such as the current study and task design, as well as limitations to the ability of cross-domain processing in language experts.

12 – Yining CHEN

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Abstract Title: Courtship song preferences in female zebra finches arise independently of early auditory experience

Abstract Authors: Yining Chen (1), Oliver Clark (2), Vivian Ng (2), and Sarah C. Woolley (1,2)

1) Integrated Program in Neuroscience, McGill University, Montreal, QC

2) Department of Biology, McGill University, Montreal, QC

Abstract Text:

Early social and sensory experiences are critical in shaping perception and social behavior and can even profoundly influence adult preferences. Songbirds communicate with learned vocal signals, including songs and calls, and female songbirds use these signals to identify male conspecifics and choose preferred mates. However, we know little about how early social and sensory experience affect female song preferences and the neural circuits underlying them. We have previously found that female zebra finches prefer a male's courtship song over his non-courtship song, regardless of the familiarity of the male. To test whether this preference is dependent on a female's early auditory experience, we compared song preferences and neural response to song between female zebra finches raised without exposure to adult male song ('isolate females') and normally reared females. Using a callback assay, we quantified adult female responses to courtship and non-courtship songs from multiple different males and found that isolate females preferred the courtship songs to non-courtship songs. In particular, they significantly increased their calling in response to the courtship songs and decreased calling in response to non-courtship songs when compared to baseline calling. Moreover, their responses were indistinguishable from normally reared females, suggesting preferences for courtship song are not significantly affected by developmental exposure to song. In a separate group of birds, we investigated the degree to which developmental song exposure affected auditory responses. Our preliminary analysis of immediate early gene expression, which is often used as a metric for neural activity, indicates that auditory responses in higher-level auditory areas are not significantly different between normally and isolate reared birds. These data indicate that the strong preference for female-directed courtship song is not dependent on early auditory exposure to song but may instead reflect an inherent bias in the auditory system.

13 – Rakhee CHOWDHURY

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Abstract Title: Pitch perception in autism is associated with superior non-verbal abilities

Abstract Authors: Rakhee Chowdhury, Megha Sharda, Esther Germain, Nicholas E.V. Foster, Ana Tryfon, and Krista L. Hyde

Abstract Text:

Autism spectrum disorders (ASD) are often characterized by atypical auditory profiles and language impairments. However, auditory perception and its relation to language ability as well as other non-verbal cognitive abilities in ASD remain poorly understood. In the current study, we examined the relationship between auditory perceptual ability (on both low and higher-level auditory pitch tasks) with both verbal and non-verbal cognitive abilities in 17 individuals with ASD and 19 typically developing (TD) participants. Both groups performed similarly on both low-level and high-level auditory pitch tasks. Verbal abilities did not predict performance on low or higher-level pitch tasks in either group. However, non-verbal abilities predicted better auditory perception in both groups, and particularly on higher-level global pitch tasks in TD. These findings underline the importance of examining the relationship between auditory perception and both verbal and non-verbal abilities in ASD.

14 – Emily COFFEY

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Abstract Title: Fundamental vs spectral pitch perception: behavioral and auditory brainstem responses

Abstract Authors: Emily B.J.Coffey, Emilia M.G. Colagrosso, Marc Schönwiesner and Robert J. Zatorre

Abstract Text:

The scalp-recorded auditory brainstem responses (ABRs) to complex sounds may present a paradox: whereas ABRs are thought to capture how the auditory system represents basic features of sound with high fidelity (Chandrasekaran and Kraus 2010; Johnson, Nicol, and Kraus 2005; Russo and Nicol 2005), ABRs vary considerably between participants, even amongst young, healthy adults (Ruggles, Bharadwaj, and Shinn-Cunningham 2012). This is surprising, because subtle variations in the frequency content, timing, and inter-trial consistency of ABRs have been linked to enhanced processing in expert groups like musicians (e.g. Musacchia et al. 2007), and are sufficiently sensitive to be useful as biomarkers of deficient sound encoding in auditory processing and learning disorders (White-Schwoch and Kraus 2013; Johnson, Nicol, and Kraus 2005; Nicole Russo et al. 2009; Hornickel and Kraus 2013; Ruggles, Bharadwaj, and Shinn-Cunningham 2012; White-Schwoch et al. 2015).

This issue raises the question of which aspects of auditory information and which cognitive processes are represented in the ABR and may therefore contribute to the differences observed in health and pathology. Conversely, it is important to determine what information that is available to the cortex and/or perceived consciously is not significantly present in the ABR signal. We address this question, in part, by testing the hypothesis that one of the most-studied components of the ABR – the magnitude of the representation of the fundamental frequency (f0) in the frequency following response – is related to the perceptual phenomenon of the 'missing fundamental' or 'virtual pitch'.

For maximum sensitivity, we used a within-subjects design. We first developed a behavioral task to demonstrate that subjects can learn to voluntarily and reversibly switch between perceptual modes (f0 vs spectral pitch). EEG data corroborate behavioural results, showing that low gamma range activity of cortical origin differs between perceptual mode conditions, when identical stimuli are presented. However, no systematic variation in f0 magnitude or other common measures of the ABR with perceptual mode was found. This suggests that the f0 information contained within the ABR is neither crucial for the cognitive mechanism that gives rise to the virtual pitch phenomenon nor does it represent the output of the computation itself. We conclude that differences in pitch computation (as it occurs in virtual pitch perception) is likely not a driver of inter-individual f0 strength variability. The virtual pitch computation might therefore either using an alternate stream of information that is not represented in the scalp-recorded ABR measurement or, perhaps less likely, the underlying neural machinery is indifferent to the quality and strength of the f0 component of the ABR.

Clarifying the 'content' of the ABR is relevant for the interpretation of a growing body of ABR-based research results, and may provide insight into the processes which can be enhanced through training and which are at fault in pathology. It may also help us to evaluate and improve models of information processing early in the auditory stream for aspects of sound that are important in speech and music.

15 – Annabel COHEN

Affiliation: University of Prince Edward Island

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Abstract Title: A singing octogenarian: A longitudinal case study employing the AIRS Test Battery of Singing Skills

Abstract Authors: Annabel J. Cohen, Ph. d. Department of Psychology, University of Prince Edward Island, Charlottetown, PE C1A 4P3

*Bing-Yi Pan, Ph. d. Department of Psychology, University of Prince Edward Island, Charlottetown, PE C1A 4P3

Abstract Text:

Much research on singing focuses on children or young adults. The present study, however, concerns the singing competence of one older adult between the ages of 84 and 87, during which time he also began and continued singing lessons. Our previous explorations with 4 persons in their 80's tested twice revealed basic singing skills (Cohen, 2015). The question addressed here is: can repeated vocal tests track general cognitive and motoric resilience associated with singing skills, and to what extent can an older person benefit from voice lessons. Data were obtained from the on-line AIRS Test Battery of Singing Skills (ATBSS) (Pan & Cohen, under review) and were compared to group data of 20 musicians and 20 non-musicians. The ATBSS assesses a variety of singing skills in persons from as young as 3 years to most senior years: the ability to sing a familiar song (Frère Jacques), to imitate notes and simple musical phrases, compose the ending of a song, make up a song, and learn a new song. Voice range is also roughly estimated, and several verbal tasks are also administered. The particular focus here is the singing of the familiar song under 4 different contexts over the course of the entire test. The song has 32 notes, 10 of which are tonic notes. Our focus is on the choice of initial tonic under the context conditions, and pitch variability of all 10 tonics in the song. The 4 context conditions were: no context (the participant is asked simply to sing the song given a few word prompts and no prior musical context), after hearing the song in the key of C, after hearing and trying to learn to sing a song in the key of Eb, and after trying to create a verbal story. Young musicians (e.g., enrolled in a university music program) and non-musicians show different patterns of tonic choices. Young musicians choose higher pitches for the key-note, and show greater sensitivity to the previous musical context (greater flexibility). The present study examines what a much older person will do over a period of 3 years while taking voice lessons. Over the 7 ATBSS sessions, the smallest standard deviation (SD) of 0.20 cents occurred on session 4, but the SD for the 3 remaining test sessions was larger (range of 0.54 to 0.81). By contrast, the average SD for young adult musicians was 0.26 and for non-musicians was 0.55. We await results of further ATBSS sessions to determine whether the higher musician-like performance of session 4 will return. Regarding choice of key, all, but one, key-notes were C (the other 1 semitone away) following the C-model, and a strong tendency to sing on or near the key of Eb, following the song that was presented in Eb (i.e., 3 Eb's, 2 D's -1 semitone away, and 2 other). This pattern is more musician-like. Consistency of the key-notes within a piece suggest stable cognitive-motoric processes over the more than 2.5 years during which performance data were collected. The change of key following the change of context (particularly the C-model and the Eb-melody) suggests cognitive flexibility. It is proposed that tests of key-choice and stability of the tonic throughout the singing of a tonal melody obtained at successive time periods might be used to track aspects of the aging process. The component examine here (familiar song) is but one from the ATBSS, Other components within ATBSS may provide information about other cognitive, motor, and emotional processes. It is recognized that this is a case study of a perhaps unusually capable participant, a former clinical psychologist, independent living and travelling, who claimed to have little music training but who greatly enjoyed classical music. [Supported by SSHRC]

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16 – Wagner DE SOUZA SILVA

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Abstract Title: Avoidance strategies in response to animate and inanimate obstacles in young healthy individuals walking in a virtual reality environment

Abstract Authors: W. Souza Silva (1, 2); G. Aravind (1, 2); S. Sangani (2); A. Lamontagne (1, 2)

1) School of Physical & Occupational Therapy, McGill University, Montreal, QC, Canada.

2) Feil and Oberfeld Research Center, Jewish Rehabilitation Hospital, Research cite of CRIR, Laval, QC, Canada.

Abstract Text:

Many studies have described obstacle avoidance strategies while walking, either in physical or virtual environments. These studies, however, were limited to the avoidance of inanimate objects (e.g. cylinders) or failed to address the influence of the visual and auditory properties of the obstacle in shaping avoidance strategies. This study aims to describe the extent to which three different types of obstacles (cylinder, visual human-like avatar and visual human-like avatar with footsteps sounds) affect the inherent avoidance strategies in young healthy individuals. Healthy young adults (n=4, 50% male, aged 24.7 ±3.5 years (mean ±1SD)) were tested while walking over ground and viewing a virtual environment (VE) displayed in a helmet mounted display (HMD) unit (nVisor SX60). The VE, controlled in Caren-3 (Motek medical), simulated a large room that included a target located 11m straight ahead. In addition, three identical obstacles were positioned 7m ahead in three locations facing the subject (40° right, 40° left, and straight ahead). As the subjects walked 0.5m, one of the three obstacles approached them by walking/moving towards a theoretical point of collision located 3.5m ahead at the midline. Meanwhile, the two remaining obstacles moved/walked away from the participant. The ability of the subjects to steer toward the target while avoiding the obstacles was characterized using the 3D position and orientation of the head recorded from reflective markers (Vicon) placed on the HMD. Preliminary findings show a trend towards smaller minimal distances in all directions when interacting with human-like avatars (left: 1.25±0.47; center: 1.22±0.20; right: 1.31±0.24) as compared to cylinders (left: 1.49±0.26; center: 1.29±0.12; right: 1.52±0.17). The addition of footstep sounds to human-like avatars did not modify minimal distance values compared to when no footstep sounds were provided (left: 1.20±0.39; center: 1.71±0.14; right: 1.31±0.28). Onset times of avoidance strategies were similar across all conditions. These findings suggest that participants had equivalent movement perception of the obstacles regardless of the condition displayed. They also indicate that smaller clearances in the presence of human-like entities may occur due to an inherent real life perception of the avatars resulting in actions that rely on strategies applied during daily locomotion. Finally, the similarity of results following the addition of footstep sounds to the visual human-like avatar condition suggests that avoidance strategies may primarily rely on visual cues.

17 – Dobromir DOTOV

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Abstract Title: Walking to a musical beat in Parkinson's disease: Benefits of stimulus variability and patient's synchronization

Abstract Authors: Dotov, D.G. (1), Bayard, S. (1,2), Cochen de Cock, V. (2,3), Geny, C. (1,2), Bardy, B. (1,4), & Dalla Bella, S. (1,4,5)

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Abstract Text:

Gait symptoms of Parkinson's disease (PD) can be partially relieved by presenting a repetitive acoustic signal, a technique known as rhythmic auditory cueing. Patients walk along with a rhythmic stimulus such as an isochronous sequence of tones or music with a salient beat. Typically, the beat in auditory cueing comprises fixed time intervals. This fails to take into account the intrinsic variability inherent in any motor activity. Stride-to-stride variability in healthy walkers is not purely random, it exhibits long-range correlation. Inter-stride-intervals (ISI) tend to be positively correlated with subsequent ISI and this correlation extends throughout the trial. This positive correlation is likely to be associated to the demands for energetic efficiency and mechanical stability. Forcing patients to perform steps with no variability places high demand on performance whereby every step the walker needs to over-correct for the variability in the previous step. This leads to the negative lag-1 auto-correlation that is characteristic of synchronization behaviors.

PD patients usually exhibit diminished long-range correlation. Furthermore, synchronizing with an isochronous stimulus removes the long-range correlations both in healthy and PD patients or can even reverse the sign of the auto-correlation. A possibility to maintain the biological properties of gait temporal patterns while using rhythmic auditory cueing is to use sequences that mimic the pattern of variability seen in healthy walkers (i.e., with embedded long-range correlations). To test this, 19 PD patients walked along with a cueing stimulus in multiple trials where the variability of the inter-beat-intervals and the type of stimulus changed across trials. Variability comprised three conditions: null (isochronous stimulus), random (non-biological), and long-range correlated (biological). Stimulus type comprised three conditions as well: metronome, amplitude-modulated noise, and music. No explicit instruction to synchronize was given.

As expected, walking with an isochronous cue removed long-range correlations in both healthy and PD patients. Non-biological variability in the stimulus also reduced long-range correlations but to a lesser extent. Biological variability in the stimulus allowed patients to maintain the long-range correlations in ISI. Notably, the deleterious effect of isochronous and random stimuli was dependent on the degree to which participants synchronized with the stimulus. This was not the case with biological variability. The three types of stimuli, in spite of their differences in rhythmic and spectral complexity, were equally effective, and equally likely to induce synchronization. In sum, we confirm that biological variability allows for an optimized cueing stimulus. The strategy is functional in various types of stimuli. We begin to unravel the important but rarely investigated role of synchronization in cueing paradigms.

18 – Yi DU

Affiliation: Montreal Neurological Institute, McGill University

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Abstract Title: Speech Motor Over-Recruitment Compensates for Dedifferentiated Auditory Representations in Seniors

Abstract Authors: Yi Du (1,2); Bradley Buchsbaum (1,3); Cheryl Grady (1,3); & Claude Alain (1,3)

1) Rotman Research Institute, Baycrest Centre for Geriatric Care, Toronto, Ontario, Canada

2) Montréal Neurological Institute, McGill University, Montréal, Québec, Canada

3) Department of Psychology, University of Toronto, Ontario, Canada

Abstract Text:

Understanding speech in noise is challenging, especially for seniors. Although evidence suggests that older adults over-recruit prefrontal cortices to offset declines in sensory processing, the brain mechanisms underlying such frontal compensation during speech in noise perception remain elusive. In the current functional MRI study, 16 young and 16 older participants listened to syllable tokens (/ba/, /ma/, /da/, and /ta/) either alone or embedded in broadband noise at multiple signal-to-noise ratios (-12, -9, -6, -2, 8 dB) and identified them by pressing corresponding keys. Results found that relative to young adults, older adults showed overactivations in frontal speech motor areas (e.g., pars opercularis of Broca's area) which positively correlated with behavioral performance. Multivoxel pattern classification further revealed that despite an age-related dedifferentiation in phoneme representations, phoneme specificity was greater in frontal articulatory regions than auditory areas in older adults. As a result, sensorimotor integration function was preserved but shifted to easier task levels in older listeners when younger counterparts did not need it. Notably, older adults with stronger activity in left pars opercularis showed higher phoneme specificity in itself and in left planum temporale, linking frontal speech motor overactivation with improvement in phoneme representations. Our results suggest that in seniors the upregulation of activity along with preserved phoneme specificity in frontal speech motor regions, provide a means of compensation for decoding dedifferentiated speech representations in adverse listening conditions. Our findings also emphasize the motor influence on speech perception for older listeners which may shed lights on rehabilitative strategies and trainings for better speech comprehension in seniors.

19 – Olivier DUSSAULT

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Abstract Title: The impact of age on induced oscillatory activity during a speech-in-noise task

Abstract Authors: Olivier Dussault (1,3), Merwin Olthof (1,4), Isabelle Peretz (1, 3), Sylvie Belleville (2, 3), Benjamin Rich Zendel (1, 2, 5).

1) BRAMS - International Laboratory on Brain Music and Sound

2) CRIUGM – Centre de Recherche de l'Institut de Gériatrie de Montréal

3) Département de Psychologie, Université de Montreal

4) University of Amsterdam

5) Faculty of Medicine, Memorial University of Newfoundland

Abstract Text:

The ability to understand speech when there is background noise declines with age. Part of this decline is related to changes in the physical mechanisms of the inner ear; however age-related changes to the neural mechanisms that underlie this decline remain poorly understood. Evidence suggests that the subcortical processing of speech is compromised in older adults, especially when there is background noise. This processing deficit results in hyper-activation of frontal brain regions when background noise is loud, suggesting that older adults engage compensatory mechanisms in order to overcome perceptual deficits. The goal of the current study was to uncover these compensatory mechanisms. Recently, it has been suggested that increased neural oscillatory activity in the alpha band is related to selectively attending to speech in background noise. Increased alpha activity during speech-in-noise perception might be related to the cognitive suppression of background noise, and if it is modulated by age, could represent a putative age-related neural compensatory mechanism. To investigate the impact of aging on alpha activity during a speech-in-noise task, older and younger adults were presented with a series of isolated words while their electroencephalogram (EEG) was recorded. Words were presented in three conditions: without background noise; with multitalker babble noise at a signal-to-noise ratio (SNR) of 15 (i.e., words were 15 dB higher than the noise – quiet noise) and with multitalker babble noise at an SNR of 0 (i.e., words and noise were at the same level – loud noise). To ensure participants attended to the stimuli, participants were asked to repeat the word aloud. The continuous EEG data was first reduced into regional cortical sources, including sources in frontal and temporal regions. Next, induced alpha activity was quantified from the onset of the target word as a function of regional source, the level of background noise and the age group of the participants. The impact of age on the noise-related increase of alpha power will be discussed in terms of its source distribution and as a potential mechanism that might partially compensate for age-related decline in the ability to encode and process speech when there is background noise.

20 – Jean-Pierre FALET

Affiliation: McGill University

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Abstract Title: Generating a tonotopic map of the human primary auditory cortex using magnetoencephalography.

Abstract Authors:

1) Jean-Pierre Falet - Medical Student, McGill University, Montreal, QC H3A 2B4, Canada.

2) Jonathan Coté - Integrated Program in Neuroscience, McGill University, Montreal, QC H3A 2B4, Canada.

3) Etienne de Villers-Sidani - Department of Neurology and Neurosurgery, McGill University, Montreal, QC H3A 2B4, Canada.

Abstract Text:

Background: Although the spatial resolution of magnetoencephalography (MEG) remains poorer than that of functional magnetic resonance imaging (fMRI), the challenge to visualize auditory cortex tonotopy using MEG remains beneficial. MEG has a greater temporal resolution, allowing for the study of discrete changes in auditory cortex processes that occur in the order of milliseconds. Several attempts have been made to map the auditory cortex in humans using MEG, but the results remain controversial.

Objective: To determine the feasibility of accurately mapping the tonotopy of the auditory cortex using MEG with human subjects, and to examine the changes that occur in this tonotopic organization following auditory training.

Methods: We used MEG recordings and generated spectro-temporal receptive fields (STRFs) for dipoles in the postulated region of the primary auditory cortex. Using these STRFs, we were able to identify the preferred frequencies for each dipole as well as several other properties, including the response amplitude, bandwidth, latency, and modulation, and map them onto the cortex surface.

Results/Conclusion: We were able to demonstrate a tonotopic organization of the postulated primary auditory cortex in humans subjects, using MEG. Moreover, our results show that auditory training alters several properties of the tonotopic organization, including response amplitude, bandwidth, and characteristic frequency.

21– Simone FALK

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Abstract Title: Non-verbal timing deficits in children, adolescents and adults who stutter

Abstract Authors: Simone Falk (1)*, Thilo Müller (2) and Simone Dalla Bella (3,4,5,6)

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2) Neurology(Stuttering Therapy), LVR-Hospital, Bonn, Germany

3) Movement to Health Laboratory, EuroMov, University of Montpellier, Montpellier, France

4) BRAMS, Montreal

5) Institut Universitaire de France, Paris, France

6) Department of Cognitive Psychology, Wyzsza Szkoła Finansówi Zarzadzania, Warsaw, Poland

Abstract Text:

The aim of this study is to examine the role of sensorimotor timing in stuttering. Twenty German-speaking children and adolescents who stutter and 43 age-matched controls, were tested to investigate whether timing deficits are associated with stuttering, in particular in the non-verbal motor domain. Participants performed a series of synchronization tasks by tapping with their finger to rhythmic auditory stimuli such as a metronome or music. Our findings reveal differences in sensorimotor timing between participants who stutter and those who do not stutter. Participants who stutter showed poorer synchronization skills (i.e., lower accuracy or consistency) than age-matched peers. Adolescents who stutter were more impaired than children, particularly for in consistency,. Low accuracy resulted from the observation that participants who stutter tapped earlier in relation to the pacing stimulus as compared to controls. Low synchronization consistency (i.e., higher variability) was observed in particular in participants with severe stuttering. We compare these results to adult data recently collected from a French-speaking group. The relevance of these findings for stuttering assessment and current theories of the motor basis of stuttering are discussed.

22 – Claudia FREIGANG

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Abstract Title: Robust magnetoencephalographic source localization of auditory evoked responses in chronic stroke patients

Abstract Authors: Freigang C., Fujioka T., Dawson D.R., Honjo, K., Stuss D.T., Black S.E., Chen J.J., Chen J.L., Horne C.D.F., & Ross B.

Abstract Text:

A novel rehabilitation strategy, employing the interaction between auditory and sensorimotor activities to facilitate motor learning for chronic stroke patients (CSP), improved arm-motor skills substantially. We studied underlying neurophysiological changes to assess training-related changes. The goal of the present study was to develop a method for assessing sensory learning in CSP after intervention by measuring auditory evoked fields (AEF) with magnetoencephalography (MEG). Since conventional assumptions about source activity (e.g., auditory cortex (AC) for AEF) do not hold for stroke-damaged brains, we propose a novel strategy based on resampling and optimization methods to localize cortical sources and analyze waveforms of cortical activity in the lesioned brain.

We recorded AEFs elicited by tonal sounds by MEG prior- and post-intervention in 28 patients. Artifacts were removed by means of principal component analysis and a spatial distribution of dipole sources was generated by repetitively applying an inverse model, co-registered with structural MRI, to resampled data. A robust estimate of the center of the dipole distribution was found by a novel optimization strategy. Source waveforms were then calculated from the individual dipole models for each hemisphere.

While dipole locations were clustered within small confidence volumes in both AC in 19 of 28 patients, the dipole coordinates were occasionally inferior/posterior to the expected location in Heschl's Gyrus. In 9 patients with extensive unilateral lesions, only unilateral responses were observed leading to largely distributed dipole locations. Centers of dipole distributions were reliably estimated based on optimization and resulting source waveforms display strong auditory activity.

Our approach to analyse AEFs to single tones in CSP yielded robust auditory sources in all patients. In further analyses, we will extend this approach to somatosensory, and motor evoked fields to study possible reconfiguration of cortical sources over time in response to the intervention.

23 – Lauren FROMONT

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Abstract Title: Finding agreement: An on-line study of gender processing, in adults and children

Abstract Authors:

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Phaedra Royle : École d'orthophonie et d'audiologie, Université de Montréal, Centre for Research on Brain, Language and Music

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Abstract Text:

Acquisition of ADJ(ective) gender agreement (masculine-feminine) in French is mastered later than DET(erminer) agreement (Royle & Valois 2010) due to irregular morphology. However, cognitive processes underlying gender acquisition have rarely been addressed (Royle & Courteau 2014). Few ERP studies focus on ADJ-noun agreement and most study morphologically transparent languages in the written modality (Molinaro et al 2011). Agreement errors typically elicit a (Left) Anterior Negativity (LAN) or an N400, followed by a later positivity (P600). In order to understand the cognitive mechanisms underlying agreement, we investigated ERP markers of agreement processing in adults, and whether these are influenced by task. Second, we studied developmental cognitive profiles for agreement in chidren?

(CORR)ect auditory sentences using vocabulary acquired by age 3 were used. These were cross-spliced to create incorrect conditions: (ADJ)ective agreement, (DET)erminer agreement errors as well as visual-(SEM)antic errors, by presenting incongruent images (e.g., a green shoe) with correct sentences (a green hat).

CORR: Je vois un soulier vert sur la table 'I see a green shoe on the table' I see a shoe green.MASC on the table

ADJ: Je vois un soulier *verte sur la table I see a shoe.MASC green.FEM on the table

DET: Je vois une *soulier vert sur la table I see a.FEM shoe.MASC green on the table

SEM: Je vois un ?chapeau vert sur la table 'I see a green HAT on the table'

EEGs were recorded with 32 electrodes on two groups: 15 adults, with two task conditions: acceptability judgment (n=8), and no task (n=7), and 40 children (aged 5 to 9).

We predicted the SEM condition would elicit an N400 in adults, the DET and ADJ conditions would elicit a biphasic LAN-P600 (Molinaro et al 2011), with the P600 reduced in the absence of a task (Sassenhagen et al 2014). In children, we predicted similar responses for the SEM and DET conditions, but different responses for the ADJ condition (an N400 instead of a LAN) (Clahsen et al 2007).

In adults, SEM incongruencies elicited an N400, and DET/ADJ agreement errors a biphasic LAN-P600. The P600 amplitude was increased with task. In children SEM incongruencies, elicited a later, left-lateralized N400 (400-600ms). DET errors elicited a very late (onset: 1000ms) positivity at parietal sites. The ERPs to ADJ errors were qualitatively different from adults as we observed a LAN + N400 pattern.

Children elicited patterns similar to but slower than adults for words (SEM) and structures (DET) they master behaviorally. For structures still being acquired (ADJ), children seem to rely more on lexical retrieval (N400) than adults (LAN-P600).

Task effects in adults confirm that the P600 is subject to experimental manipulations, while the LAN is not yet stable across error types in children. In order to better understand developmental stages of agreement acquisition, further analyses will involve comparisons between age groups.

24 – Esther GERMAIN

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Abstract Title: Pitch direction perception predicts the ability to detect local pitch structure in autism and typical development

Abstract Authors: Esther Germain (1), Nicholas E.V. Foster (1), Rakhee Chowdhury (1), Megha Sharda (1), Ana Tryfon (1,2), and Krista L. Hyde (1,2)

Abstract Text:

Individuals with Autism Spectrum Disorders (ASD) often present atypical auditory perception. Studies have reported both enhanced low-level pitch discrimination and superior abilities to detect local pitch structure on higher-level global-local tasks in ASD. However, it is unclear how low and higher levels of auditory perception are related in ASD or typical development (TD), or whether these skills change with development. In the present study, 17 children with ASD and 19 TD children matched in age were tested on a low-level pitch direction task and a high-level global-local task. Groups performed similarly on both pitch tasks, moreover pitch direction ability improved with age. Low-level pitch direction ability strongly predicted performance in higher-level global-local pitch perception in general, but most prominently for local pitch judgments in ASD. The study of auditory perception in ASD serves as a complementary lens to symptom-based studies and to refine ASD endophenotypes.

25 – Anastasia GLUSHKO

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Abstract Title: High-level expectation mechanisms reflected in slow ERP waves during musical phrase perception

Abstract Authors: Anastasia Glushko (1), Stefan Koelsch (2), Karsten Steinhauer (1)

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Abstract Text:

The present study looked at local and global neurophysiological mechanisms underlying phrase perception in music. At the local level of phrase boundary processing, the study tapped into the Closure Positive Shift (CPS) – a positive-going event-related potential (ERP) reported in language research at intonational phrase boundaries. In music, however, it remained to be determined whether the neurophysiological correlates of phrase boundary processing are similar to those in language. At the more global level of phrases, we were interested in investigating whether top-down expectation mechanisms can influence phrase perception in music. We asked whether prediction processes driven by syntactic cues and/or musical phrase repetition would have specific effects on the ERP responses. Professional musicians (N=14) and participants without formal musical training (N=16) listened to 40-second-long melodies while their electroencephalogram was recorded. Each melody consisted of four (10-second-long) musical phrases: a phrase ending with a half cadence (1); a phrase ending with a full cadence (2); a repetition of phrase (1); and finally, a repetition of phrase (2). Each melody was presented in three conditions in order to manipulate the acoustic characteristics of the phrase boundary: with pauses placed between each phrase; with a prolonged final pre-boundary note, or with short notes in place of pauses between phrases. We found that local effects at phrase boundaries were almost exclusively influenced by acoustic phrasing cues (i.e., the presence vs. absence of the pause). However, earlier differences between ERP waves, lasting for several seconds in the musical phrase, were elicited by the presence (vs. absence) of the preceding context and syntax-based expectations formed during the experiment (tension, or closure expectation). Whereas these long-lasting ERP differences were present in both groups of participants, they were additionally found to be modulated by musical expertise. The study is the first to report global, phrase-level ERP effects of music perception that are relatively independent of and superordinate to local effects of acoustic-driven phrase boundary recognition.

26 – Reyna GORDON

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Abstract Title: Examining the contributions of musical rhythm and speech rhythm to typical and disordered language acquisition

Abstract Authors: Reyna L. Gordon, Rita E. Pfeiffer, Alison J. Williams, Magdalene S. Jacobs, C. Melanie Schuele, J. Devin McAuley

Abstract Text:

A growing body of research has linked individual aspects of language development to variance in music abilities and training. Rhythm skills in particular may be of relevance in normal and disordered language acquisition (e.g., language impairment, dyslexia and stuttering). The current research project consists of a series of experiments designed to investigate the role of rhythm in grammatical development. In our preliminary study (Gordon et al, 2015a, Dev. Sci.), behavioral data was collected from children with typical language development (TD; n=25, mean age=6.5 years) and children with Specific language impairment (SLI; n=3, mean age 6.6 years). Musical rhythm perception was measured with a children's version of the beat-based advantage test (BBA) and the Primary measures of Music Audiation (PMMA). Expressive grammar was measured with the Structured Photographic Expressive Language Test-3 (SPELT-3).

Results in the TD group showed a positive correlation between the Rhythm composite (combined BBA and PMMA) and grammar skills even while controlling for non-verbal IQ, music activities, and SES ($r=0.70$, $p<0.001$). Items on the SPELT-3 were grouped into subsets of syntactic categories and showed that performance on the Rhythm composite predicted variance in their production of complex sentence structures (complex syntax: $r=0.46$, $p=0.02$; and transformation/reorganization: $r=0.42$, $p=0.04$; Gordon et al, 2015b, ANYAS). Preliminary results for the SLI group revealed weaker behavioral performance for musical rhythm discrimination on the BBA compared to their TD peers ($d=-0.88$). Taken together, we have uncovered a robust relationship between rhythm and grammar in language development, such that individual differences in rhythm perception appear to be related to syntactic competence, and in particular to complex sentence production.

We are now continuing this line of research to explore the dynamics of rhythm deficits in specific language impairment (SLI) and investigate whether facilitative effects of rhythm perception on grammar are due to auditory working memory, speech rhythm sensitivity, or both. To test speech rhythm sensitivity, we have developed a child-friendly version of the speech cycling task created by Cummins and Port (1998), in which participants repeat short, metrically regular phrases along with an isochronous metronome. Our pilot work on this task includes data from n=12 TD six-year-olds speaking a set of ten different phrases (e.g., "beg for a dime") with two different metronome patterns. Preliminary data indicates modest correlations between expressive grammar skills and the ability to speak in synchrony with the metronome ($r=-0.39$). These findings will be discussed in the context of a theoretical framework that incorporates domain-general rhythm perception into language acquisition.

27 – Terry GOTTFRIED

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Abstract Title: Adapting to Vocoded Speech: Relation of Musical Training

Abstract Authors: Terry L. Gottfried, Tahnee Marquardt (Psychology, Lawrence University, Appleton, WI), and Gina Scharenbroch (Speech-Language-Hearing Sciences, University of Minnesota, Minneapolis, MN)

Abstract Text:

Research has shown that aspects of musical training and ability transfer to speech perception in an unfamiliar language (e.g., Mandarin tones, Gottfried, 2007) and in one's native language. For example, musical training relates to the neural mechanisms of selective auditory attention (Strait, Slater, O'Connell, & Kraus, 2015); musical enrichment improves children's neural encoding of speech (Kraus, Slater, Thompson, Hornickel, Strait, Nicol, & White-Schwoch, 2014); musicians show enhanced speech encoding in noise (Zendel, Tremblay, Belleville, & Peretz, 2015). These findings led us to test whether a musician advantage might also be observed in comprehension of acoustically degraded speech. Normal-hearing listeners performed a pretest in which they transcribed 8-channel TigerCIS vocoded speech (which presents information similar to that provided by cochlear implants; see Loebach, Bent, & Pisoni, 2008). These listeners were then trained (with feedback) on 60 vocoded Harvard sentences and 40 MRT (Modified Rhyme Test) words or the same sentences and words in natural speech. Musicians (conservatory-trained) and non-musicians were compared on their initial accuracy in transcribing the vocoded speech, and their transcription accuracy after the limited amount of training on natural or vocoded speech. Accuracy was significantly greater on sentences than words. However, musicians and non-musicians were not significantly different in their transcription accuracy neither on the pretest, nor on tests after training (new 8-channel and 4-channel stimuli). Accuracy for all listeners on 8-channel posttests was greater than on pretests, but there was no significant difference in posttest performance between those trained on natural vs. vocoded speech. Given the limited amount of training provided, we plan further tests using a more extensive training regimen. We will also add a control group (with no training) and perceptual tests to assess listeners' musical abilities.

28 – Andrea HALPERN

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Abstract Title: Conductors at cocktail parties: Attention and memory in conductors and pianists

Abstract Authors: Clemens Wöllner (University of Hamburg), Andrea R. Halpern

Abstract Text:

Individuals with high working memory capacity are more flexible in attending to detail, for example, they excel at both divided and selective attention tasks such as verbal shadowing ("cocktail party phenomenon"). However little is known about the relationship between attention and working memory (WM) for auditory and visual stimuli among different types of highly trained musicians. Orchestral conductors need to focus their attention both on individual instruments and on larger sections of various instruments. We investigated their attentional flexibility by comparing them to equivalently trained pianists. Following a series of musical WM span tests, they were asked to detect small pitch and timing deviations in three dichotic attention tasks presenting two melodic streams (a) separately: baseline, (b) together, while concentrating on only one stream: selective, or (c) together, while concentrating on deviations in both streams simultaneously: divided attention. Conductors showed higher detection than than pianists for timing deviations across attention conditions. Professionals detected more targets than students. We found no group differences for working memory capacity or for pitch deviations in the attention tasks. Musicians' WM span across multimodal conditions was positively related to selective and divided attention. High WM participants also had shorter reaction times in selective attention. Taken together, conductors showed higher attentional flexibility in successfully switching between different foci of attention – a process also described as "zooming in and out".

29 – Vanessa HARRAR

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Abstract Title: The Multisensory substitution device: Replacing vision with multisensory perception.

Abstract Authors: Vanessa Harrar (1,2), Alexandra Beaudry Richard (3), Malika Auvray (4), Charles Spence (2), Ron Kupers (5), & Maurice Ptito (1,5)

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Abstract Text:

Sensory substitution devices have been used to demonstrated considerable cross-cortical plasticity in congenitally blind people; that is, neurons in the occipital lobe, normally devoted to vision, respond to auditory and tactile stimuli. Sensory substitution devices transform images into, for example, sounds (e.g. the vOICe), or into vibrations on the tongue (Tongue Display Unit – TDU). These devices, and the plasticity they enable, are meant to help people with visual loss navigate in their environment. Although, the learning curve of these devices is generally very slow, and the spatial acuity is very coarse. Our hypothesis is that these limitations are due to the uni-sensory feedback provided. Thus, Multisensory devices should be easier to learn to use, and should also result in a better spatial acuity because of the availability of redundant information. In this experiment, we set out to improve training and acuity with a new "user-friendly" device: The Multisensory Substitution Device (MSSD), combines the audio and the tactile modalities. To test its efficiency, we trained participants to recognize shapes and letters either with audio alone, solely through touch, or with both modalities simultaneously. Learning curves were analysed by measuring the time it took them to recognize alphabet letters, and we compared their spatial acuity before and after training using a grating orientation detection task. Here, we present a comparison of the efficiency of the vOICe, TDU, and the MSSD, and discuss the suggestion that the multisensory stimulation may replace vision and improve rehabilitation in the blind.

30 – Sylvie HÉBERT

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Abstract Title: Noise generators for the treatment of tinnitus and hyperacusis: a case series.

Abstract Authors: Anaïs Mihoubi, Chloé Labossière, Emilia Collagrosso, Philippe Fournier, Sylvie Hébert

Abstract Text:

Tinnitus, or ringing in the ears, is accompanied by an increased sensitivity to external sounds, or hyperacusis. These two hearing disorders may stem from an increased neural activity due to peripheral hearing damage, that is, the central auditory system would increase its "gain" to compensate for hearing loss. Indeed, the normal auditory system changes its response depending on the environmental noise: wearing earplugs increases sound sensitivity whereas wearing noise generators decreases it. The aim of our study was to examine whether a 3-week treatment with noise generators in tinnitus participants would 1) decrease tinnitus loudness and sensitivity to external sounds; and 2) improve subjective tinnitus distress and hyperacusis. Participants with tinnitus were fitted bilaterally with noise generators (white noise ~20 dB SPL) and tested on several psychoacoustical (tinnitus frequency spectrum and loudness, loudness functions) and psychological (tinnitus handicap and hyperacusis questionnaires) measures. Testing took place before the beginning of treatment, after 1 week, and after 3 weeks of treatment. A follow-up testing was done 1 month after the end of treatment. Preliminary results in 10 participants indicate an increased psychophysical sound tolerance (~ 3-5 dBs for "too loud" sounds) as well as a decrease in tinnitus handicap (~ 79-105 points) after three weeks of treatment. These effects extended to 1-month follow-up (N=6), but no effect on subjective hyperacusis was observable. These preliminary findings suggest beneficial effects of noise generators for tinnitus.

31– Molly HENRY

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Abstract Title: Metrical structure makes discriminating intensity and pitch targets more difficult

Abstract Authors: Molly J. Henry & Jessica A. Grahn

Abstract Text:

Auditory rhythms with a simple metrical structure afford better discrimination of temporal perturbations, faster detection and discrimination of target stimuli, and more accurate production of events at strong versus weak metrical positions. These findings can be interpreted in the context of Dynamic Attending Theory, which proposes that dynamic fluctuations of attention align with the temporal structure of rhythms. For rhythms with a simple metrical structure, Dynamic Attending Theory suggests that multiple nested attentional oscillations peak together coincident with metrically strong positions. The result is that target events at metrically strong positions are better detected, discriminated, or produced than those at weak metrical positions.

In the current study, we were interested in the possibility that a specific type of target – an intensity deviant – might contradict previous results. This is because metrically simple rhythms tend to promote "subjective accentuation", whereby events presented at metrically strong positions are heard as louder than those presented at weak positions, despite identical acoustics. We hypothesized that intensity targets embedded in metrically simple rhythms would be more difficult to detect when they occurred at strong relative to weak metrical positions.

Participants listened for targets embedded in short (~6 s) auditory rhythms. Rhythms had either a simple metrical structure that induced a strong beat percept or a complex metrical structure that did not induce a strong perception of a beat. Targets occurred in the second half of the rhythm, either at strong or weak metrical positions. Rhythms were composed of 500-Hz sine tones presented at 50 dB sensation level. Targets differed from the rest of the rhythm either in loudness (in which case participants reported whether the target was "quieter" or "louder" than the rest of the tones) or in pitch (in which case participants reported whether the target was "lower" or "higher" than the rest of the tones).

When rhythms had a simple metrical structure, discrimination performance was worse for both intensity and pitch targets occurring at metrically strong relative to metrically weak positions, but only for musically skilled individuals. We interpret the strong and weak performance difference for metrically simple rhythms as evidence that subjective accents had a "masking" effect on targets.

32 – Peer HERHOLZ

Affiliation: Laboratory for Multimodal Neuroimaging, Philipps-University Marburg

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Abstract Title: Overlapping does not necessarily mean sharing: neural representational geometries of hierarchical language and music processing

Abstract Authors:

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Abstract Text:

Numerous imaging studies investigated the domain specificity of cortical networks underlying the processing of different cognitive functions. Their results indicate common principles of processing and therefore shared cortical resources. One example is the processing of hierarchical structures. The majority of studies emphasized comparable neural networks and event-related potentials (ERPs) underlying “syntactic violations” especially for music, within a left-hemispheric fronto-temporal network previously assigned to language only.

Studies which have already investigated this topic, concentrated on music or language only, focused on one type of syntactic processing (ELAN / ERAN or P600), or when investigating language and music within one study conducting a conjunction analysis. Studies investigating shared cortical resources of music and language with regard to the different types of hierarchical structure processing not only within one paradigm, but also within one subject are still missing. Additionally the widely used conjunction analysis might not be the best suitable method as the underlying mass univariate statistic model and averaging of activation patterns do not allow to gain profound insights on the relationship between cognitive functions and processes.

To overcome the described existing gap of a within-subject design investigation of both mentioned syntactic processing types we applied an fMRI paradigm fulfilling these requirements to 20 participants, assessing cortical areas and networks. All participants (right handed, non-musicians and free of any neurological and psychiatric history) were presented with 120 auditory stimuli per condition, language/music and early/higher syntactic processing in a randomized block design.

The first step of analysis included a first-level analysis in order to create the respective statistic parametrical map for each condition. On second-level, we computed conjunctions between language and music for early and higher syntactic processing. In order to investigate the resulting overlaps, until now identified as shared cortical resources, more closely, we conducted a representational similarity analysis (RSA) within the respective areas, as this multi voxel pattern analysis illustrates spatial similarities between the conditions in a high dimensional space. In contrast to traditional MRI analysis techniques, this method preserves details not only whether information is represented but also how.

The conjunction analysis revealed the expected and well-described left-hemispheric activation patterns, for early syntactic processing within the STS/STG and for higher syntactic processing within the IFG. These results might indicate shared cortical resources.

However, the RSA showed clear distinct patterns for language and music in both conjunction areas. Focusing on the area for early processing, revealed by the conjunction analysis, highest dissimilarities are present between early syntactic conditions. Same accounts for the area for higher processing within the higher syntactic conditions.

Our results indicate that despite identifying an area by a conjunction analysis, this area might contain distinct properties according the investigated processes. This assumption is supported, as the conditions, which were used to create the conjunction analysis revealed greatest dissimilarities indicating highly specialized sub-processes. Together with the other conditions being more similar, as they are not active in the investigated area our results indicate that an overlap of activation can be found, however not robustly indicating shared cortical resources.

33 – Jiancheng HOU

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Abstract Title: Resting-State Functional Connectivity and Pitch Identification Ability in Non-Musicians

Abstract Authors: Jiancheng Hou1, 2, Chuansheng Chen3, Qi Dong1

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Abstract Text:

INTRODUCTION Some professional musicians can identify a single musical note accurately without the benefit of a reference note, and they are considered as having absolute pitch (Parncutt & Levitin, 2001). Neuroimaging studies have identified some neural markers of absolute pitch (as well as quasi-absolute pitch) in musicians (Hirose et al., 2002; Oechslin et al., 2010; Wilson et al., 2009). However, little is known about the neural basis of general pitch identification among non-musicians. Resting-state functional connectivity (RSFC) measures the low-frequency spontaneous neuronal activity in the brain and is believed to reflect neuronal function (Zhang et al., 2014). The current study investigated the RSFC correlates of pitch identification ability as well as musical training in a large sample of Chinese non-musicians.

METHODS Subjects were 320 Chinese undergraduate students. 56 participants (11 males and 45 females) had musical training experience (mean starting age was 10.67±1.44), and 264 participants (118 males and 146 females) had no musical training experience. They were given a pitch identification test. The RSFC data were acquired by a 3.0 T Siemens MRI scanner (TR/TE/θ = 2000 ms/25 ms/90°, FOV = 192 × 192 mm, matrix = 64 × 64, and slice thickness = 3 mm). The Data Processing Assistant for Resting-State fMRI (DPARSF) version 2.2 and REST version 1.8 were used for data preprocessing and group analysis, respectively. Based on previous studies, seven brain regions were selected as seed regions: right dorsolateral prefrontal cortex, right medial frontal gyrus, right medial frontal lobe, bilateral premotor areas and bilateral intraparietal sulcus.

RESULTS AND DISCUSSION The pitch identification accuracy rate was significantly higher for the group with music training than the group without training ($t(318) = 10.21$, $p < .001$). Compared to participants without musical training, those with musical training showed stronger RSFC between the right dorsolateral prefrontal cortex seed and the bilateral superior temporal gyri and right inferior parietal lobule; between the right medial frontal gyrus seed and the right precuneus; between the left premotor area seed and the right cerebellum, right superior medial frontal gyrus, and left pars triangularis; between the right premotor area seed and the bilateral inferior temporal gyrus, right pars triangularis, right cerebellum, and left middle frontal gyrus; and between the left intraparietal sulcus seed and the left middle frontal gyrus. These results indicated that musical training was associated with increased RSFC within the networks for multiple cognitive functions, such as vision, phonology, semantics, auditory encoding, and executive functions. Moreover, for participants with musical training, pitch identification ability was associated with RSFC between the bilateral premotor area seeds and the left cerebellum. For participants without musical training, pitch identification ability was associated with RSFC between the right dorsolateral prefrontal cortex seed and the right cerebellum, and between the left premotor area seed and the bilateral inferior parietal lobule, right pars triangularis, and left superior temporal gyrus. These results indicated that pitch identification ability was associated with RSFC with regions for perceptual and auditory encoding for participants with musical training, and with RSFC with regions for short-term memory, semantics, and phonology for participants without musical training.

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34 – Falisha KARPATI

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Abstract Title: Overlapping gray matter structural correlates of dance and music

Abstract Authors: Falisha J. Karpati, Chiara Giacosa, Nicholas E.V. Foster, Virginia B. Penhune, Krista L. Hyde

Abstract Text:

Introduction: Individuals with specialized training provide an opportunity to investigate human brain plasticity and the interaction between the brain and behaviour. Specifically, those with artistic auditory-motor training, such as dancers and musicians, allow the study of sensorimotor integration and the fusion of sensorimotor expertise with artistic performance. Although dance and music training have similarities, such as the importance of sensorimotor integration, they also possess several differences. Music training generally focuses on producing sound using effector-specific movements, while dance training commonly focuses on following sound using whole-body movements. While the neural correlates of music training are well-investigated (1), the brain structural correlates of dance are only beginning to be understood (2). Additionally, no studies have yet compared the gray matter structural correlates of dance versus music training. This study aims to examine the specificity of long-term dance versus music training on gray matter structure and behaviour.

Methods: We used magnetic resonance imaging (MRI) to measure cortical thickness (CT) and gray matter concentration (GMC) in 20 expert dancers, 19 expert musicians and 20 untrained controls. Participants were also tested on a battery of music- and dance-related tasks, including dance imitation, rhythm synchronization and melody discrimination tasks. Statistical analyses were performed across the whole brain to test for group differences in CT and GMC, as well as regions where CT or GMC are correlated with task performance.

Results: Both dancers and musicians showed greater CT than controls in the right superior (STG) and middle temporal gyri. Greater GMC in dancers compared to controls controls was observed in the STG and inferior frontal gyrus (IFG) bilaterally. CT in the left STG was correlated with performance on all three tasks. GMC in the STG and IFG bilaterally was correlated with performance on the dance imitation task.

Conclusions: These results suggest that dance and music training affect gray matter structure in an overlapping manner, specifically in temporal regions. The shared gray matter structural correlates of dance and music is furthered by the finding that structure in the STG is correlated with performance on dance- and music-related tasks. These findings are consistent with previous work implicating the STG in dance- and music-related skills, such as dance observation/performance as well as melodic processing (3-6). The observation of the IFG in the dance-related analyses is consistent with its involvement in observation and embodiment of actions (7,8). This work advances our understanding of the specificity of the neural correlates of dance and music training, and may have potential applications in therapies for motor disorders.

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35 – Inga Sophia KNOTH

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Abstract Title: Development of auditory repetition suppression and its relation to learning

Abstract Authors: Inga Sophia Knoth, Karine Lacourse, Phetsamone Vannasing, Sarah Lippé

Abstract Text:

Repetition suppression (RS), the decrease of neural response to repeatedly presented stimuli, is known to occur from early age on. However, data is lacking as to how consistent RS is throughout development and how RS is related to efficient learning as reflected in memory performance. EEG was recorded in 53 healthy participants ranging from 3 to 32 years during an auditory habituation paradigm featuring repeatedly presented pseudowords. Differences in signal energy between presentations were calculated in order to quantify RS. We found RS to occur overall between the first and second presentation of a pseudoword, over fronto-central and left temporal areas. However, this was only found consistently in adults and adolescents older than 13 years, whereas responses in younger participants showed more variability: RS but also repetition enhancement were observed between the first and second presentation. All children eventually showed RS within several repetitions. No relation was found between strength of RS during encoding and recognition performance. However, maintenance of a stable signal in the left temporal area once RS occurred was related to higher memory performance in the subsequent recognition task. Results are discussed in a predictive coding perspective, considering aspects of brain maturation.

36 – Amineh KORAVAND

Affiliation: University of Ottawa

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Abstract Title: Could Musical Training affect the Cortical Auditory Evoked Responses in children with hearing loss?

Abstract Authors: Koravand, A.[1], Riel, A. [1], Martel-Lamothe, P. [1], Comeau, G.[2] & Trainor, L[3]

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Abstract Text:

Background & Objectives:

The main objective of the present study was to explore the effect of piano lessons on the Cortical Auditory Evoked Potentials (CAEP) in children with normal and abnormal auditory function. It has been documented that special auditory training and the quality of acoustic environments have complex impacts on the neural auditory system. On the other hand, the absence of early acoustic stimulation during optimum periods of central auditory system plasticity may prevent the normal maturation of the central auditory system.

Method:

Eighteen 4 to 9 year-old children with normal hearing (NH) and with hearing loss, HL (users of Cochlear Implant, CI, and/or Hearing aids) participated in the study. CAEP were recorded in a passive oddball paradigm. Cortical auditory evoked responses, P1, N1, P2, N2, and MMN were measured before and after six months of intensive piano training.

Results:

Different pattern of results have been found; N1 and P2 deflection were absent in more children with CI compared to children with NH. Moreover, the N2 and MMN latency and/or amplitude values were different between the groups of participants. Larger N2 amplitude was found only in NH after the musical training.

Conclusion:

Findings indicate different patterns of cortical responses in children with CI and/or with Hearing Aid before and after musical training. Findings suggest that musical experience may have advanced the developmental trajectory only in children with NH. Results suggest that 6 months of musical training may not be sufficient to compensate for the maturational delays in children with HL.

37 – Amineh KORAVAND

Affiliation: University of Ottawa

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Abstract Title: Measuring the effects of tinnitus on temporal processing using auditory evoked brainstem responses

Abstract Authors:

Victoria Milloy, MSc Audiology and Speech-Language Pathology Program, University of Ottawa, Ontario, Canada

Amineh Koravand, Ph.D Audiology and Speech-Language Pathology Program, University of Ottawa, Ontario, Canada

Daniel Benoit, Ph.D Physiotherapy Program, University of Ottawa, Ontario, Canada

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Abstract Text:

Subjective tinnitus affects about 10% of the general population, up to 30% of adults above 50 years of age and is a major burden on the healthcare system (Davis, 2000; Moller, 2000; El-Shunnar 2011). In the clinical setting, the current methods for tinnitus assessment require patients to complete various questionnaires and match the intensity and pitch of their tinnitus to a tone (Ward and Baumann, 2009). Development of an objective measurement of tinnitus has not yet been possible as measured changes in neural activity have been due to factors that accompany tinnitus instead of characteristics specific to tinnitus alone (Liu and Chen, 2012).

A gap paradigm has been recently proposed as a behavioural method of objectively detecting tinnitus in animal models. In this model a noise burst is presented followed by a silent gap and a loud startling noise. In normal hearing animals, the detection of a silent gap decreases the startle to the loud noise (Turner et al. 2006). However, in rats with noise or chemical induced tinnitus, the startle is not reduced due to the impaired detection of the silent gap (Turner et al., 2006; Yang et al, 2007; Turner and Parrish, 2008; Wang et al, 2009; Kraus et al, 2010; Ralli et al., 2010; Zhang et al., 2010; Engineer et al., 2011; Longenecker and Galazyuk, 2011; Mao et al., 2011; Middleton et al., 2011). It is believed this may be due to tinnitus "filling" in the gap.

Auditory Brainstem Responses have shown increased amplitudes in tinnitus populations (for example, Gu et al 2012, Schaette and McAlpine 2011, Nemati et al 2014, Bing et al 2015, Hickox and Liberman 2014, Liu and Chen 2012, Coomber et al 2014), but the contamination of these results with cochlear damage has been known as a major limitation of this method. By using a gapped narrowband noise centered at the tinnitus frequency percept, we believe the precision of the ABR can be improved and gap detection thresholds can be objectively measured. Fournier and Hébert (2012) objectively measured gap detection in a tinnitus population using startle reflexes. Since the startle reflex and the ABR use similar neural pathways, it is expected that gap detection should produce similar results to the startle reflex model. To date, only Lowe and Walton (2015) have used the GIN-ABR and reported significantly larger gap detections in tinnitus-induced rats. It is our objective to explore whether this data replicates in humans.

We are currently working on human pilot data using the GIN ABR. We expect to find enlarged gap detection thresholds in normal hearing participants when tested at frequency bands similar to a pure tone masking noise. We plan to see similar effects in a clinical population when the tested frequency band is similar to the pitch of the tinnitus percept. These results will provide an idea of whether tinnitus perception impairs gap detection and whether the GIN ABR is a viable method for objectively detecting tinnitus.

38 – Jens KREITEWOLF

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Abstract Title: A Network of Left- and Right-Hemispheric Areas Involved in Linguistic Prosody Processing

Abstract Authors: Jens Kreitewolf, Tomás Goucha, Angela D. Friederici

Abstract Text:

Linguistic prosody serves various functions in human communication. However, its neural representation has gained relatively little attention and in contrast to the left-hemispheric dominance found for other language processes, linguistic prosody has been mainly associated with functions of the right hemisphere (e.g., 1). Here, we presented 44 participants with sequences of speech stimuli while functional MR scans were acquired. Within these sequences, stimuli varied in linguistic prosody in terms of rising and falling pitch contours that are typical for the intonation of questions and statements, respectively. Furthermore, stimuli varied in terms of speaker pitch. Participants were instructed to either judge the linguistic prosody or the speaker identity in these sequences. The results show that linguistic prosody compared to speaker judgement involves inferior frontal, premotor and parietal areas in the left hemispheres as well as superior temporal regions in the right hemisphere. Furthermore, left frontal areas showed increased functional connectivity to bilateral superior temporal areas during judgement of linguistic prosody. In contrast to the common notion that linguistic prosody is preferentially processed by the right hemisphere, our results suggest an interhemispheric mechanism for the processing of linguistic prosody: left and right hemispheres seem to communicate with each other via transcallosal connections at the level of the temporal cortex (2). Right superior temporal areas might be particularly involved in the analysis of suprasegmental pitch information (3), whereas inferior frontal areas appear to be essential for the linguistic judgment of pitch in the stimulus (4).

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39 – Christine LEFEBVRE

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Abstract Title: Sound objects, rather than contour, is indexed by the SAN.

Abstract Authors: Christine Lefebvre, Pierre Jolicoeur

Abstract Text:

The sustained anterior negativity (SAN) is an electrophysiological index of maintenance in auditory STM (ASTM). It is characterised by increased negativity at frontocentral electrodes when a larger number of stimuli are effectively maintained. Our goal was to verify whether the SAN indexes individual sounds or if it indexes the contour created by pitch transitions between sequential tones. To test that possibility, participants memorized a series of one to four tones interspersed with irrelevant white noise bursts, and had to compare the memorised set with a second set, comprised with tones only. The insertion of white bursts made it harder to perceive a contour. ERPs were recorded during the 2s silent interval between memory and probe presentation. This memory condition was compared to a control condition in which only white noise bursts were presented in the memory set, and therefore no stimuli maintained. There was as a sharp return to zero of activation after presentation of the memory set in the control condition, confirming the SAN indexes maintenance of sounds, and not other processes that follow stimulation. We also observed Load modulation of amplitude at fronto-central electrodes that was correlated with individual performances, as individuals with a larger ASTM span had larger increases in SAN with Load. Since white noise bursts were added randomly, in some trials all tones were presented consecutively. The SAN modulation was observed whether tones were grouped or not. This suggests the SAN is an index of the maintenance of sound objects, rather than contour, in ASTM.

40 – Kyle LOGIE-HAGEN

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Abstract Title: A Magnetoencephalography Study of Emotional Auditory Stimuli Processing

Abstract Authors: Kyle Logie1,2, Simon Rigoulot1,3, Pierre Jolicoeur1,4 and Jorge L. Armony1,3,4

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3) Department of Psychiatry, McGill University and Douglas Mental Health University Institute, Montreal, Quebec, Canada

4) Department of Psychology, Université de Montréal, Montreal, Quebec, Canada

Abstract Text:

We used magnetoencephalography (MEG) to investigate the similarities and differences in how humans process emotionally charged music compared to voices. Participants (N=21) listened to human vocalizations, as well as short (1.5 sec) musical excerpts played with saxophone, piano, or violin. Prior to the study the auditory stimuli were rated either sad, happy, fearful or neutral. Source localization (dSPM) revealed significant differences in spatial and temporal activation patterns between vocalizations and music, particularly within the temporal lobes, consistent with previous fMRI results. Specifically, vocalizations elicited stronger activation in both hemispheres during the magnetic equivalent of the P50, compared to music. Vocalizations also resulted in slightly more temporal/frontal lobe activation in later components (200 ms onwards), however, musical excerpts resulted in significantly stronger responses during the magnetic equivalent of the N100, especially in the right temporal lobe. These differences between music and human vocalizations were mainly driven by piano. In contrast, violin elicited similar patterns in magnetic signal to those of vocalizations, which is likely due to the similarity of violin to the human voice. In terms of emotion, the largest differences were observed between happy and sad stimuli. This MEG study is unique in the use of emotionally complex auditory stimuli across various mediums and provides valuable insight into how of music and vocalizations are processed in the brain. Our study is also useful as a means to assess the strengths and limitations of the MEG approach in measuring this particular brain activity.

41 – Adiel MALIK

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Abstract Title: The Role of Opioids in the Emotional Rewards of Music Listening

Abstract Authors: Adiel Mallik and Daniel J. Levitin

Abstract Text:

Music is a potent regulator of human emotions and has been shown to moderate pain thresholds, immune system function, empathy, attention, and mood. However, the neurochemical mechanisms underlying these effects are not well understood. We examined the contribution of endogenous opioid peptides to feelings of pleasure during music listening. Participants received the opioid receptor antagonist naltrexone in a double-blind, placebo controlled crossover study (participants were tested on two days, oral administration of drug or placebo was counterbalanced). Participants self-selected 2 pieces of music from their own musical collections that they reported could reliably give them intense feelings of pleasure, including chills. Participants also listened to two pieces of experimentally verified neutral music. Dependent measures were real time slider pleasure ratings, McGill Musical Engagement Scale Questionnaire (MMES), blood volume pulse amplitude (BVP AMP), respiratory rate (RR), zygomatic electromyogram (EMG ZYG) and corrugator electromyogram (EMG COR). We found significant ($p < 0.05$) decreases in real-time slider ratings in the naltrexone group compared to the placebo group in both the self-selected and neutral music conditions. We also found significant decreases in the MMES items of sadness and hope in the naltrexone group compared to the placebo group in the self-selected and neutral music groups, respectively. Similarly, we found significant ($p < 0.05$) decreases in BVP AMP, RR, EMG ZYG and EMG COR in the naltrexone group compared to the placebo group in both the self-selected and neutral music conditions. These results suggest that endogenous opioids are involved in mediating the physiological responses to music, and in mediating the experience of musical pleasure.

42 – Adiel MALIK

Affiliation: PhD Student, Integrated Program in Neuroscience, McGill University

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Abstract Title: The Effect of Rock Band® on Theory of Mind (ToM)

Abstract Authors: Adiel Mallik, Tabea Haas-Heger, Yueyang Li, and Daniel J. Levitin

Abstract Text:

Reading, music and musical video games have been previously shown to affect empathy and compassion. However, no one has examined how music and playing musical video games such as Rock Band affects the mental components of empathy known as affective and cognitive theory of mind (ToM). Here we hypothesize that playing Rock Band increases ToM. Healthy subjects (n=44) were recruited and randomly assigned to the experimental group, playing Rock Band (n=22), or to the control group, reading non-fiction (n=22). ToM performance was assessed using the Yoni task and the Positive and Negative Affect Scale (PANAS) was used to assess mood. We found significant ($p < 0.05$) increases in second-order affective trials of the Yoni task, as well as the total affective trial scores and the sum of all scores (first and second-order affective, and first and second-order cognitive) in the experimental group compared to the control group. No significant changes were obtained on the PANAS. These results suggest that playing Rock Band improves affective ToM but has no discernable effect on cognitive ToM.

43 – Fiona MANNING

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Abstract Title: Symmetrical temporal attention surround targets as a consequence of tapping

Abstract Authors: Fiona Manning & Michael Schutz

Abstract Text:

Temporal context is an important factor that influences perceived timing (Jones, Boltz, & Kidd, 1982; McAuley & Jones, 2003: Repp, 2002). Temporal detection tasks using isochronous sequences yield expectancy profiles surrounding targets that are asymmetrical, where late targets are more easily identified than early targets (Large & Jones, 1999; McAuley et al., 1995). In the present set of studies, participants listened to a sequence of beats grouped in a 4/4 meter and identified the timing of a final target tone. We manipulated the metrical position on which temporal deviations of the target occurred in a series of experiments. Participants either tapped along to the beats or listened while remaining still. In each experiment the target tone fell on a different perceived metrical position of the 4/4 pattern to examine how the amount of attentional energy focused at the site of the deviation affects movement's impact on perception. The data showed that when tapping with the sequence, timing judgments around the probe tone were more symmetrical than when listening alone. This differed across metrical positions, highlighting the pattern of attentional focus surrounding the probe tone at different perceived beat arrangements. This finding suggests that movement and a metrical context changes expectation of targets, perhaps due to increased attention surrounding the targets.

44 – Sandra MARKOVIC

Affiliation: University of Ottawa

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Abstract Title: Teaching Piano to Pediatric Cochlear Implant Recipients (CIs): Implications and Effects

Abstract Authors: Sandra Markovic

Abstract Text:

Teaching Piano to Pediatric Cochlear Implant Recipients (CIs): Implications and Effects

The few studies on the effects of music instruction on deaf children (Abdi et al., 2001; Kosaner et al., 2012) conclude that music training enhances the ability of pediatric cochlear implant recipients (CIs) to recognize, enjoy, and reproduce music, suggesting that daily exposure and practice are positively correlated factors for them.

Virtually no research exists on how teachers can modify their formal music curricula to allow CIs to benefit from music lessons. Amid the plethora of research on music therapy for CIs, no individual formal lesson plan has yet been proposed to investigate the possibilities and effects of teaching CIs classical music on piano.

This paper examines the aural modeling method of teaching piano to deaf children with cochlear implants, focusing on the methodology, material, observations on practicing challenges, parental involvement, and overall implied strategies for teaching CIs. Five CIs participated in a six-month pilot study in which a Suzuki-based method and materials were used to teach music recognition and reproduction.

The aural approach to teaching classical music to CIs suggests that it is possible for them to learn to recognize musical patterns and contours and gain the ability to enjoy music. Moreover, parents and teachers reported that the opportunity to participate in and understand current music trends improved the CIs' social skills and behaviour. Therefore, CIs should be included in music activities, guided by the appropriate teaching methodologies.

45 – Ernest MAS HERRERO

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Abstract Title: Indifferent to music: neural substrates underlying specific-musical anhedonia

Abstract Authors:

Martinez-Molina, Noelia
Mas-Herrero, Ernest
Zatorre, Robert
Rodriguez-Fornells, Antoni
Marco-Pallares, Josep

Abstract Text:

Music is a universal feature of all human societies but not all people enjoy it with the same intensity. Recent studies have identified a group of healthy individuals who present a specific lack of sensitivity to musical reward, a condition known as specific-musical anhedonia. The study of these individuals provides a unique opportunity to identify the specific brain substrates involved in musical reward. With this goal in mind, functional magnetic resonance imaging (fMRI) was recorded from three groups of 15 people each with low (anhedonic group), medium (hedonic group) and high (hyper-hedonic group) musical reward sensitivity. Participants performed two different tasks in counterbalanced order: a music task in which they had to rate the degree of pleasure they were experiencing while listening to music, and a gambling task in which participants could accumulate or lose monetary reward of different magnitudes. Our results show a reduced activity in ventral striatum, amigdala and hippocampus in the music task in the specific-musical anhedonic participants compared to the other two groups. In contrast, the three groups showed comparable brain activity in these areas as response to monetary outcomes. Therefore, these results reveal a specific reduction of striatal, amigdala and hippocampal activity to music in specific-musical anhedonia and, thus, point out a crucial role of these regions in the individual differences in the experience of musical pleasure.

46 – Matthew MASAPOLLO

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Abstract Title: Auditory and visual contributions to vowel perception biases

Abstract Authors: Matthew Masapollo, Linda Polka, and Lucie Ménard

Abstract Text:

Previous research has demonstrated that perceivers (both adult and infant) are universally biased to attend to peripheral vowels, which display a high degree of formant frequency convergence, or "focalization" (Polka & Bohn, 2011). The nature of information that drives this "peripheral" vowel bias is a matter of debate. One possibility is that salient spectral prominences created by formant convergence underlie this vowel perception bias. An alternative account is that perceivers are attuned to detect the distal vocal tract gestures that give rise to these salient spectral peaks. In an attempt to experimentally tease apart these two phonetic accounts, we investigated English adults' auditory-only (AO) and visual-only (VO) perception of English and French /u/ variants. Crucial to this study's design is that French /u/ is more peripheral (within F1/F2 vowel space) than English /u/. Consequently, the proximity between F1 and F2 is greater for French /u/ variants. Additionally, English and French /u/ productions are optically distinct, due to differences in their lip rounding properties (i.e., lip compression and protrusion). If the peripheral vowel bias is driven by focal acoustic patterns per se, then perceivers should be biased to attend to the French /u/ variants when tested in the AO mode, but not in the VO mode. Alternatively, if this bias is observed in the visual modality, then this would support the view that perceivers detect articulatory information in speech. The results confirmed a perceptual bias favoring the more peripheral (and hence focal) French /u/ variants when tested in both the AO and VO modes. We interpret these findings as evidence for a potential gestural account of vowel perception.

47 – Brian MATTHIAS

Affiliation: McGill University

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Abstract Title: Auditory-motor learning modulates sensory and cognitive processing of pitch in music

Abstract Authors: Brian Mathias, Barbara Tillmann, Caroline Palmer

Abstract Text:

Previous research has demonstrated that sounds that have been produced with one's own motor system tend to be remembered better than sounds that have been learned by listening alone. We investigated influences of motor experience on pitch perception in musicians using behavioral, event-related potential (ERP), and neural source current density measures. On the basis of the auditory production effect, we hypothesized that motor learning of melodies would enhance electrophysiological and behavioral signatures of melodic pitch expectancy violations. We also addressed whether sensorimotor memory encoding can influence expectations for upcoming auditory events, including sensory (acoustic) and schematic (rule-based) expectations for musical pitch.

Twenty pianists learned one set of novel melodies by production on an electronic keyboard with normal auditory feedback, and another set of novel melodies by listening to recorded performances. Pianists produced or perceived 10 repetitions of each melody with the music notation in view. Following learning, pianists completed an altered pitch detection test, in which they listened to all melodies that they had learned and were asked to indicate whether each melody contained an altered pitch. Occasional pitch alterations were out-of-key, and therefore violated both sensory and schematic auditory expectations established by the preceding melodic context, which contained in-key pitches only. Electroencephalography was recorded while pianists completed the detection test. ERPs were time-locked to onsets of altered pitches and to pitches in matched positions within the unaltered melodies. Source localization of ERP components that showed effects of learning condition allowed contrasts of whole brain electric source current densities for production and perception conditions.

Pianists showed high accuracy following sensorimotor learning in the identification of altered and original melodies. Altered pitches (expectancy violations) elicited N1, N2, and P3 ERP components. The N2 component was sensitive to learning condition: Amplitudes were larger in response to altered pitches in previously performed than in heard-only melodies, and correlated with listeners' detection accuracy for the production condition. Cortical motor planning regions showed greater contributions to the production N2 compared to the perception N2, and the anterior cingulate cortex showed the reverse effect. N1 and P3 amplitudes were not sensitive to learning modality, and instead correlated with changes in acoustic and melodic features. N1 amplitudes correlated with simulations of Leman's (2000) model of acoustic sensory consonance, and P3 amplitudes correlated with Krumhansl and Kessler's (1982) ratings of relatedness of target pitches to the tonal context (i.e., tonal hierarchy profiles).

These findings suggest that auditory-motor associations influence responses to context-based expectancy violations in music, and provide evidence for distinct time courses of sensory, schematic, and motoric influences within the same tonal perception task. Whereas an influence of sensorimotor memory encoding on pitch processing occurred about 250 ms following pitch onsets, sensory expectations showed an earlier time course (~150 ms following pitch onsets), and schematic, rule-based expectations a later time course (~350 ms following pitch onsets). Overall, the findings provide new evidence for low-level sensory and higher-level, production-based influences during auditory perception, and suggest that expectations during the perception of familiar auditory stimuli take into account learned auditory-motor associations.

48 – Tomas MATTHEWS

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Abstract Title: Activation in right motor and frontal regions is modulated by tapping and rhythm complexity during a beat maintenance task

Abstract Authors: Tomas E. Matthews, Virginia B. Penhune

Abstract Text:

Studies have identified a network of cortical and subcortical brain regions involved in processing musical rhythms, whether tapping synchronously or simply listening (Grahn, 2012). The basal ganglia (BG) are thought to be important for beat-based timing in particular (Teki et al., 2011). Metrical complexity, here indexed by the number of auditory onsets that align with predicted beat points, has been shown to be a strong predictor of beat perception (Kung et al., 2013), and is therefore expected to affect BG engagement. However, there have been conflicting results regarding the effect of metrical complexity on BG activity, which are likely a result of differing paradigms (e.g., tapping vs. listening only). The current functional magnetic resonance imaging (fMRI) study investigated the precise role of the BG in beat processing by including both tapping and non-tapping trials as well as by manipulating metrical complexity. Trained pianists heard rhythms of varying metrical complexity and were asked to maintain the underlying beat through a short silence, either covertly or by tapping, in order to make a judgment as to whether a probe tone was on or off the beat. Judgements regarding the probe tone showed higher accuracy in the tap condition compared to the notap condition for the isochronous rhythm only. fMRI results showed a significant tapping by complexity interaction for voxels in the right pallidum, right caudate as well as right inferior frontal regions and the right insula. Specifically, these regions showed highest activation for the notap compared to the tap condition for the isochronous rhythms only. The bilateral putamen showed decreasing activity with increasing metrical complexity in the notap condition only. Activation in the supplementary motor area (SMA) and lobules V and VI of cerebellum was higher in the notap condition over the tap condition across all levels of metrical complexity. These results show that activation related to beat maintenance depends on whether one is tapping along or just listening. Differences in activation patterns between the putamen and other BG structures supports the idea that the putamen has a unique role in beat processing, as shown in previous studies (e.g., Grahn & Rowe, 2009). Metrical complexity does not seem to modulate cerebellum and SMA engagement, which suggests that these regions are more involved in general timing compared to beat-based timing.

49 – Lucy McGARRY

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Abstract Title: Investigating music-based rhythmic auditory stimulation for gait rehabilitation: Weak beat perceivers perform better without instructions to synchronize

Abstract Authors: Lucy M. McGarry (1)*, Cricia Rinchon (1,2), Emily A. Ready (3), Jeffrey D. Holmes (3,4), & Jessica A. Grahn (1,4)

1) Brain and Mind Institute

2) Schulich School of Medicine and Dentistry

3) Health and Rehabilitation Sciences

4) School of Occupational Therapy

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Abstract Text:

Music-based rhythmic auditory stimulation (RAS) is a cueing technique used to rehabilitate abnormal gait, typically involving synchronizing footsteps with the beat. However, instructions to synchronize may be detrimental to individuals who have difficulty perceiving the beat in music, such as people with Parkinson's disease, because of increased cognitive load.

The present study evaluates how beat perception skills influence gait responses to RAS when instructed to synchronize steps with the beat versus when permitted to walk freely. Healthy participants walked on a pressure-sensor walkway to music that they rated to be high in groove (a quantification of 'desire to move to the music'). Beat perception was evaluated using the Beat Alignment Test from the Goldsmiths Music Sophistication Index v1.0.

As predicted, instructions to synchronize facilitated gait in strong beat perceivers, whereas walking freely facilitated gait in weak beat perceivers. This instruction x beat perception interaction occurred significantly for stride width, an indicator of balance, and marginally for stride length and stride velocity. Results support the premise that RAS should be tailored to beat perception skill: weak beat perceivers exhibit greater improvements if there is no pressure to synchronize steps to the music.

50 – Larissa McKETTON

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Abstract Title: No otoacoustic evidence for a peripheral basis underlying absolute pitch

Abstract Authors: Larissa McKetton (1), Christopher Bergevin (2), Victoria Stone (3), Jessica Grahn (4), David Purcell (3)

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Abstract Text:

Absolute pitch (AP) is the ability to identify or produce the perceived pitch of a sound (e.g., fundamental frequency of a piano note) without an external reference. This ability is relatively rare (~1/10000 individuals possess it) and the mechanisms underlying AP are not well understood. This study examined whether there was evidence for a peripheral (i.e., cochlear) basis for AP based upon otoacoustic emissions (OAEs). The chief motivations were that both AP and spontaneous emissions (SOAEs) appear to have genetic components and anecdotal observations of prevalence in certain populations (e.g., relatively higher incidence of both in Asians). We examined SOAEs and stimulus-frequency emissions (SFOAEs) in both control (N=21) and AP (N=13) normal-hearing populations. We found no substantial differences in SOAE activity between groups (e.g., no evidence for one or more strong SOAEs that could act as a cue). SFOAE phase-gradient delays, measured using several probe levels (20-50 dB SPL), also showed no significant differences. This latter observation argues against sharper frequency selectivity in AP subjects. Taken together, these data support the prevailing view that AP mechanisms arise at a processing level in the central nervous system at the brainstem or higher (e.g., optimized neural coding).

51 – Brandon PAUL

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Abstract Title: Cochlear Factors Contributing to Tinnitus

Abstract Authors: Brandon T. Paul, Larry E. Roberts, Ian C. Bruce, Daniel J. Bosnyak, & David C. Thompson

Abstract Text:

Evidence from human and animal studies suggests that chronic subjective tinnitus occurs when central auditory structures are deafferented by cochlear damage caused by noise exposure or the aging process. However, not all cases of tinnitus are associated with audiometric hearing loss. One explanation of this finding is that tinnitus may be associated with cochlear damage not expressed in the audiogram. Type I auditory nerve fibers (ANFs) with low firing thresholds and high spontaneous firing rates (LT-HS ANFs) may have been comparatively well preserved for these tinnitus subjects, resulting in a normal audiogram. However, high-threshold low-spontaneous rate (HT-LS) ANFs may have been damaged in the tinnitus subjects, which could be expected to affect the processing of suprathreshold sounds but would not be expected to express in threshold measures.

To test this hypothesis, we measured the ability of tinnitus and control subjects with clinically normal hearing to detect the presence of 19 Hz amplitude modulation (AM) in a suprathreshold 5 kHz tone (75 dB SPL), which lies in the frequency region where tinnitus is typically experienced and where hidden hearing loss was expected to be present in tinnitus. All tones were presented against narrowband noise (40 dB spectrum level centered at 5 kHz) intended to saturate LT-HS ANFs such that their ability to contribute to encoding AM is greatly reduced. In a separate condition we measured a neuroelectric midbrain response, the 85 Hz auditory steady state response, evoked by an 85 Hz AM, 5 kHz tone (75 dB SPL) at modulation depths of 100%, 75%, and 50% also against narrowband background noise. A no-noise control condition was also included.

Preliminary results show reduced midbrain responses in tinnitus subjects (N = 6) in all conditions compared to controls (N = 31). Simulations of ANF responses based on the auditory-periphery model of Zilany, Bruce and Carney (2014) suggests that 100% loss of HT-LS ANFs combined with ~30% loss of LT-HS fibers is sufficient to account for the reduced brain responses observed in the tinnitus subjects and the differing effects of the background noise for the tinnitus and non-tinnitus subjects. A loss of ~30% of LT-HS ANFs would not be expected to have a substantial effect on hearing thresholds.

Supported by NSERC of Canada

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Abstract Title: Designing a category learning task to assess learned categorical perception – An ERP study

Abstract Authors: Pérez-Gay, F., Sabri, H., Gregory. M, Botero, N., Rivas, D., Harnad, S.

Abstract Text:

BACKGROUND

Do we put things in the same category because they look or sound more alike? Or do they look or sound more alike because we put them in the same category? Our research is on Categorical Perception (CP), in which our categories influence our perception, making members of the same category seem more alike (compression) and members of different categories seem more different (separation). The question is: how and why? Inborn compression/separation effects are well documented in the perception of color, phonemes, and facial expression. Pitch and timbre CP, too, are at least partly inborn. But acquired CP effects are now drawing increasing interest because, as any dictionary shows, the overwhelming majority of our categories are learned rather than inborn. Our experiments induce CP through new categories (textures). We analyze brain activity correlates of successful and unsuccessful category learning and the relation between how difficult it is to learn the category and the size of the CP effect induced.

METHODS

In these preliminary experiments we trained human participants to categorize a large set of unfamiliar, computer-generated visual textures though trial-and-error learning, with error-corrective feedback. Our learning criterion was a sustained correct response rate of 80% or higher. Category membership depended on the presence of a series of features assembled together. We increased difficulty by decreasing the proportion of co-varying features. We created 4 levels of difficulty and tested 10 (different) subjects per level. Each subject completed 400 trials total (4 blocks of 100 trials) plus a questionnaire on their categorization strategy during the pauses between blocks. We recorded electroencephalographic activity during the task and extracted early and late Event Related Potential (ERP) differences between successful learners and nonlearners, and before and after learning in learners. Our overall theoretical

HYPOTHESIS is that CP effects induced by new category learning are due to dimensional reduction: task difficulty increases as the proportion of features co-varying with category membership decreases. Our PREDICTIONS were that the harder the learning (1) the larger the number of trials needed to learn and (2) the larger the proportion of subjects who fail to learn. For the electrophysiological part of the study, we predicted (3) an increase in the late (cognitive) ERP components in the successful learners after learning, compared to before, but (4) not in the unsuccessful learners (comparing the second half of their learning trials to the first half). We also predicted (5) an increase in early (perceptual) ERP components in successful learners after learning, but (6) not in unsuccessful learners.

RESULTS: We have so far tested and confirmed (1), (2), (3) and (4). Further experiments will measure learned CP by comparing within-category and between-category similarity judgements before and after category learning. We will also assess the early and late ERP components elicited during these judgements, with the prediction that CP increases with difficulty and is correlated with differences in the early ERP components. According to our hypothesis, the compression/separation is caused by learning to ignore the irrelevant dimensions (features).

53 – Claudia PICARD-DELAND

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Abstract Title: The Musical Prodigy: Putting the Definition to the Test

Abstract Authors: Claudia Picard-Deland, Dominique Vuvan, Mikael Swirp, Yixiao Chen, Gilles Comeau & Isabelle Peretz

Abstract Text:

Child prodigies offer a natural experiment to explore fundamental questions concerning the development of exceptional abilities. However, very little empirical research has been conducted on this phenomenon, in no small part due to the fact that there exists no agreed upon definition with which to identify prodigies. This project aimed to explore the limits of the predominant definition of prodigy in the literature, which proposes that a prodigy is a child who, at a very young age (typically younger than 10 years old) performs at an adult professional level in a highly demanding, culturally recognized field (Feldman, 1986; Feldman & Morelock, 2011). We tested this definition with piano prodigies, focusing on the two central aspects of the definition: precocity and high-level performance. In a first condition, we asked expert musicians and non-musicians to judge whether audio clips were played by a child prodigy or an adult professional. In a second condition, we asked them to identify which of two clips of the same classical piece was played by a prodigy. We found that all evaluators performed above chance in both tasks, but by a very modest margin, and musicians performed better than non-musicians. Evaluators' low performance implies that the musical prodigy performs well enough to be judged in terms of the most demanding criteria for performance in that field. We also found that older prodigies (11 to 14 years old) were harder to distinguish from professionals than younger prodigies (under 10 years old), demonstrating a developmental trajectory for prodigy performance. Indeed, the rate at which the prodigies progress in their playing is significantly higher than for regular piano students, suggesting that rate of progress might be used as an additional criterion for defining musical prodigy. Finally, an acoustical analysis of the audio clips shows that the variation of sound intensity is greater in experts' musical performances and that musician evaluators mainly judge clips with higher intensity variability as being professional. This acoustic determinant therefore seems to be one of many cues used by listeners to discriminate between prodigies and professionals.

54 – Hanna POIKONEN

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Abstract Title: Event related brain potentials evoked by Carmen in musicians and dancers

Abstract Authors: Hanna Poikonen (1), Petri Toiviainen (2), Mari Tervaniemi (1)

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2) Department of Music, University of Jyväskylä, Finland

Abstract Text:

Event-related potentials (ERPs) evoked by simple tones in the brain have been extensively studied. However, in reality the music surrounding us is spectrally and temporally complex and dynamic. Thus the research using natural sounds is crucial in understanding the operation of the brain in its natural environment. Music is an excellent example of natural stimulation, which, in various forms, has always been an essential part of different cultures. In addition to sensory responses, music elicits vast cognitive and emotional processes in the brain.

When compared to laymen, professional musicians have stronger ERP responses in processing individual musical features in simple tone sequences, such as changes in pitch, timbre and harmony. Here we show that the ERP responses evoked by rapid changes in individual musical features are more intense in musicians than in laymen also while listening to long excerpts of the composition Carmen. Interestingly, for professional dancers, the amplitudes of the P200 response are weaker than for musicians but still stronger than for laymen. Also, the P200 latencies of musicians are significantly shorter whereas the latencies of laymen are significantly longer. In contrast, N100 do not differ in amplitude or latency between musicians and laymen. These results, gained with a novel ERP methodology for natural music, suggest that we can take the leap of studying the brain with long pieces of natural music also with the ERP method of electroencephalography (EEG) as has already been made with functional magnetic resonance (fMRI), these two brain imaging devices complementing each other.

55 – Simon RIGOULOT

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Abstract Title: Different adaptation patterns for speech and music: evidence from ERP

Abstract Authors: Simon Rigoulot (1,2,3) & Jorge L. Armony (1,2,3,4)

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Abstract Text:

Cerebral activity tends to decrease in response to a stimulus that is repeated. This phenomenon is referred to as neural adaptation. Whereas the majority of works has focused on the repetition of an identical stimulus, very little is known on the categorical effects that could occur in neural adaptation, especially in the auditory modality. Using stimuli from different categories would help to understand how the brain differentiates sound categories, like speech and music, which is a currently heated debate in the field. Consequently, we investigated here how speech and musical sounds adapt each other. We modified an fMRI adaptation paradigm for EEG sequences of stimuli, and presented pseudo-sentences, piano and violin excerpts. The task of the participants was to detect occasional white noise, while their EEG was recorded. We observed on the N1 component an adaptation of the responses to musical sounds (piano and violin) when they were preceded by musical, but not speech, sounds. In contrast, responses to speech sounds were not influenced by the preceding stimulus, regardless of their category. For P2 component, the pattern was reversed, as we observed an adaptation of responses to speech but not musical sounds. Altogether, these results suggest that speech and music are processed separately in the first steps of auditory processing, confirming that category selectivity takes place in the auditory cortex.

56 – Sébastien SANTURETTE

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Abstract Title: Effects of incongruent auditory and visual room-related cues on sound externalization

Abstract Authors: Juan Camilo Gil Carvajal, Sébastien Santurette, Jens Cubick, Torsten Dau

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Abstract Text:

Sounds presented via headphones are typically perceived inside the head. However, the illusion of a sound source located out in space away from the listener's head can be generated with binaural headphone-based auralization systems by convolving anechoic sound signals with a given binaural room impulse response (BRIR) measured with miniature microphones placed in the listener's ear canals. Sound externalization of such virtual sounds can be very convincing and robust but there have been informal reports that the illusion might break down when the listening environment differs from the room in which the BRIRs were recorded. This may be due to incongruent auditory cues between the recording and playback room during sound reproduction. Alternatively, an expectation effect from the visual impression of the room may affect the position of the perceived sound image. Here, we systematically investigated whether incongruent auditory and visual room related cues affected sound externalization in terms of perceived distance, azimuthal localization, and compactness. Eighteen naïve listeners rated the externalization of virtual stimuli in three rooms: 1) a standard IEC listening room, 2) a small reverberant room, and 3) a large dry room. Before testing, individual BRIRs were recorded in the standard room while listeners wore both earplugs and blindfolds. The listeners were divided into two groups and provided either auditory or visual knowledge of the test rooms, while cues from the other modality were limited as much as possible. The first half of the listeners were blindfolded during testing but provided auditory awareness of the room from a loudspeaker emitting noise bursts every 5 s throughout the experiment (condition A). The other half of the listeners could see the room but were shielded from room-related acoustic input and tested without the additional noise source (condition V). All listeners were then tested with all cues available (condition AV). Seven azimuthal source positions were reproduced, with loudspeakers visible at four azimuthal positions. In condition AV, the auditory images were perceived closer to the listener in rooms 2 and 3 than in room 1, with a larger effect in the reverberant than in the dry environment. In room 2, the perceived distance of the virtual sounds was more accurate in condition V than in conditions A and AV, where it was reduced. In room 3, differences in distance judgments between A, V, and AV conditions were much less pronounced. In contrast to distance, localization and compactness judgments were largely room independent, although localization judgments were less accurate and compactness ratings less consistent in conditions V and A than in condition VA. Overall, a mismatch between recording and playback room was found to be detrimental to virtual sound externalization. The auditory modality governed externalization in terms of perceived distance when cues from the recording and playback room were incongruent, whereby the auditory impression of the room was more critical the more reverberant the listening environment was. While the visual impression of the playback room did not affect perceived distance, visual cues helped resolve localization ambiguities and improved compactness perception.

57 – Teppo SÄRKÄMÖ

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Abstract Title: Neural basis of amusia after stroke: a voxel-based lesion-symptom mapping and morphometry study

Abstract Authors:

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Vera Leo (Cognitive Brain Research Unit, University of Helsinki, Finland)
Seppo Soinila (University of Turku, Faculty of Medicine, Finland)
Riitta Parkkola (Medical Imaging Center of South-West Finland, Finland)
Antoni Rodríguez-Fornells (Cognition and Brain Plasticity Unit, University of Barcelona, Spain)
Teppo Särkämö (Cognitive Brain Research Unit, University of Helsinki, Finland)

Abstract Text:

Acquired amusia is a relatively common disorder after stroke to the middle cerebral artery (MCA) territory, but its precise neuroanatomical basis is still unknown. To evaluate which brain regions are critically associated with acquired amusia and its recovery, we performed a voxel-based lesion-symptom mapping (VLSM) and morphometry (VBM) study with 77 stroke patients. Structural MRI images were acquired at acute and 6-month post-stroke stages. Amusia and aphasia were behaviorally assessed at acute and 3-month post-stroke stages using the Scale (pitch) and Rhythm subtests of the Montreal Battery of Evaluation of Amusia (MBEA) and different language tests. At the acute stage, VLSM analyses indicated that amusia was associated with a lesion pattern clearly distinct from aphasia involving the superior temporal gyrus (STG), transverse temporal gyrus (TTG), insula, and striatum in the right hemisphere. Pitch-amusia and rhythm-amusia showed extensive lesion overlap in the right striatum, with rhythm-amusia lesions extending more dorsally and rostrally. VBM analyses of change in grey matter (GM) and white matter (WM) volume from the acute to the 6-month stage showed a clear decrease in GM volume (atrophy) in the right superior and middle temporal gyri in non-recovered amusic patients compared to non-amusic or recovered amusic patients. This increased atrophy was more evident in anterior temporal areas in severe rhythm-amusia and in posterior temporal and temporoparietal areas in severe pitch-amusia. Overall, the results implicate right temporal and subcortical regions as the crucial neural substrate for acquired amusia and highlight the importance of different temporal lobe regions for amusia recovery.

58 – Geneviève SAUVÉ

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Abstract Title: Putting sound recognition in context: A pilot event-related potentials study

Abstract Authors:

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Abstract Text:

INTRODUCTION: Numerous studies have demonstrated that objects are more easily and more accurately recognized when they are presented in their usual context in comparison to when they are presented in isolation or in an inconsistent context. We have recently described the electrophysiological brain signature of the context effect that visual scenes exert over images of objects. ERPs from 250 to 1000ms, including the N300/N400, were more positive at fronto-central sites and more negative at posterior sites, when objects appeared in congruent scenes as opposed to when they appeared in neutral scenes. Since contexts reflect multimodal environments, we hypothesized that some components of the context effect, particularly the frontal ones, are supramodal, meaning that they should occur regardless of the sensory modalities of the context. For the present study, we were interested in exploring whether ERP differences that are associated with contextual processing could also be observed in the auditory modality.

METHODS: Thus far, EEG was recorded over 64 Ag/AgCl electrodes and ERPs were computed in 11 healthy subjects (6 women) aged between 19 and 29 years old. All participants were right-handed, had no auditory problem, and reported no history of neurological or mental health conditions. Participants were presented with a contextual sound (3 seconds duration) followed by a target sound (2 seconds duration). A blank screen with the word “next” indicated to participants the beginning of the next trial (total 120 trials). Their task was to press the spacebar when they had identified the target sound. Contextual and target sounds pairs were divided into two categories: congruent (n=60) and neutral (n=60). Congruent pairs were composed of a target sound that one could possibly and probably expect to hear following the contextual sound presentation. Neutral pairs comprised target sounds that could possibly, but improbably be heard following the contextual sound presentation. Prior to the EEG recordings, the congruity and neutrality of sounds were normalized with 38 healthy subjects (19 women, mean age 28.9 years old).

RESULTS: Analyses focused on ERPs within three time windows (250-350ms, 350-500ms, and 500-800ms). A significant main effect of condition was found within the 500-800ms time window over the central region (electrodes C1 to C6 and CP1 to CP6). Stimuli from the congruent condition yielded positive voltage amplitudes while those from the neutral condition were associated with negative ones. Similar effects were observed over the frontal area but they were not statistically significant. A third effect, in opposite direction to the central effect, was found over the right anterior temporal region. Reaction times were comparable for both conditions.

CONCLUSIONS: The ERP brain signature in the auditory context differs from that in the visual one by the lack of posterior difference, and the weakness of the frontal effect. On the other hand, auditory contexts generated activations over the central area which were shorter than those observed with visual context. However, the activation for both contexts was spatially similar. Auditory contexts triggered one activity that was not found in visual contexts and which was measured over the fronto-temporal area.

59 – Esther SCHOTT

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Abstract Title: Cues to language discrimination: Language rhythm and geographical proximity

Abstract Authors: Esther Schott, Kristine H. Onishi

Abstract Text:

In our multicultural society, more people are multi- than monolingual, but research often focuses on monolinguals, thus we are just beginning to understand bilingual/monolingual differences. Initially, the focus was on negative consequences of bilingualism, but recent work has discovered bilingual advantages, e.g., that bilinguals have enhanced selective attention (e.g., Bialystok et al., 2005), perhaps arising from their greater need (compared to monolinguals) to focus on one language in the presence of another. In addition to predicting monolingual/bilingual differences, the idea that enhanced selective attention skills arise from focusing on one language while inhibiting another suggests that we may also find differences within the group of bilinguals. Specifically, if the languages of the bilingual are harder to keep separate (harder to discriminate from each other), the bilingual may have enhanced selective attention compared to a bilingual whose languages are easier to keep separate (easier to discriminate).

To explore this question, we need a measure indexing which pairs of unfamiliar languages adults find harder to discriminate. When monitoring a target language for meaning while it is embedded in noise (speech in another language), adults were less accurate when the noise was a language rhythmically similar (rather than dissimilar) to the target language (Reel et al., 2012). However, to monitor for meaning, subjects must know the target language and thus few language pairs have been examined (e.g., Calandruccio et al., 2010).

In the current study, native English speakers heard two talkers speaking simultaneously either the same or different languages, and they indicated how many languages they heard (1 or 2). If a pair of languages is harder to discriminate, participants may be more likely to erroneously report hearing 1 language. We had recordings of 3 native talkers of 16 languages and participants heard multiple trials of each language pairing. Means were calculated for each participant for each language pairing, and then across participants.

Pairs including English or French were always heard as 2 languages (M = 1.9) as these were languages familiar to the participants, showing (not surprisingly) that familiarity affects the discriminability of the languages. The reported analyses exclude all pairings containing English or French (although including them did not change the pattern of results). A cluster analysis on the mean number-of-languages heard for each of the 182 (= 14*13) 2-language pairs revealed two rhythm-based clusters: (1) syllable-timed (e.g., Spanish, Hindi), (2) mostly stress-timed (e.g., German, Hebrew); and two geographical proximity clusters: (3) from Asia (e.g., Vietnamese, Mandarin), and (4) from Africa (Arabic, Yoruba). The patterns were not explained by (1) language family or (2) whether most participants were able to identify the language (based on a short soundclip). For adults listening to unfamiliar languages, discriminating pairs of languages may rely both on cues that relate to language rhythm and geography. Studying the cues to language discrimination can inform us about the aspects of language that are salient if the listener has no knowledge of the language, as for example in the early stages of learning a new language.

60 – Megha SHARDA

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Abstract Title: Language functioning predicts cortical structure and covariance in Autism Spectrum Disorders

Abstract Authors: M.Sharda, N.E.V. Foster, A. Tryfon, K.A.R. Doyle-Thomas, E.Anagnostou, A.C. Evans, and K.L. Hyde for NeuroDevnet ASD imaging group

Abstract Text:

There is significant clinical heterogeneity in the language and communication abilities of individuals with Autism Spectrum Disorders (ASD). However, no consistent pathology, especially in regards to the relationship of these abilities to brain structure has emerged. Recent developments in anatomical correlation-based approaches to map structural covariance networks (SCN), combined with detailed behavioural characterization, offer an alternative for studying such relationships. In this study, we employed such an approach to study the integrity of SCNs of cortical thickness and surface area associated with language and communication, in 46 high-functioning, school-age children with ASD compared with 50 matched typically developing controls (all males) with IQ>75. Our findings showed that there was alteration of both cortical structure as well as widespread disruption of left hemisphere fronto-temporal cortical covariance in ASD compared to controls. Furthermore, alterations in both cortical structure and covariance were modulated by the structural language ability of the ASD group (measured by CELF-4) rather than communicative function (measured by CCC-2). These findings support the importance of better characterizing ASD samples to minimize heterogeneity in terms of phenotype while studying brain structure. They also indicate that structural language abilities in particular, influence the development of altered fronto-temporal cortical covariance in ASD, irrespective of symptom severity or cognitive ability. These novel findings have important implications for better understanding cortical trajectories in ASD and in the development of biomarkers to monitor targeted treatments that may benefit subgroups.

61 – Diana TAT

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Abstract Title: The Relation between Perceived Physiological Arousal and Valence during Relaxing Music Listening

Abstract Authors: Diana Tat (1,2), Gabriel Pelletier (1), Edith Massicotte (1,2), Nathalie Gosselin (1,2)

Abstract Text:

Amongst all the functions music listening can fulfill, emotions and mood regulation are the most reported by listeners (Chafer, Sedlmeier, Stadtler & Huron, 2013). In fact, the power of music listening to reduce stress seems particularly attractive to listeners (Thayer, Newman, & McClain. 1994). In order to empirically explore the effect of music on emotions and stress, close attention must be addressed to the description and selection of the musical material used. In that sense, musical emotions have often been described using a two-dimensional (orthogonal) space defined by two main emotional characteristics, namely physiological arousal and valence (Zentner, 2008; Eerola & Vuoskoski, 2011). The aims of this study is to 1) explore the relationship between those two dimensions, with a particular focus on relaxing musical excerpts; 2) select relaxing and pleasant excerpts that will be used to explore the effect of perceived physiological arousal conveyed by music on stress regulation.

Twenty musical excerpts with relatively slow tempi and written in a major mode (i.e., relaxing) were chosen by two musicians. These relaxing musical excerpts, along with 22 fast-tempi and major-mode music excerpts (i.e., stimulating; also used in Roy & al., 2008) were presented in a pseudo random order. Ten participants rated all music excerpts in terms of physiological arousal (from very relaxing to very stimulating) and valence (from very pleasant to very unpleasant) by using visual analog scales (Ahearn, 1997).

Results show a significant relationship between self-reported valence and physiological arousal amongst the relaxing and pleasant excerpts. Interestingly, this was not the case for the stimulating and pleasant music excerpts. These findings are discussed in relation to existing literature and show the importance of a systematic evaluation of music excerpts for a research purpose.

62– Jessica THOMPSON

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Abstract Title: Mapping the representation of linear combinations of dynamic ripples in auditory cortex with 7T fMRI

Abstract Authors: Jessica Thompson, Federico Demartino, Marc Schönwiesner, Elia Formisano

Abstract Text:

Previous work has shown that spectrotemporal modulations are important features used by the mammalian auditory cortex. The dynamic ripple, a complex broadband sound with a sinusoidal spectral envelope that drifts along the logarithmic frequency axis over time, is a commonly used stimulus in this line of research. These synthesized sounds have been used to calculate reliable modulation transfer functions in human and mammalian auditory cortex. Dynamic ripples can be characterized by several features, such as fundamental frequency, temporal modulation rate, and spectral modulation rate, which have been shown to be good predictors of neural responses to natural sounds. Dynamic ripples have been proposed as a basis function to describe the neural encoding of sound in auditory cortex. In this work, we wish to characterize to what extent and in which regions does human auditory cortex rely on linearized representations of spectrotemporal modulations for the encoding of sound.

To investigate this issue, we conducted a 7T fMRI experiment (N=6) using simple dynamic ripples and mixed pairs of ripples in varying ratios. These ripple combinations represent a small step towards more complex sounds. Preliminary results show that our stimuli evoked reliable activation in bilateral auditory cortex in all subjects. Ongoing analyses test the hypothesis that the response to ripple combinations can be explained by a linear combination of the responses to simple ripples. To do so we are using the General Linear Model (GLM) to understand if a linear model fits to the responses of both simple and ripple combinations. The same hypothesis will be tested using an "fMRI encoding" approach. We expect a linear model to be best representing the responses in primary auditory cortex. For regions where the linear model fails, we will investigate possible nonlinearities by analyzing the function relating the response to ripple combinations with the ripple features. These analyses will help us understand the nature of the computational processes performed by both primary and non-primary auditory cortical areas.

63 – Katherine THOMPSON

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Abstract Title: Examining the influence of music training on cognitive and perceptual transference: A quantitative meta-analysis

Abstract Authors: Katherine J. Thompson, Konstantine Zakzanis, Mark Schmuckler

Abstract Text:

A meta-analysis was conducted in order to delineate whether musicians and non-musicians differ on specific cognitive and music processing domains, and determine the magnitude of any differences. Moreover, potential covariates outlined by the literature were included as moderator variables. As predicted, musicians significantly differed from non-musicians on all music processing tasks (melody perception: d=1.18; pitch perception: d=1.00; temporal perception: d=.834). Furthermore, as predicted, musicians significantly differed on the cognitive domains related to musical ability (Motor: d=1.08, and Audition: d=.837). Significant differences were also obtained in General Intelligence (d=.348), Memory (d=.421), Orientation and Attention (d=.283), Perception (d=.190), and Verbal Functions and Language Skills (d=.423). Meta-regression and sub-group analyses of moderating variables indicated that years of music training, age group, and categories (breakdown of groups within domains) had an effect on summary effects; this impact was not consistent across all domains. The effects of other potential moderating variables are discussed in the context of existing literature.

64 – Pauline TRANCHANT

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Abstract Title: Micro-timing deviations modulate groove and pleasure in electronic dance music

Abstract Authors: Pauline Tranchant, Alexandre Lehmann

Abstract Text:

« Groove is that aspect of music that induces a pleasant sense of wanting to move along » (Janata et al, 2012). This phenomenon is of central interest for the study of how people engage in musical and dancing behaviors. Little is known on the characteristics of a musical rhythm that are important to convey groove. Medium degrees of syncopation yielded higher groove ratings of funk drum breaks (Witek et al. 2014); whereas non-constant systematic micro-timing deviations - typical of jazz, funk, and samba - decreased groove ratings of short rhythms (Davies et al. 2013). In electronic dance music (EDM), « swing » is believed to play an essential role in creating the sense of groove (Butler 2006, Danielsen 2010). In popular genres such as house or techno, it consists of constant deviations in the duration and timing of every second 8th or 16th note.

Here we investigated the effect of systematic micro-timing deviations on groove and pleasantness ratings of 16 bar-long, realistic EDM excerpts. Ratings of groove and pleasantness were compared between different swing conditions, as well as against conditions designed to control for polyphony and regularity. Groove ratings positively correlated with pleasantness. Swing amount negatively modulated groove, while higher regularity and polyphony positively modulated groove. We will discuss these empirical findings in relation to groove research and genre-specific production guidelines. We suggest future studies that involve music producers, dancing, and neuro-imaging modalities.

65 – Régis TRAPEAU

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Abstract Title: The encoding of sound source elevation in human auditory cortex

Abstract Authors: Régis Trapeau, Marc Schönwiesner

Abstract Text:

The human auditory system infers the location of a sound source from different acoustic cues. Interaural differences in time and level produced by the separation of the two ears, enable sound localization on the horizontal plane. The spectral cues generated by the direction-dependent filtering of the pinnae and the upper body, are used to disambiguate locations on the vertical plane. There is a large body of evidence from both animal and human models, that horizontal sound direction is represented in the auditory cortex by a rate code of two opponent neural populations, tuned to each hemifield. However, nothing is known about the representation of vertical sound direction. To explore the coding of sound elevation, 16 young adults took part in a fMRI study composed of 3 sessions. In each session, participants listened to individual binaural recordings of sounds emanating from different elevations. Stimuli of session 1 were recorded from the participants' bare ears and thus carried their own spectral cues. Stimuli of session 2 were recorded while silicone earmolds were inserted in the participant's ears. The earmolds were inserted in order to modify the spectral cues of our participants and consequently disrupt their elevation perception. Session 3 was identical to session 2 but took place after the participants wore the earmolds for a week. Consistent with previous behavioral studies, the insertion of the earmolds significantly disrupted the elevation perception of our participants, who were able to adapt to the earmolds and regain substantial elevation perception after a week wearing them. We extracted voxel-wise elevation tuning curves from the functional data. The majority of the active voxels of session 1 showed a decrease of activation level with increasing elevation, wide tuning curves with maximal slope around zero elevation. Tuning curves extracted from session 2 (when the elevation perception was disrupted by the earmolds) were flatter and less voxels were sensitive to elevation. The slope of the tuning curves and the number of elevation-sensitive voxels increased from session 2 to session 3, after the participants learned to localize with the earmolds. These results are consistent with a rate code representation of sound elevation in the human auditory cortex. This coding shows similar features with the population rate code of horizontal space (wide tuning, steepest slope around the midline), the main difference being that only one population, tuned to the lower elevations, appears to be present.

66 – Ana TRYFON

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Abstract Title: Neural correlates of auditory-motor synchronization are related to social symptomatology in children with autism spectrum disorder

Abstract Authors: Ana Tryfon (1,2), Nicholas E.V. Foster (1,2), Tia Ouimet (1,2), Krissy Doyle-Thomas (3), Evdokia Anagnostou (3), Alan C. Evans (4), Lonnie Zwaigenbaum (5), Krista L. Hyde (1,2) for NeuroDevNet ASD imaging group (6)

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Abstract Text:

Background: Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication skills, repetitive behaviors and restricted interests as well as atypical sensory processing. The "mirror neuron system" (MNS) refers to a group of neurons that fire when performing an action as well as observing that same action performed by another. Social communication deficits have often been attributed to an impaired MNS. Studies in visual-motor integration point to an atypical functioning of the MNS in individuals with ASD versus typical development (TD). A parallel MNS-like system is thought to exist in the auditory domain and be engaged during auditory-motor synchronization (Chen et al., 2008). Recent evidence suggests that MNS regions may be dysregulated in the auditory domain in ASD (Wan et al., 2011). However, no studies have examined basic auditory-motor synchronization in ASD versus TD children.

Objectives: The objectives of the present research were: 1) to test for group differences between ASD and TD children on a basic auditory-motor synchronization task, and 2) to investigate the relationship between performance on this task with brain structure and ASD social communication symptomatology.

Methods: Participants included 23 ASD and 23 TD control male children pairwise-matched in age and full-scale IQ recruited as part of the 'NeuroDevNet ASD project', an ongoing multi-site study on brain and behavioral development in ASD. In an auditory-motor synchronization task, subjects were asked to tap in synchrony with auditory rhythms of varying levels of complexity (easy, simple, and complex).

In addition, a partially overlapping set of participants from the 'NeuroDevNet ASD project' (23 ASD and 18 TD male children) were imaged using T1-weighted MRI anatomical scans on a 3T scanner. The groups were matched on age and had an IQ above 70. We performed cortical thickness (CT) analyses on these MR data, correlated performance on the auditory-motor task with the CT results as well as social-communication symptomatology.

Results: Results revealed that all children (both ASD and TD) performed worse on more complex rhythms. However, children with ASD showed better performance relative to TD at younger ages. Across all subjects, better performance had a significantly positive relationship with CT in right superior temporal sulcus (STS). In children with ASD, analyses showed a significant interaction between CT in right STS, performance, and social symptomatology. Specifically, children who had lower symptom severity on measures of social functioning showed a stronger relationship between performance on auditory-motor synchronization and CT in right STS, whereas individuals who had higher symptom severity on these same measures showed a weaker relationship between performance and CT in right STS.

Conclusions: We provide behavioral evidence that basic auditory-motor synchronization is enhanced in younger children with ASD relative to TD. Cortical structure in the 'auditory MNS' in ASD showed relationships with both task performance and symptomatology. These findings are in contrast to the view that individuals with ASD are generally impaired in cross-modal processing and implicate the importance of ASD symptomatology in action-observation.

67 – Lucía VAQUERO

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Abstract Title: Structural neuroplasticity in expert pianists depends on the age of onset of musical training

Abstract Authors: Lucía Vaquero, Karl Hartmann, Pablo Ripollés, Nuria Rojo, Joanna Sierpowska, Clément François, Estela Càmara, Floris Tijmen van Vugt, Bahram Mohammadi, Amir Samii, Thomas F. Münte, Antoni Rodríguez-Fornells, Eckart Altenmüller

Abstract Text:

Introduction: In the last decades, several studies have investigated the neuroplastic changes induced by long-term musical training. Here we investigated structural brain differences in expert pianists compared to non-musician controls, as well as the effect of the age of onset of piano playing. Differences with non-musicians and the effect of sensitive periods in musicians have been studied previously, but importantly, this is the first time in which the age of onset of music-training was assessed in a group of musicians playing the same instrument, while controlling for the amount of practice.

Methods: We recruited a homogeneous group of expert pianists (n = 36) who differed in their age of onset but not in their lifetime or present amount of training, and compared them to an age-matched group of non-musicians (n = 17). In addition, a subset of the pianists (n = 28) also completed a scale-playing task in order to control for performance skill level differences. Voxel-Based Morphometry analysis was used to examine gray-matter differences at the whole-brain level.

Results: Pianists showed greater amount of gray matter (GM) in bilateral putamen (extending also to the anterior hippocampus and amygdala –specifically the superficial and medial nuclei, the central nuclei and the laterobasal amygdala–), right thalamus (particularly, in the ventral posterolateral and lateral posterior nuclei, as well as in parts of the dorsomedial and the pulvinar regions), bilateral lingual gyri and left superior temporal gyrus, but a GM shrinkage in the right supramarginal, right superior temporal and right postcentral gyri, when compared to non-musician controls. Behaviorally, early-onset pianists showed higher temporal precision in their piano performance than late-onset pianists, especially in the left hand. Furthermore, GM in the right putamen and the left hand performance were positively correlated with age of onset.

Discussion: VBM results reveal a complex pattern of plastic effects due to sustained musical training: a network involved in reinforcement learning showed increased amount of GM, while areas related to sensorimotor control, auditory processing and score-reading presented a reduction in the amount of GM. Our findings show therefore for the first time in a single large dataset of healthy pianists the link between onset of musical practice, behavioral (piano) performance, and putaminal gray matter structure (although Granert and collaborators, 2011, found also similar results with a smaller sample of healthy and dystonic pianists). In summary, skill-related plastic adaptations may include decreases and increases in the amount of gray matter, dependent on an optimization of the system caused by an early start of musical training. We believe our findings enrich the field of neuroplasticity and the discussion about sensitive periods, shedding light as well on the neural basis of expert skill acquisition.

68 – Jérémie VOIX

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Abstract Title: Did you really say "bionic" ear?

Abstract Authors: Jérémie Voix

Abstract Text:

Over the past decades, Hearing Protection Devices have existed simply as passive acoustical barriers intended to prevent sound from reaching the ear canal. Over the last decade though, with the increasing miniaturization of electronic components and consolidation of consumer electronic goods, new electronic Hearing Protection Devices have been brought on the marketplace to protect from noise induced hearing loss in more sophisticated ways. Likewise, Hearing Aids have benefited from this sophistication and entirely new communication devices have been developed, such as the wireless cellphone earpiece. The convergence of hearing protection devices, hearing aids and communication earpieces appears to be the next step and is sometimes referred to as a "bionic" ear. This poster will detail a proposed roadmap leading to the development of this bionic technology. It will also present several other intra-aural applications ranging from in-ear energy harvesting, to hearing-health monitoring and brain-wave recording, all of which could truly make your next earpiece a "bionic" ear.

69 – Annekathrin WEISE

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Abstract Title: Evidence for higher-order auditory change detectors

Abstract Authors: Annekathrin Weisea, Erich Schröger, János Horváth

Abstract Text:

Auditory changes are processed by dedicated change-detectors. Their activity can be indexed by event-related potential (ERP) signatures such as N1 and P2. Following this logic, distinct ERP signatures to first-order (i.e. constant-to-glide) frequency changes provide evidence for first-order change detectors. However, evidence from ERP signatures for higher-order (i.e. glide-to-constant) change detectors has remained sparse to date. This study aimed at elaborating the hypothesis that the asymmetry in ERP elicitation is not due to the complete lack of higher-order change detectors but due to their smaller number compared to first-order change detectors. To this end electrophysiological and behavioral data were collected to the corresponding changes in different blocks in a go/ no-go paradigm. Each block utilized two types of sounds of equal probability which did or did not contain a transient change (e.g. 50% constant-to-glide and 50% constant-only or 50% glide-to constant and 50% glide-only). The rate of frequency change within the glide was varied in different blocks (i.e. 10 vs 40 semitones per second) in order to increase the number of responding change detectors. Participants attended the sounds and were required to respond as fast as possible to the transient change. The current data show distinct ERP signatures not only for first-order changes but, importantly, also for higher order changes when the frequency change rate of the glide was largest. This ERP result is accompanied by faster change detection on behavioral level. Thus, the current data support the proposed hypothesis and provide evidence for higher-order change detectors.

70 – Jocelyne WHITEHEAD

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Abstract Title: Isolating the neural correlates of auditory and visual information processing relevant to social communication: an fMRI adaptation study

Abstract Authors: Jocelyne C. Whitehead (1, 3, 4) & Jorge L. Armony (2, 3, 4)

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2) Dept. of Psychiatry, McGill University
3) Douglas Mental Health University Institute
4) BRAMS Laboratory, Centre for Research on Brain, Music and Language

Abstract Text:

Social communication in a natural environment requires the processing of multi-modal sensory information. Some brain regions sensitive to emotion, such as the amygdala, are capable of responding to such information (e.g., auditory and visual) using different channels (e.g., face and body expressions, speech and music). Yet, it remains unknown whether these different forms of affective stimuli are processed by the same subpopulations of neurons, or rather by overlapping, distinct neurons, responsive only to a specific modality and/or category. To address this question, we employed a functional magnetic resonance imaging (fMRI) adaptation paradigm designed to measure neural responses to social information as a function of their sensory modalities (visual vs. auditory), affective values (neutral vs. fear) and category (music vs. speech; faces vs. body expressions). We used a fast (TR=529ms), high-resolution (8mm3 isotropic) multiband sequence to maximize the temporal and spatial specificity of the observed responses, as well as to optimize statistical power. Initial results confirmed modality- and category-specific adaptation effects in cortical regions, which could not be explained solely in terms of category differences along basic physical properties. Our findings for music, a powerful emotionally arousing stimulus with no obvious survival or evolutionary relevance, are particularly interesting as they can provide new empirical evidence that can inform the ongoing debate about the nature of the neural representation of such type of stimulus class. When including affective value in our analysis, we observed a more prominent activation in auditory domains in response to fear, particularly those activated by speech and violin. Specifying these neural correlates of fear can assist in identifying the appropriate targets for clinical work related to anxiety and panic disorders.

71 – Anna ZAMM

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Abstract Title: Mobile EEG captures neural correlates of endogenous rhythms

Abstract Authors: Anna Zamm (1), Caroline Palmer (1), Anna-Katharina R. Bauer (2), Martin G. Bleichner (2), Alexander P. Demos (1), Stefan Debener (2,3)

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Abstract Text:

Human behaviours are often rhythmic. From circadian sleep-wake cycles to solo music performance, many behaviours are characterized by endogenous rhythms: periodicities that occur in the absence of external stimuli. What neural mechanisms support endogenous timing? Evidence from electroencephalography (EEG) suggests that exogenous (externally paced) timing is supported by cortical oscillations that respond to frequencies of external stimuli. Here we investigate whether endogenous rhythms are characterized by cortical oscillations at the frequency of one's own behavior. We address this question in the context of self-paced music performance, a naturally rhythmic behavior in which humans show a wide range of endogenous frequencies. 40 skilled pianists completed a Solo piano performance task in which they continuously performed a melody at a comfortable rate while mobile EEG was recorded. Endogenous rhythms were assessed for each pianist in terms of performance rate (measured by number of tone onsets per second) during Solo performance. Cortical oscillations for each pianist were assessed by computing EEG power spectra at each channel during Solo performance. To allow for cross-participant comparison of spectral power associated with performance rates, individual spectra were normalized relative to a fixed window surrounding each pianists' endogenous frequency, corresponding to their Solo performance rates. Findings demonstrated a significant spectral peak at the frequency of endogenous rhythms across channels, with maximal power at fronto-central channels; The observed scalp distribution could not be accounted for by head movement or other motion artefacts. Thus, we provide the first evidence that production of endogenous rhythms is supported by increased power of cortical oscillations corresponding to the frequencies of each musician's performance.

72 – Jacqueline ZIMMERMANN

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Abstract Title: Effects of Music and Externalization on Self-relevant Processing

Abstract Authors: Zimmermann, Jacqueline [1].; Perrin, Fabien [2]; Corneyllie, Alexandra [2]

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Abstract Text:

We examined the effects of short-term listening to preferred music on subsequent processing of the own-name stimulus embedded within a sequence of others' names in a group of thirteen healthy young adults (21-40 years; 5 male). We evaluated the subjects' own name effect with evoked auditory ERPs using high-density EEG recordings and with a passive paradigm that we will apply to study cognitive processing in patients with disorders of consciousness. We showed that listening to preferred music, in contrast to unfamiliar music and noise, facilitated enhanced early responses (P200) to others' names, which were localized in central-parietal regions. In the context of other preliminary research in our lab, we suggest that preferred music has a boosting effect on cognitive and/or attentional processes only for those stimuli which are not excessively salient (i.e., in the background of attention).

In addition to the effects of music listening, we examined how characteristics (i.e., distance cues) of the auditory signal can further influence own-name/other-name discrimination. Specifically, the current study was one of the first to measure neural responses to externalization of sound (i.e., manipulating the auditory signal presented through headphones such that it appears correctly located in space, with its source outside the head). Externalizing sound (music/noise) by modulating the signal's reverberation influenced pre-attentive processing of subsequent name stimuli. An increased right-lateralized negativity was observed around 120ms in fronto-central areas. A behavioural post-test also confirmed the effectiveness of externalization, showing that externalized stimuli were evaluated as appearing from a more distant source than their diotic counterparts.

The findings help us develop a more comprehensive understanding of various factors effecting own-name processing in healthy individuals, which can in the future aid in determining the extent of cognitive functioning in patients with disorders of consciousness, and also to determine those factors that can contribute to gains in cognitive abilities in this population.

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