UNIVERSITY OF HELSINKI
FACULTY OF BEHAVIOURAL SCIENCES

CICERO LEARNING

Neurodynamics of language and music
12-13 June 2014, Helsinki, Finland

Poster abstracts

Prominent interhemispheric functional symmetry in musicians during free listening

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We present a novel and straightforward approach for studying interhemispheric functional connectivity in the brain during a continuous listening. Findings on the enlarged corpus callosum in musicians with an early start in training (Schlaug et al., 1995; Lee et al., 2003), and on the enhanced somatosensory left-hand finger representation in string players (Elbert et al., 1995) motivate this study. Analyses revealed that the temporal courses of the brain responses to music were mirrored more prominently (somatomotor, visual and prefrontal cortices) in musicians, particularly in keyboard players, than in controls. Findings evidence a positive relationship between musical training and functional symmetry, which seems to be enhanced by body postural and kinematic symmetry of instrument playing. Thus results coherently build upon current knowledge on musicians' neuroanatomy.

Applying psycholinguistic principles in melody cognition: An investigation of brain potentials during identification of familiar tunes

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Application of psycholinguistic principles (cohort model, gating paradigm) in melody cognition has shed some light on the mental processes (e.g. the number of tones needed to identify a played melody) contributing to the aural identification of tunes. Daltrozzo et al. (2010) investigated neuronal activity in an ERP study at the moment where listeners first report a feeling of knowing—the familiarity emergence point (FEP). Results revealed greater amplitudes of early brain potentials at FEP gate compared with those succeeding it. Increased fronto-central negativity was found for highly familiar melodies, peaking around 400 msec.—thus pointing to conceptual melody processing. We investigated ERPs in cohorts of musicians (n = 18) and nonmusicians (n = 15) around FEP but also at the moment of definitely identifying a melody as familiar—the familiarity point (FP). Our findings are similar to those of Daltrozzo. Furthermore, musicians showed a late positive potential emerging at centro-parietal sites during FP, resembling a music closure positive shift usually associated with syntactic caesuras, e.g.

motive boundaries. Our results suggest that musical expertise differently affects EEG responses in early vs. late stages of melody identification processes. Contrary to nonmusicians, musicians appear to anticipate mental closure of syntactic musical structures.

Language-based plasticity in the auditory brainstem

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The cABR (complex auditory brainstem response) detects language-based plasticity in subcortical stages of auditory processing, revealing differences between language groups, particularly in the latency and amplitude of wave V peaks. We asked whether the known enhanced behavioural duration discrimination abilities of quantity language speakers can originate at the brainstem level. Finnish uses quantity to encode lexical meaning: the difference between *tuli*, “fire,” and *tuuli*, “wind,” is the length of segment /u/. Since German does not have this system, we compared cABR between groups using seven short complex stimuli. We found a main effect of language group on cABR response amplitude, with Finns having a larger amplitude, while the onset latency was only affected by the intensity and spectral band of the stimulus. The results suggest that the early cABR responses would be better synchronised for Finns. This could underpin the enhanced duration sensitivity of quantity language speakers.

Affective and cognitive brain responses to music relate to adolescent personality and wellbeing

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In spite of the centrality of musical emotion in adolescence, little is known about how the adolescent brain responds to musical sounds with emotional connotations. Event-related brain potentials (ERPs) were measured from 34 adolescents (age 14) and 24 adults while they listened to chord cadences with which they performed either an affective task (happy or sad?) or a cognitive task (correct or incorrect?). The final cadence chord was manipulated to be either major or minor and mistuned or in tune. Participants also answered questionnaires assessing personality traits and behavioural symptoms. We found a dissociation in affective and cognitive music processing between adolescents and adults. The processing of the affective connotations in music is more prominent in less conscientious adolescents with peer problems, whereas the cognitive music processing is advantageous in adults and in adolescents with higher conscientiousness and higher agreeableness.

An EEG Study of Musical Conversation

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Music and language are two sophisticated cognitive behaviours that employ extensive bilateral neural networks. Recent research investigating the brain engaged in active music-making, both pre-composed and improvised, has localized this network, and made comparisons to similarities and differences as they relate to the production of speech.
This study investigated the EEG data of musicians engaged in dyadic instrumental improvisation. Ten musicians (3 pianists, 5 guitarists, and 2 ukulelists) engaged in two dyadic free improvisations while data was recorded from one of the pair. Playing conditions were established by the participants, and musical features were extracted from the audio data following the experiment.
Common musical features were analyzed in the EEG data, and showed evidence of an overall music improvisation network with minor differences between instrument groups and conditions. Further analysis is ongoing and the final results will be returned for the completion of a master's thesis by early May. Results will be compared to existing research on the neural processes of language production, and the concept of "musical conversation" will be discussed, as well as therapeutic implications in the treatment of non-verbal clinical populations.
Keywords
Music, EEG, Neurodynamics, Language, Music Therapy

The Effects of Musical Valence on the Cognitive Processing of Lyrics

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The effects of music on the brain have been extensively researched, and numerous connections have been found between music and language, music and emotion, and music and cognitive processing. Despite this work, these three research areas have never before been drawn together in a single research paradigm. This is significant as their combination could lead to valuable insights into the effects of musical valence on the cognitive processing of lyrics. Based on the feelings-as-information theory, which states that negative moods lead to analytic, systematic and fine-grained processing, while positive moods encourage holistic and heuristic-based processing, the current study (n = 64) used an error detection paradigm and found that error words were detected significantly better when paired with negatively valenced music compared to positively valenced music. Non-musicians were better at detecting error words than musicians, and native English speakers outperformed non-native English speakers. Such a result explains previous findings that sad and happy lyrics have differential effects on emotion induction, and suggests this is due to sad lyrics being processed at deeper semantic levels. This study provides a framework in which to understand the interaction of lyrics and music with emotion induction - a primary reason for listening to music.

Individual Differences in Reward-Related Activity during Music and Learning

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We applied evidence linking musical enjoyment and neural reward-related activity to reward-based learning. Thirty-eight participants completed a battery of psychological tests and a reinforcement learning task while they listened to pleasurable or neutral music and were measured with functional magnetic resonance imaging (fMRI). Participants with more musical experience learned better with pleasurable music in the background and worse with neutral music, with psychological factors influencing this effect. Musical experience interacted with musical enjoyment in the auditory cortex, inferior parietal lobule, and cerebellum. Rewards preferentially activated the inferior frontal gyrus, the parahippocampal gyrus, and the ventral striatum during pleasurable music. Together, these results represent a neurobehavioral relationship between reward-related learning and music listening that varies from person to person, and a step towards exploiting music in school and other learning settings.

Acquisition of Novel Morphosyntax by Language Learners: an EEG Study

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To investigate the acquisition of novel morphosyntax, we presented second-language (L2) learners and native (L1) speakers of Finnish with balanced sets of real inflected (e.g., kuva-sta – 'from picture') and derived (e.g., kuva-sto – 'catalogue') words that were contrasted against non-existing combinations of stems and affixes (e.g., *kuva-la – 'picture place'). Acoustically similar pseudowords (e.g., *kuva-lo, *kuva-spa) were used as a control. We recorded high-resolution EEG in a passive multifeature paradigm. L1 speakers showed characteristic increases in deviant response to novel stem-affix combinations, which was reduced in L2 learners. L1 speakers also replicated recent findings (Leminen et al., 2013, Cortex) that showed stronger responses for derived words (e.g. kuva-sto) than for inflectional words (e.g. kuva-sta), demonstrating the existence of word-specific memory traces for derivations. Native speakers demonstrate that novel but meaningful derivations are processed through a syntactic-parsing route, not whole-form access. These preliminary results showed beginning L2 learners' attempt to syntactically parse inflected words into their constituents. However, even with basic knowledge of lexemes and morphosyntactic combinations, memory traces for derived words are absent. These results suggest a flexible and dynamic switching between segmentation and holistic access of novel complex words in the process of their acquisition in both native and foreign languages.

Neural dynamics of morphosyntactic and morphophonological processing during online sentence comprehension

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What are the exact neural correlates and sources related to processing of different types of morphological information? Here, spatiotemporal neural responses for processing of word- and phrase-level morphological information were assessed with a simultaneous electroencephalography (EEG) and magnetoencephalography (MEG) recording during silent reading of Finnish sentences. Processing of well-formed grammatical sentences (correct condition) was compared against processing of sentences containing a) morphosyntactic violations (adjective-noun number agreement violations), b) morphological violations (incorrect stem allomorph and inflectional suffix combination), and c) combined violations (concurrent morphosyntactic and morphological violation). Signal space and source reconstruction (sLORETA) results showed that morphosyntactic violation elicited a left anterior negativity effect, generated in the left inferior frontal cortices. Incorrect stem allomorph and suffix combinations elicited an N400-like negativity, which was localized to the right temporal cortices. Both the LAN and the N400 effects were elicited 410–430 ms post stimulus onset. Furthermore, phrase- and word-level violations elicited P600 effects, which, however had different neural source lateralization in the morphological and morphosyntactic conditions. Source modeling evidence thus suggests different hemispheric organization of neural networks involved in morphological and morphosyntactic analyses. Word- and phrase-level parsing processes are governed by near simultaneously activated but parallel and distinct fronto-temporal cortical networks.

Cortical mechanisms of rapid novel word learning and memory trace formation: neurophysiological evidence

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Recent studies suggest that only within ~15 minutes of repetition, the initially weaker ERP response for meaningless pseudo-words increase to the level of real words, likely reflecting automatic rapid formation of new memory representations for novel speech content. In the current study we investigated if the rapid learning of novel words depends on their phonology and on the level of attention paid to the input. We recorded ERPs for known words, pseudo-words with native phonology and non-native pseudo-words passive and attentive listening conditions. We found that, in the passive condition a negative-going ERP peak at ~50 ms after the divergence point was strongest for the real words and weakest for the non-native pseudo-words. Crucially, the ERP response to pseudo-words with native phonology increased during the short recording session to resemble the initial response magnitude of words, while non-native stimuli did not reach such extent and responses for words suppressed. Additionally, the dynamics of the ERP response for native pseudo-words showed a differential pattern compared to the others at ~150 ms in the attentive condition. The results suggest phonetically restricted, attention-modulated rapid learning and plastic changes in the brain reflected by activation pattern changes for novel words.

Musical expertise fractionated: Neural discrimination of musical features depends on the practiced musical style

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Acquired musical skills enrich the ability for neuronal discrimination of sound feature changes, this ability can be further fine-tuned to the requirements of the practiced style/genre. Here we aimed at determining the differences in location and strength of the neuronal responses to musical feature changes in non-musicians, amateurs and musicians playing different styles (rock/pop, jazz and classical). By means of magnetoencephalography (MEG), we measured the change-related magnetic mismatch negativity (MMNm) to 6 feature changes, all presented within a music-like sequence. MMNm generator sources were individually modeled as equivalent current dipoles and analyzed for strength and laterality effects across subject groups. The data provide evidence for expertise-related effects on the ability of the auditory cortex to discriminate sound feature changes. Also the MMNm laterality was modulated within the musicians' group depending on their practiced musical style.

Electrophysiological evidence of brain plasticity induced by passive auditory exposure in rats

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Active exposure to auditory stimuli produces changes at the behavioral and brain level in humans and rats. We tested whether it is possible to enhance auditory discrimination of different speech sound features by passive training in rats. Eighteen animals divided into two groups were passively exposed to auditory material (either syllables changes or syllable duration changes in oddball condition) for ten consecutive days, one hour per day. After the exposure, local-field potentials to the both syllable changes and syllable duration changes were recorded epidurally above their primary auditory cortex while the rats were urethane-anesthetized. We found that evoked responses for syllable changes were higher in the trained group compared to the naïve group, but no training effect was found for the syllable duration changes. The results suggest that passive exposure to changes in syllables produce plastic changes in the electrophysiological level more easily than changes in syllable duration. Consequently, in the future it is interesting to investigate whether same effects can be found in humans, for example for foreign speech sound features.

Sublexical speech and corresponding nonspeech sound processing in preschoolers

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We investigated sound processing in 6-year-old children using a multi-feature mismatch negativity (MMN) paradigm. Stimuli were semi-synthetic syllables with five changes: consonant, vowel, vowel duration, frequency and intensity. Their nonspeech counterparts were derived with an algorithm corrupting the "speechness" of the sound. For standards, P1 and N2 were larger and N4 smaller in the nonspeech than speech condition. Discriminating negativities were obtained from three time windows. Peaks surrounding the MMN were labeled early and late discriminant negativity (EDN/LDN). Consonant, vowel and vowel duration EDNs, and consonant MMNs and LDNs were larger for speech than nonspeech sounds. The vowel MMN had a more leftward distribution than its nonspeech counterpart. Syllable frequency and to some extent also intensity MMNs had more leftward topographies than their nonspeech counterparts. The LDN for intensity was enhanced in the parietal left for the speech and in the frontal right for the nonspeech sounds compared to the other condition. In summary, preschoolers' ERP patterns to standard sounds reflect processing of sound "speechness." Cortical discrimination patterns depend on the speechness of the sound, the sound feature, and the time from sound onset. Speech and nonspeech sounds are thus processed by at least partially different neural substrates in 6-year-olds.

Emotion processing in congenital amusia: Deficits for music, but not for faces

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Cases of acquired amusia have revealed that music perception and emotion can be altered selectively. As for congenital amusia, numerous research has shown impaired music perception, while two studies suggested intact recognition of musical emotions (Gosselin et al.; Paquette et al. at *Neuroscience & Music* 2011). Here, we asked 13 amusic and 13 control participants to indicate the emotion evoked by real musical recordings or by faces (joy, sadness, fear, serenity/neutral) and to rate the intensity of this emotion on a subjective scale. For faces, the two groups showed similar response patterns for both categorization and intensity ratings. For music, amusics and controls rated emotion intensity similarly, but the amusics were significantly impaired in emotion categorization. These results suggest that abnormal pitch and timbre processing in congenital amusia, linked to fronto-temporal cortical anomalies, has an impact on emotion recognition, but does not decrease emotion intensity.

Detecting mistuning in musical context: an ERP and behavioral study in musicians

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Previous studies have proposed different limits for perception of mistuning, and it seems that the context of listening is crucial. Hutchins et al. (2012) suggested that mistuning might be detected worse in singing than in

instrument playing since we hear a lot more out-of-tune singing than playing. By EEG recordings and behavioral listening test, we investigated whether the accuracy of detecting mistuning in singing and saxophone playing differs in professional singers vs. non-musicians. Results showed that the detection of mistuning was more accurate in singers, without differences between voice and saxophone timbres (which are acoustically relatively similar). Thus, detection of mistuning seems to be context dependent so that the acoustical structure of the sounds is sensitively reflected in the readiness to detect mistunings.

Location of violation in the word structure is associated with distinct patterns of gaze trajectories and occipital source activation: Combined EEG and eye-tracking study.

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We previously found that the location of the violations in word structure attracts fixational eye movements. These anomalies in the beginning of the word attract movements earlier than anomalies in the end during lexical decision task, possibly indicating serial processing of letters during word recognition. In order to investigate neural basis of this, we combined EEG and eye-tracking in 16 typical adults. Again gaze trajectories at 250-275ms were oriented towards the anomalies in the beginning of the words, whereas at 300-325ms they were oriented towards the violations at the stimulus end. The early (0-300ms) occipital source activation for the anomalies in the beginning of the words showed clearly distinct pattern from the activation exhibited by normal words. Source at approximate location of the left fusiform gyrus displayed long lasting (100ms) attenuation of activity around 200ms, whereas the source at right fusiform gyrus region displayed enhanced activity during same time window. In comparison, the stimuli with anomalies in the end showed enhanced activity in the left fusiform source around 200ms lasting 50ms with early attennuation (50-100ms) in the response at right fusiform source. The location of violations in the word structure generates clearly distinct bilateral activation patterns in the fusiform gyri.

Tracking cortical language processing streams with navigated TMS

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Interhemispheric specialization and interaction have been investigated by measuring reaction times (RTs) in lexical decision tasks (LDTs). Several studies have shown a right-visual-field advantage (RVFA) in RTs and/or accuracy for right-handed subjects. In the *callosal relay* model, the RVFA is explained by the time needed for the signal to propagate to the language-dominant left hemisphere (LH) for processing. In the *direct access* model, the RVFA occurs because the left-visual-field information is processed slower in the nondominant RH. To the

authors' knowledge, neither of the models has yet been proven to outweigh the other. In this study, navigated transcranial magnetic stimulation (TMS) was applied during a hemifield LDT in both right-hand- and left-hand-response conditions; RTs and error rates were measured. We hypothesized that TMS to a languagerelated LH site yields different RTs compared to the no-TMS condition, whereas TMS on the homologous RH site should not affect performance. Frequent fourletter Finnish words and non-words were presented in one hemifield at a time. The preliminary results suggest that, first, there are RT differences between different hemifield and hand conditions, and second, TMS on Broca's area is
able to affect the subject's performance. More subjects will be measured to further evaluate the models.

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From the onset of hearing, at approximately 27 weeks gestation, the fetal brain starts to learn from the sounds it is exposed to in utero. The effects of fetal learning are seen after birth as newborns can recognize familiar environmental sounds, their mother's native language, and melodies they have been exposed to in the uterus. Fetal learning has been suggested to have an important role in development, facilitating language learning and providing a basis for attachment. Here we present results for two studies indicating that fetuses can learn speech and music already in utero and these learning effects can be seen in the brain's event related potentials right after birth.

Imagery in Piano Pedagogy. Visualisation of musical language in children's piano cycle Musical Toys, Gubaidulina

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Although much literature has been written on various aspects of the pedagogical art of piano technique, very little research has focused on a holistic approach to teaching which takes into account the child's physical condition of, and response to, childlike imagery in order to simplify the complex musical and technical challenges of piano playing. Recent scientific research has demonstrated that infants are born with multisensory perception (Infants synesthesia), but their growing brains later in life (adults) separate those senses into visual, auditory and tactile, etc. functions. It could be beneficial in Music and the Arts to cultivate the development of synesthetic perception. Ramachandran and Hubbard sum up this as follows: 'It could lead to both synaesthesia and to a propensity toward linking seemingly unrelated concepts and ideas – in short, creativity'. This paper will aim to demonstrate the possibility of alternative teaching method based on child's ability to cross-modal perception and developing synesthetic inner-screen used by natural synesthetes for memory store. Luria described it as 'turning sounds into vivid imagery'.'
Demonstration of method is based on graphics and imagery of Sofia Gubaidulina's piano miniatures cycle Musical Toys.

Rhytmical exercises as tools for rehabilitation following cerebellar stroke
Abstract of Case Study, Master's Theses of Music Therapy, Department of Music, University of Jyväskylä

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Recent research has indicated a close link between musical, auditory, cognitive, and motor processes in the brain. External auditory cues have been reported to demonstrate to facilitate movements and vocal output. There is an evident shortage of research on cases where auditory, tactile, and visual stimuli are combined simultaneously as sensory activation for rehabilitation of movements. Impairments caused by stroke in the cerebellum are rather different than in strokes in one hemisphere of the brain. Timing, coordination, the strength of movements, and problems with balance are the most common impairments in patients with stroke in cerebellum.

Physiotherapist's representation of a cross discipline rehabilitation process where the cerebellar stroke patient's movements and vocal output were facilitated auditory with external, rhythmical speech together with patients own. Tactile, visual and motor stimuli were simultaneously used as further sensory activation for fluent movements.
Rhymes and rhythmical speech may help the patient in drumming with the hands, or while moving with music by helping the timing of movements. Ten rehabilitation sessions with rhythmic exercises showed that the patient benefited from simultaneous combination of movement, speech, and rhythm. Authentic video excerpts illustrate the unique process.

Genetic and environmental contributions to individual differences in the musical pitch and rhythm perception abilities

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We investigated the relative contribution of genetic and environmental effects on musical pitch and rhythm perception abilities in 384 twins from a population-based FinnTwin16 study. Participants (71.6 % females, 53.6 % monozygotic, age range 32–38 years) performed an online version of Montreal Battery of Evaluation of Amusia (MBEA) music perception test, which involved different musical features and task constraints. In scale subtest participants compared two consecutive melodies for any pitch differences in piano timbre. Out-of-key subtest required ability to detect pitch incongruences (violation of musical key) in single melodies with varying instrumental timbres. In off-beat subtest participants were asked to detect rhythmic incongruences in single melodies with varying instrumental timbres. Additive genetic effects accounted for about half of the variance in the scale subtest. In contrast, additive genetic effects did not play a role in out-of-key subtest; instead common environmental effects explained over half of the variance in this subtest. Off-beat subtest was explained mostly by unique environmental effects. Our results suggest that different components of MBEA show different architecture of genetic and environmental effects.

Allocation of attentional resources during cognitively demanding tasks are altered in job burnout

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Job burnout is a significant cause of work absenteeism, concerning over 25 % of working people. Behavioral studies and patient reports suggest it is associated with impairments of attention and decreased working capacity. However, studies on cognition and burnout are scarce, and those concerning electrophysiological mechanisms are almost absent. Here, we studied involuntary engagement of attention to novel work-distracting sounds during performing a series of visual n-back tasks (0-back, 1-back, 2-back) with event-related potentials (ERP) in burnout. Participants (N=67) were currently working people from two groups: burnout (N=41), and non-burnout controls (N=26). The groups were matched on age, gender, education, and working experience. Along the visual n-back tasks, participants were presented with 96 distractor sounds, 32 in each condition, once every 10-16 seconds. Results showed that the sounds elicited a positive P3 response with two peaks. Groups differed in respect to the P3 amplitudes, the burnout group showing smaller responses in all conditions than the controls. Interestingly, as the task became more difficult, the amplitudes of the latter P3 response decreased in both groups. The results suggest that in burnout, attentional resources are more intensively allocated to the ongoing, cognitively demanding task, resulting in decreased attention allocation to the distracting auditory stimuli.

A sustainable musical working memory task for patient populations

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Working memory (WM) for musical chords has been investigated in few neuroimaging studies using the n-back task in healthy participants. The paradigms previously implemented were however quite long and not well suited for application to pathological populations, although in some conditions such as schizophrenia, auditory WM disruption is a diagnostic aspect of the disease. In that context, even interactions between WM and emotions are relevant for possible therapeutic interventions. Our aim was to adapt an auditory WM n-back task exploring the effects of cognitive load and emotionally loaded chords, for future applications to a clinical setting. 38 healthy adults and 8 psychiatric patients completed two n-back tasks, including major, minor and dissonant chords. We found effects of cognitive load and chord type on reaction time and accuracy, with worse performance with the cognitive load increase in the patient group. The results suggest the use of this paradigm in a clinical setting.

Inter-Subject Correlation of Brain Activity during Music Listening

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Music has been able to create powerful and intercultural connections between human beings since the early stages of human society. In neurocognitive studies, basic musical features such as pitch, rhythm and timbre have been found to activate distinct brain areas. However, in the majority of these studies, only artificial stimuli have been used. This magnetoencephalographic (MEG) study investigates brain responses to real pieces of music in 45 musically trained and untrained listeners. The participants listened to three whole musical pieces of different genres. The listener's familiarity with the pieces was assessed by questionnaires and ratings. To investigate how similarly listeners' brains process the music, we are computing inter-subject correlations (ISC) of the dynamics of specific MEG frequency bands. The results will likely provide insight to the processing of such real-world stimuli as music and may thus shed light on the neural basis of the cultural and societal importance of music.
Keywords: Music, Continuous Stimuli, MEG, Intersubject Correlation

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Neural correlates of perceived musical emotion during continuous listening

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We investigated neural correlates of perceived emotion during continuous listening to music by measuring 36 participants with functional magnetic resonance imaging (fMRI) while they were listening to musical pieces (lasting 25 minutes). Subsequently, they continuously rated the activity and valence of the same musical stimuli. Both encoding and decoding approaches were used to investigate the neural correlates of the emotional dimensions of arousal and valence. The encoding analyses revealed that perceived arousal was positively associated with activity in superior temporal gyri and negatively associated with activity in orbitofrontal and limbic areas. Valence correlated positively with activity in the superior temporal gyri and primary motor cortex, and negatively with that in the orbitofrontal areas and precuneus. Subsequent decoding analyses revealed that perceived arousal could be predicted significantly better than valence, the right superior temporal gyrus being the core area for the prediction of arousal.

Singing – a tool for rehabilitation of children with cochlear implants?

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The degraded input from a cochlear implant (CI) can lead to difficulties in the perception of timbre, pitch, and speech prosody, and in auditory working memory and attention. We have investigated the connections of singing to these perceptual and cognitive abilities in children with CIs. In the first study, children with CIs who participated in musical activities (with an emphasis on singing) performed similarly to normal-hearing children in prosody perception and auditory working memory while other children with CIs performed significantly more poorly. In the second study, children with CIs who sang regularly at home had consistently larger and earlier P3a responses than those children with CIs who did not sing. This suggests that music-based rehabilitation may promote the development of attention shift and of discrimination, especially for timbre and pitch (F0).

Basic auditory processing skills do not relate to literacy at the end of primary school

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In the longitudinal Dutch Dyslexia Programme, children with a familial risk of dyslexia (FR) and a control group have been followed their entire pre- and primary school period. Over time the FR group has been divided into two groups; a group of familial risk non-dyslexic (FRnondys), and a group of familial risk dyslexic (FRdys) children, allowing us to discern factors that relate to reading and not merely relate to being at risk for dyslexia. The current study investigated whether basic auditory processing is related to dyslexia. We specifically investigated amplitude rise-time (Art) processing, as diminished Art processing has been connected to reading fluency. Participants' sensitivity to amplitude rise time changes, but also to intensity and frequency changes were measured with the MMN. Our results indicate that controls, FRdys and FRnondys children do have an MMN to changes in Art and frequency processing. On intensity, only controls showed an MMN . Contrary to previous findings our results suggest that neither art nor frequency processing is related to reading fluency. Furthermore, our results imply that diminished sensitivity to changes in intensity should be regarded as risk factors for dyslexia that do not directly relate to reading fluency.

Musicianship facilitates the processing of Western music chords – an ERP and behavioral study

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The present study addressed the effects of musicianship on neural and behavioural discrimination of Western music chords. In abstract oddball paradigms, minor chords and inverted major chords were presented in the context of major chords to musician and non-musician participants in a passive listening task (with EEG recordings) and in an active discrimination task. Both sinusoidal sounds and harmonically rich piano sounds

were used. Musicians outperformed non-musicians in the discrimination task. MMN was evoked to minor and inverted major chords in musicians only, and N1 amplitude was larger in musicians than non-musicians. While MMN was absent in non-musicians, both groups showed decreased N1 in response to minor compared to major chords. The results indicate that processing of complex musical stimuli is enhanced in musicians both behaviorally and neurally, but that major-minor chord categorization is present to some extent also in absence of music training.

Brain responses to foreign-language words are diminished in dyslexic children

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Dyslexia is manifested as a reading impairment, which is thought to result from compromised processing of phonological units. The impariment is not restricted to reading, however: dyslexic readers often have difficulties also in foreign-language learning. In this case, the processing of foreign speech sounds may form a "bottleneck" of learning for these children, which may result in incomplete or inaccurate neural representations for foreign-language words. In the present study, we recorded event-related brain responses to foreign- and native-language words and pseudowords in 9-11-year-old dyslexic children and typically-reading control children. The groups were matched with respect to age and length of foreign-language studies in school. The results show that although no difference between the groups was found in native-language processing (suu-sii*), dyslexic children's brain responses were markedly weaker for a foreign-language word contrast (shoe-she) compared to controls. This suggests that in dyslexia, the processing of speech sounds or words is more compromised in a foreign language than in the native language, possibly resulting in inefficient word encoding and inaccurate phonological or word representations for foreign language. To overcome these difficulties, targeted intervention improving the processing of foreign speech sounds should be developed for individuals with dyslexia.

Two distinct auditory-motor circuits for monitoring speech production as revealed by content-specific suppression of auditory cortex

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Speech production, both overt and covert, down-regulates the activation of auditory cortex. This is thought to be due to forward prediction of the sensory consequences of speech, providing a feedback control mechanism for speech production. Critically, however, these regulatory effects should be specific to speech content to enable accurate monitoring of speech. To determine the extent to which such forward prediction is content-specific, we recorded the brain's neuromagnetic responses to heard multi-syllabic pseudowords during covert rehearsal in working memory, contrasted with a control task. The cortical auditory processing of target syllables was significantly suppressed during rehearsal compared to control, but only when the stimuli matched the rehearsed items. This critical specificity to speech content enables accurate speech monitoring by forward prediction, as proposed by current models of speech production. The one-to-one phonological motor-to-auditory mappings also appear to serve rehearsal in phonological working memory. Further findings of right-hemisphere suppression in the case of whole-item matches and left-hemisphere enhancement for last-syllable mismatches suggests that speech production is monitored by two auditory-motor circuits operating on different timescales: finer-grain in the left *vs.* coarser-grain in the right hemisphere. Together, our findings provide hemisphere-specific evidence of the interface between inner and heard speech.

Predictive coding mediates word recognition and learning in 12- and 24-month-old children

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In adults, word recognition has been proposed to be guided by predictive coding, whereby upcoming speech sounds in words are predicted on the basis of long-term memory word representations. In language learners who are constantly confronted with novel words, rapid activation of these word representations requires an efficient neural mechanism for distinguishing between familiar and unfamiliar word forms. For children, the second year of life is a period of rapid word learning. However, the neural mechanism and the exact timescale for recognizing familiar word forms and detecting unfamiliar word forms during this period are unknown. Our results show that 12- and 24-month olds' electrophysiological brain responses to syllables are faster and more robust when the preceding word context predicts the word ending, and that these brain responses differ in both latency and polarity for familiar and unfamiliar word forms. For unfamiliar word forms, predictive coding results in a word-expectancy violation and generates a prediction error response, the strength of which significantly correlates with children's vocabulary scores at 12 months. Based on these results, we argue that predictive coding serves as the neural mechanism not only for word recognition, but also for the early learning of novel word forms.