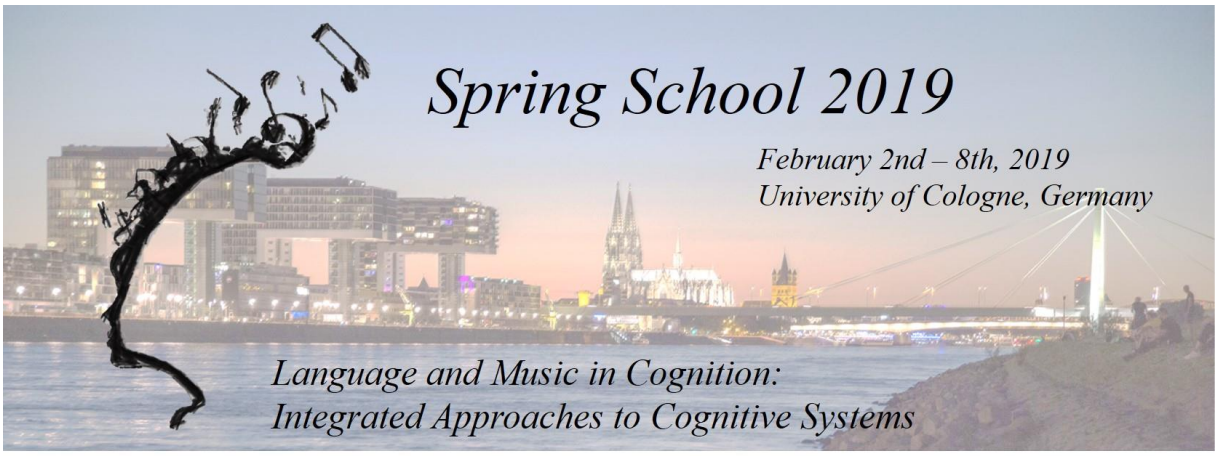


# Students' Poster Abstract Booklet

Spring School 2019 – Language and Music in Cognition: Integrated Approaches to Cognitive Systems

Poster Session

February 5th, 2019

University of Cologne, Cologne, Germany

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Gianna Urbanczik & Nadine Dietrich

# New Materialism on Social Cognition

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Low-level descriptions of individual or group interactions are performed in current cognitive neuroscience through state of the art techniques and methodologies. These observations can be defined as being close to the material niveau of the structure and functioning of our organism as a body. Goals, emotions, actions and thoughts that motivate human behavior transcend the reach of this lense, nonetheless (i.e. psycholinguistics used to be quite English based and postulated general principles of which later turned to be proven that they were not replicable with other languages); thus, the general claims made about these –cultural– constructs as a whole, should be more qualified. Theory of embodiment has informed for the last decades about the relevance of both sensorimotor information and the experiential context of their perception, so as to model cognition, but has failed regarding the study on the conveyance of socially shared meaning and individual/group identity. This paper will pursue the conveyance of a New Materialism based on a crossbreed between neuroscience and anthropology –which has long made the effort to posit the exploration of Otherness into the scope of the cognitive sciences–, so as to guide the spotlight of the research agenda on social cognition and interaction to occur at a level that comprises both cultural constructs and constraints that can be measured with current neurophysiological analysis. The purpose of this guidance is to act as a bridge between the referred gap, that is, the results of investigations of elementary biological mechanisms of human bodies and the discoveries of experimental psychologists. Whereas so called neuroanthropology places the brain at the center of discussions about human nature, following that the nervous system is our most cultural organ, New Materialism focuses on the deconstruction of the dynamic interaction between the sociocultural milieu and its contingent sensory environment at the material level, in order to comprehend the relation between the formation of self and group identity in terms of brain percepts.

**Embodied spaces in music-making**

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Space has not been a primary topic in music research. We investigate empirically how music-making changes our experience of space pertaining to the body. As space emerges from both perception and bodily action, it is worth noting that music is performed in two ways. We use our vocal apparatus in singing and our limbs in instrument-playing, which may lead to different spatial experience. Embodied spaces in music-making can studied considering different features: body-part centered specificity, multisensory integration, sensorimotor coupling, and plasticity (i.e. extended space due to tool use). In this study, we focus on first two features and test differences between non-musicians, singers and instrumentalists with an audio-tactile integration experiment. Brief sound and touch pulse in a pair are presented near and on hands respectively. Onsets of sound and touch are different and participants' arms are in either crossed or uncrossed position. The task is to judge whether either sound or touch is presented first. Reaction times show main effects of participant group (vocalists fastest, non-musicians slowest) and gender (f<m). A significant interaction between these factors was found that for instrumentalists the gender difference is reduced and reversed than in the other two groups. There is also an interaction between group and arm position, only with instrumentalists showing a significant difference for the crossed and uncrossed position. Accuracy is significantly higher for instrumentalists (73.77%) than for vocalists (65.72%) and non-musicians (65.74%). Instrumentalists show a reduced fusion threshold compared to the other groups. An interaction effect of group and gender shows gender differences for accuracy in the two musician groups are larger than for non-musicians. The two preliminary analyses indicate musical training changes spatial processing (e.g. faster reaction in musician groups) and different musical training affect our experience of space in distinctive ways (e.g. changed fusion threshold; sensitivity to arm position).

Schäfer, T., Fachner, J., & Smukalla, M. (2013). Changes in the representation of space and time while listening to music. *Frontiers in Psychology*, 4. doi: 10.3389/fpsyg.2013.00508

Zampini, M., Brown, T., Shore, D. I., Maravita, A., Röder, B., & Spence, C. (2005). Audiotactile temporal order judgments. *Acta Psychologica*, 118, 277–291. doi: 10.1016/j.actpsy.2004.10.017

de Vignemont, F., & Iannetti, G. D. (2015). How many peripersonal spaces?. *Neuropsychologia*, 70, 1, 327-334. doi: 10.1016/j.neuropsychologia.2014.11.018

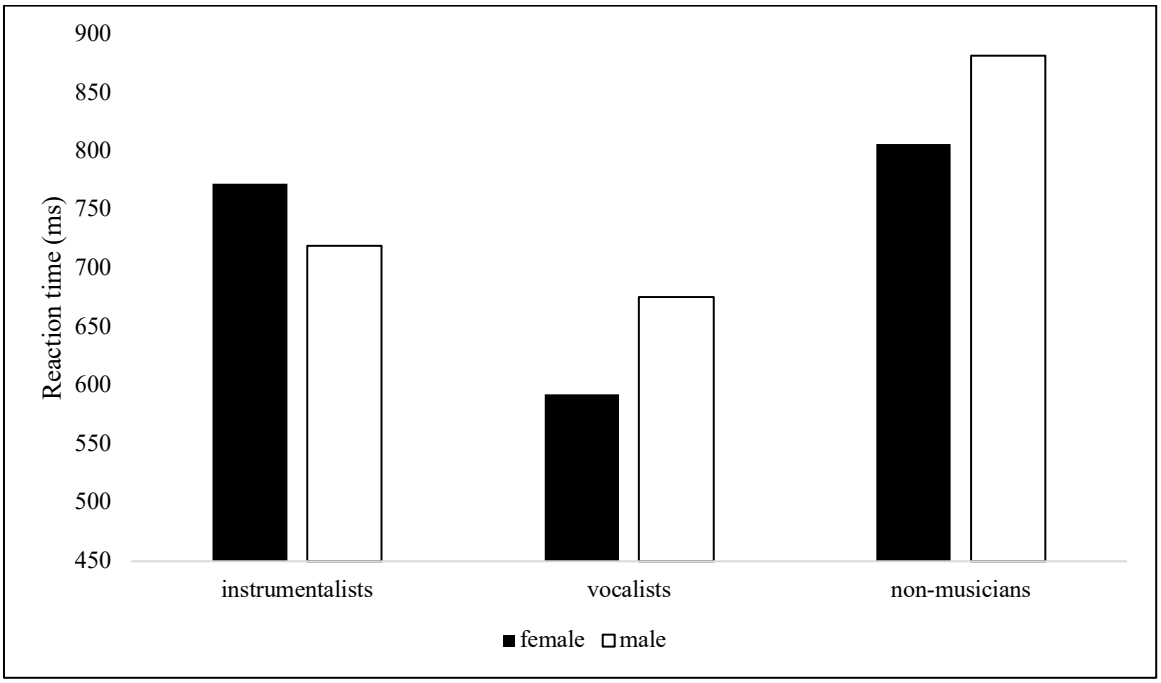


*Figure 1.* Mean reaction time (in ms) for female and male under 3 participant groups instrumentalists, of vocalists, and control non-musicians

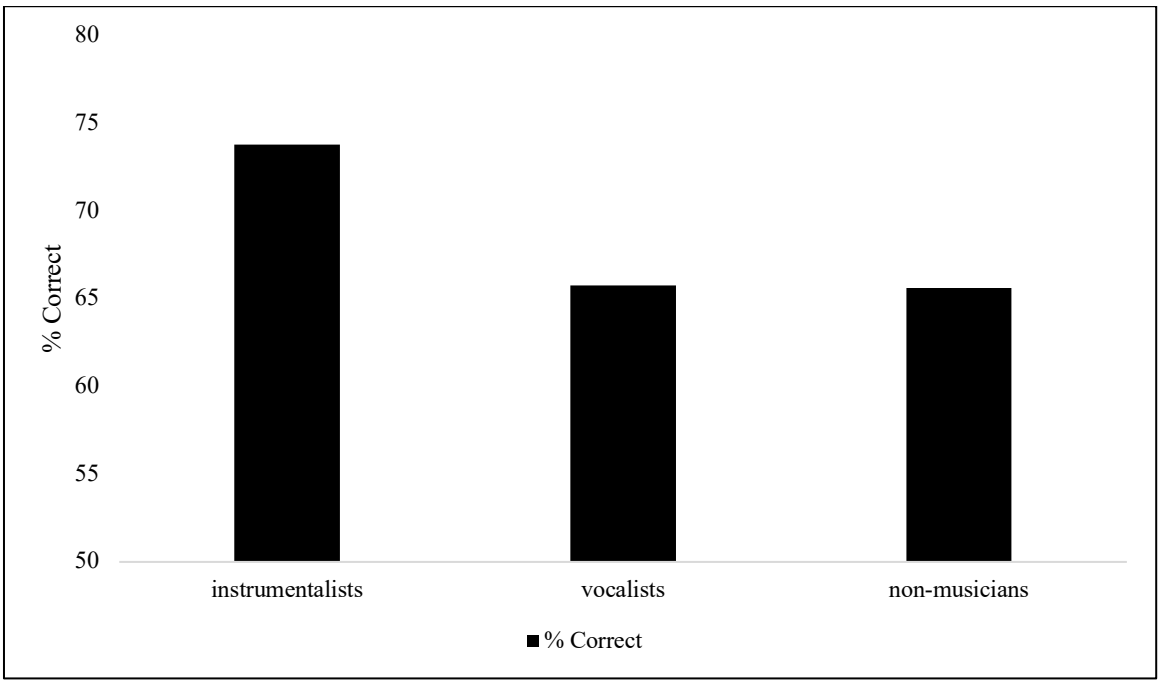


*Figure 2.* Accuracy for 3 participant groups of vocalists, instrumentalists and control non-musicians

# The relationships between early literacy, phonological processing and musical skills in kindergarteners: a comparison of pre-readers at risk and not at risk for dyslexia

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A growing body of studies reports evidence for a link between musical skills and linguistic processes involved in reading, such as phonological processing. This is especially relevant for children struggling with language-based deficits such as developmental dyslexia as it could help to find new ways to enhance reading development. However, whether there is a causal relationship between music and language and in particular reading skills, remains an open question. In the present study, we investigated longitudinally the relationships between early literacy (letters and graphemes knowledge), phonological processing (verbal working memory, rapid automatized naming, phonological awareness) and musical skills (melody and rhythm perception, incidental memory), in a large group of kindergarteners including 20 pre-readers at familial risk for dyslexia and 70 typically developing children. Preliminary results at T1 (last year of kindergarten) revealed no significant between-group difference for any variable of interest. However, there were positive correlations across groups between literacy, phonological skills and musical performances, after partialling out for non-verbal intelligence, attentional level, socio-economical status and music education. The follow-up of these children during reading acquisition (T2: Grade 1 and T3: Grade 2) will allow us to investigate the nature of these links, in particular to determine if linguistic and musical abilities are linked by a causal relationship.

# he Role of Flow in Processing Syntax when Imitating Musical Actions: an ERP Study

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Some evidence suggests that mechanisms of detecting syntactic irregularities in music and language have similar neural features, namely an early anterior negativity. Recently, it has been found that these syntactic mechanisms can also be applied to music actions: the (silent) motoric imitation of chord sequences in pianists with music-syntactic irregularities evokes an early anterior negativity (Sammler et al., 2013), specified as early right anterior negativity (ERAN) and/or observer error-related negativity (observer-ERN). Although this suggests an embodied knowledge of musical syntax, the role of continuity may be vital when detecting syntax errors in musical actions since the ERN/ERAN response occurred when imitating harmonic progressions in a smooth (from videos, Sammler et al., 2013), but not in a discrete fashion (from pictures, Bianco et al., 2016). To explore the role of syntactical flow further, classically trained expert pianists ($n$ = 15) were asked to imitate chord sequences played by a model hand on screen, presented as continuous motion (videos) or discrete acts (series of pictures). Sequences concluded with a Neapolitan chord (syntax error) or a Tonic chord (control) at equal probability. The amplitudes of ERN/ERAN and late reprogramming negativity, as well as speed and accuracy of imitating chords, will be compared between videos and pictures. We predict that syntax errors (compared to control) evoke a larger ERN/ERAN and late reprogramming negativity in the video compared to the picture condition, due to videos evoking greater sense of continuity between chords in pianists, thus increasing detection of syntax errors. Analysis is ongoing and results will be presented at the Spring School. Results could further our understanding of syntactical processing by suggesting that identification of syntactical errors in musical actions depends not only on the *content* itself, but on the temporal continuity of elements and how strongly elements are perceived to be connected together.

Sammler, D., Novembre, G., Koelsch, S., & Keller, P. E. (2013). Syntax in a pianist's hand: ERP signatures of embodied syntax processing in music. *Cortex*, *49*(5), 1325–1339. http://doi.org/10.1016/j.cortex.2012.06.007

Bianco, R., Novembre, G., Keller, P. E., Scharf, F., Friederici, A. D., Villringer, A., & Sammler, D. (2016). Syntax in action has priority over movement selection in piano playing: an ERP study. *Journal of Cognitive Neuroscience*, *28*(1), 41–54. http://doi.org/10.1162/jocn

# Interactive vocal rhythms in harbour and grey seal pup vocalizations

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Both language and music have an important part of their use in interactive social settings, and studying animal interactive vocal behaviours can provide interesting insights into underlying components of these complex cognitive systems. Pinnipeds (true seals, sea lions, fur seals, and walruses) are one particularly promising clade for comparative investigations in the vocal domain (Ravignani et al., 2016), showing remarkable vocal flexibility (Ralls et al., 1985; Reichmuth & Casey, 2014) as well as rhythmic capacities (Cook et al., 2013; Mathevon et al., 2017), while being phylogenetically closer related to humans than birds.

I will compare results from a playback experiment with a harbour seal pup (Ravignani, 2018) to audio recordings of grey seal pups housed in groups. Grey and harbour seals are both very vocal during puppyhood, during which they live in large mother-pup groups and pup vocalizations serve for recognition by the mother (McCulloch & Boness, 2000; Sauvé et al., 2015). Call timing mechanisms across species are often shaped by socio-ecology and include (amongst others) synchronizing, overlapping, and antisynchronizing behaviours (Ravignani, Bowling, & Fitch, 2014). For seal pups, it could be beneficial to time their calls antisynchronously to those of nearby conspecifics, avoiding acoustic masking to maintain conspicuousness.

Results from the playback experiment were accompanied by computational modelling to show that the harbour seal pup indeed timed her calls to occur at a fraction of the playback phase, avoiding overlap with the simulated conspecific. If grey seal pups follow the same antisynchronous strategy in spontaneous group settings, we would expect choruses of alternating calls, with pups taking turns to minimize overlapping vocalizations. I will discuss the design and preliminary results of our multitrack recordings exploring this hypothesis, emphasizing the relevance of spontaneous animal signal timing for studies into the rhythmic cognition behind linguistic and musical behaviours.

Cook, P., Rouse, A., Wilson, M., & Reichmuth, C. (2013). A California sea lion (*Zalophus californianus*) can keep the beat: Motor entrainment to rhythmic auditory stimuli in a non vocal mimic. *Journal of Comparative Psychology, 127*(4), 412–427. https://doi.org/10.1037/a0032345

Mathevon, N., Casey, C., Reichmuth, C., & Charrier, I. (2017). Northern Elephant Seals Memorize the Rhythm and Timbre of Their Rivals' Voices. *Current Biology, 27*(15), 2352-2356.e2. https://doi.org/10.1016/j.cub.2017.06.035

McCulloch, S., & Boness, D. J. (2000). Mother-pup vocal recognition in the grey seal (*Halichoerus grypus*) of Sable Island, Nova Scotia, Canada. *Journal of Zoology, 251*(4), 449–455.

Ralls, K., Fiorelli, P., & Gish, S. (1985). Vocalizations and vocal mimicry in captive harbor seals, *Phoca vitulina*. *Canadian Journal of Zoology, 63*(5), 1050–1056. https://doi.org/10.1139/z85-157

Ravignani, A. (2018). Timing of Antisynchronous Calling: A Case Study in a Harbor Seal Pup (*Phoca vitulina*). *Journal of Comparative Psychology. http://dx.doi.org/10.1037/com0000160*

Ravignani, A., Bowling, D. L., & Fitch, W. T. (2014). Chorusing, synchrony, and the evolutionary functions of rhythm. *Frontiers in Psychology, 5*. https://doi.org/10.3389/fpsyg.2014.01118

Ravignani, A., Fitch, W., Hanke, F. D., Heinrich, T., Hurgitsch, B., Kotz, S. A., Scharff, C., Stoeger, A.S. & de Boer, B. (2016). What pinnipeds have to say about human speech, music, and the evolution of rhythm. *Frontiers in Neuroscience, 10*, 274. https://doi.org/10.3389/fnins.2016.00274

Reichmuth, C., & Casey, C. (2014). Vocal learning in seals, sea lions, and walruses. *Current Opinion in Neurobiology, 28*, 66–71. https://doi.org/10.1016/j.conb.2014.06.011

Sauvé, C. C., Beauplet, G., Hammill, M. O., & Charrier, I. (2015). Mother-pup vocal recognition in harbour seals: influence of maternal behaviour, pup voice and habitat sound properties. *Animal Behaviour, 105*, 109–120. https://doi.org/10.1016/j.anbehav.2015.04.011

# Babbling bat pups and human infants: common features in the babbling behaviour of vocal learners

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Human language acquisition is characterized by several key features (e.g. vocal imitation, subsequent developmental speech stages) which are universal. Infant speech development is composed of different stages, each determined by different characteristics, "canonical babbling" being probably the most prominent. Canonical babbling is a milestone mandatory for spoken language acquisition in humans; therefore, a comparative approach investigating non-human animals with a complex vocal repertoire regarding vocal ontogeny and possible babbling behaviour would be revealing. A promising species to investigate vocal ontogeny is the highly social bat species, *Saccopteryx bilineata.* This species is capable of vocal production learning (at least one adult song type is acquired through vocal learning) and owns a complex vocal repertoire. The vocal repertoire is acquired by a conspicuous vocal practice in form of babbling bouts, reminiscent of the "canonical babbling" in human infants. With our study, we want to elucidate whether infant canonical babbling and pup babbling behaviour share common features. During two consecutive field seasons, we recorded and analyzed babbling behaviour during pup ontogeny (range 10-12 weeks) in two different *S. bilineata* populations (Costa Rica & Panama, N=20 pups). Our results demonstrated that the main features found in human canonical babbling are likewise present in babbling behaviour of bat pups; (i) babbling started at an early age in ontogeny, it was composed of (ii) well-formed adult like vocalizations and (iii) non-adult sound variants leading to vocal overproduction. During babbling pups only acquired a subset of the adult repertoire (iv), babbling was dominated of reduplication of syllables (v) and was universally (vi) observable in both, female respectively male pups. Our study aims to increase the knowledge of vocal ontogenetic processes and especially the possible function of babbling behaviour.

**The role of Production Experience in Musical Predicition**

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We aimed to investigate the prediction-by-simulation account of turn-taking by exploring whether piano production experience aids turn-end prediction accuracy during piano music listening. Analyses suggests that piano players are more accurate at predicting turn ends (the gap between the turn-end and the participant's button press) than piano music enthusiasts (those who regularly listen to piano music but who do not play it). This suggests that production experience (i.e., piano playing motor experience) may aid piano music prediction accuracy more so than mere exposure to piano music, supporting the prediction-by-simulation account of turn-taking. We additionally examine whether this potential enhanced prediction accuracy is instrument specific by comparing accuracy of pianists with accuracy of non-pianist instrumentalists. As pianists appear to be more accurate than the other instrumentalists, prediction-by-simulation appears to be instrument specific, as opposed to abstracted across instruments.

**Different Levels of Perception of Prosodic Categories in Music and Language**

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The goal of this project is to verify whether the perception of sound as music, as opposed to language, depends on the distinction between degrees of perceived intentions – specifically, to produce sound or to communicate. The ability to understand others' intentions relies on two neural systems (Vogeley, 2017): the 'mentalizing system' (MENT) and the Mirror Neurons System (MNS). As neither awareness of the context nor complex forms of meaning are required, I hypothesize that we can distinguish between music and language through MNS, before MENT is involved. I shall compare the perception of musical prosody and linguistic prosodic categories. Recent studies revealed the role played by the perception of prosody in understanding communicative intentions in utterances (Hellbernd & Sammler, 2016). This role is attributed mainly to MENT areas, with relative rightward asymmetry (Sammler, Grosbras, Anwander, Bestelmeyer & Belin, 2015). Assuming that prosodic categories are related to specific forms of communicative intentions, whereas the distinction between music and language might pertain to a general level, I mean to verify whether the latter distinction is related to MNS or MENT. The comparison of prosodic types would involve the employment of fMRI on controls. Controls will be asked to distinguish between music and language, while perceiving de-semanticized auditory signals designed to emulate specific prosodic categories. The fMRI should reveal regions involved in the identification of the nature of the signal. It would also be possible to verify the extent to which prosodic categories can be modified before losing their specificity: the gradual modification of acoustic features should result in an enhanced perceived focus on sound – thus, perception of music. If similar modifications across different prosodic categories homogeneously lead to perceiving music, we can assume that musical prosody is not related to specific linguistic categories; therefore, the distinction would pertain to a different level.

Hellbernd, N., & Sammler, D. (2016). Prosody conveys speaker's intentions: Acoustic cues for speech act perception. *Journal of Memory and Language, 88*, 70-86.

Sammler, D., Grosbras, M., Anwander, A., Bestelmeyer, P., & Belin, P. (2015). Dorsal and Ventral Pathways for Prosody. *Current Biology, 25*(23), 3079-3085.

Vogeley, K. (2017). Two Social Brains: Neural Mechanisms of Intersubjectivity. *Philosophical Transactions of the Royal Society B,* 372.

**Does neural synchrony predict coordinated entry during ensemble piano performance?**

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People often use sensorimotor cues such as rhythmic movement or counting to coordinate the onset of joint actions, for example the timing of a joint entry in music performance. Here we propose that these sensorimotor signals may be purposefully shared by interacting individuals in order to align their neural oscillations, which in turn would facilitate the synchronous beginning of their collective behaviour. Previous research has shown that rhythmic sensorimotor input entrains brain oscillations (e.g. Doelling & Poeppel, 2015) similarly in both interaction partners sharing this input. As a result, brains of people who coordinate their behaviours – synchronize (Lindenberger, Li, Gruber, & Müller, 2009; Dumas, Nadel, Soussignan, Martinerie, & Garnero, 2010). These findings prove co-occurrence of neural and behavioural synchrony, but do not yet allow inferring whether the former facilitates the latter. A recent study has shown that synchronized motor-related beta-activity induced by in-phase tACS improves interpersonal synchrony of movement onsets, suggesting a direct link between interbrain coupling in the absence of shared sensorimotor input and interpersonal motor coordination (Novembre, Knoblich, Dunne, & Keller, 2017). The present study uses a novel approach to extend these findings to natural behaviour in piano performance. Pairs of classical pianists perform complementary parts of excerpts from Bach chorales. Two jointly played phrases are separated by a pause (two bars long) in which players have to keep the tempo they agreed upon in the first phrase. Then, they have to start the second phrase synchronously. We hypothesize that interbrain power correlations during planning of the joint entry will allow predicting synchrony of the movement onset in the second phrase. The current poster will present preliminary results from 14 pairs of pianists.

Doelling, K. B., & Poeppel, D. (2015). Cortical entrainment to music and its modulation by expertise, *Proceedings of the National Academy of Sciences, 112*, (45), 6233–6242.

https://doi.org/10.1073/pnas.1508431112

Dumas, G., Nadel, J., Soussignan, R., Martinerie, J., & Garnero, L. (2010). Inter-Brain Synchronization during Social Interaction. *PLoS ONE*, *5*(8), e12166. https://doi.org/10.1371/journal.pone.0012166

Lindenberger, U., Li, S.-C., Gruber, W., & Müller, V. (2009). Brains swinging in concert: cortical phase synchronization while playing guitar. *BMC Neuroscience, 10,* 22. https://doi.org/10.1186/1471-2202-10-22

Novembre, G., Knoblich, G., Dunne, L., & Keller, P. E. (2017). Interpersonal synchrony enhanced through 20 Hz phase-coupled dual brain stimulation, *Social Cognitive and Affective Neuroscience, 12,* 4, 662–670. https://doi.org/10.1093/scan/nsw172

# Linguistic syncopation:
# Alignment of musical meter to syntactic informativeness and its effect on sentence processing

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Intrinsic neuronal oscillations constrain the processing of rhythmically structured signals such as language and music (Rimmele et al, 2018; Giraud & Poeppel, 2012). This fundamental importance of nested delta, theta, and gamma oscillations in the auditory system and specifically for speech segmentation has been well supported both empirically (Giraud et al, 2007; Doelling et al, 2014) and computationally (Ghitza, 2011; Hyafil et al, 2015). However, segmentation isn't the only function that oscillations support. Delta has also been observed to track syntactic phrase structure in the absence of prosodic cues (Ding et al, 2016), and one interpretation is that delta selectively aligns attention with syntactic informativeness (Meyer & Gumbert, 2018). That is, consistent with dynamic attending and active sensing frameworks (Henry & Herrmann, 2014), delta modulates excitability of underlying neuronal populations such that certain words in a phrase are processed more fully than others. We explore this hypothesis in two experiments by presenting sentences set to a musical meter. By manipulating what part of the syntactic phrase the 'strong-beat' falls on, we presume to manipulate the phase of delta-entrainment and thus the attentional focus. We predicted that accuracy and RTs to comprehension probes would be optimal when the beat aligns with the most syntactically predictable word in a phrase. In experiment 1, sentences were delivered visually one word at a time and the meter was induced passively as physical accents to isochronous auditory tones synchronized with the language presentation. In experiment 2, sentences were delivered auditorily as speech, and meter was induced actively by tasking the participants to tap on a drumpad in time with the speech, allowing us to also measure tapping consistency. The results of both experiments support our hypotheses and the idea that linguistic rhythms may follow similar metrical constraints to that in music (Brown et al, 2017).

Brown, S., Pfordresher, P. Q., & Chow, I. (2017). A musical model of speech rhythm. *Psychomusicology: Music, Mind, and Brain*, *27*(2), 95–112. https://doi.org/10.1037/pmu0000175

Ding, N., Melloni, L., Zhang, H., Tian, X., & Poeppel, D. (2016). Cortical tracking of hierarchical linguistic structures in connected speech. *Nature Neuroscience*, *19*(1), 158–164. https://doi.org/10.1038/nn.4186

Doelling, K. B., Arnal, L. H., Ghitza, O., & Poeppel, D. (2014). Acoustic landmarks drive delta-theta oscillations to enable speech comprehension by facilitating perceptual parsing. *NeuroImage*, *85*, 761–768. https://doi.org/10.1016/j.neuroimage.2013.06.035

Ghitza, O. (2011). Linking speech perception and neurophysiology: Speech decoding guided by cascaded oscillators locked to the input rhythm. *Frontiers in Psychology*, *2*(JUN), 1–13. https://doi.org/10.3389/fpsyg.2011.00130

Giraud, A. L., Kleinschmidt, A., Poeppel, D., Lund, T. E., Frackowiak, R. S. J., & Laufs, H. (2007). Endogenous Cortical Rhythms Determine Cerebral Specialization for Speech Perception and Production. *Neuron*, *56*(6), 1127–1134. https://doi.org/10.1016/j.neuron.2007.09.038

Giraud, A.-L., & Poeppel, D. (2012). Cortical oscillations and speech processing: emerging computational principles and operations. *Nature Neuroscience*, *15*(4), 511–517. https://doi.org/10.1038/nn.3063

Henry, M. J., & Herrmann, B. (2014). Low-Frequency Neural Oscillations Support Dynamic Attending in Temporal Context. *Timing and Time Perception*, *2*(1), 62–86. https://doi.org/10.1163/22134468-00002011

Hyafil, A., Fontolan, L., Kabdebon, C., Gutkin, B., & Giraud, A. L. (2015). Speech encoding by coupled cortical theta and gamma oscillations. *ELife*, *4*(MAY), 1–45. https://doi.org/10.7554/eLife.06213

Meyer, L., & Gumbert, M. (2018). Synchronization of Electrophysiological Responses with Speech Benefits Syntactic Information Processing. *Journal of Cognitive Neuroscience*. https://doi.org/10.1162/jocn

Rimmele, J. M., Morillon, B., Poeppel, D., & Arnal, L. H. (2018). Proactive Sensing of Periodic and Aperiodic Auditory Patterns. *Trends in Cognitive Sciences*, *22*(10), 870–882. https://doi.org/10.1016/j.tics.2018.08.003

# A Timescale-Specific Representational Hierarchy in Cortical Oscillations during Spoken Language Comprehension

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During spoken language comprehension, cortical oscillations have been shown to track acoustic landmarks present in the stimulus (e.g., Doelling et al., 2014) and linguistic structures, i.e., information without a one-to-one physical manifestation in the acoustics (e.g., Ding et al., 2016; Keitel et al., 2018). It is unclear, however, which information the brain draws on to generate structure and meaning from the acoustic signal. Here, we investigated whether oscillations are modulated by the linguistic information conveyed at different timescales by systematically manipulating the amount of semantically- and syntactically-deployable information in our stimuli, asking how much information from distinct levels of linguistic representation we could detect in the brain response via Mutual Information (MI) analysis.

We collected EEG recordings of 29 adult native speakers listening to naturally-spoken Dutch sentences, jabberwocky sentences with sentence-like prosody and morphology, and word lists (80 items/condition). We discovered a 'meaning-and-structure' power hierarchy ranging from jabberwocky (lowest) to grammatical (highest) in the delta-theta band. MI analysis further revealed enhanced speech tracking at distinct timescales: First, MI was equally high at the phrasal timescale (0.6-1.5Hz) for grammatical and jabberwocky sentences, suggesting that delta-band tracking is largely driven by prosody, rather than lexically-driven syntactic processing (Glushko et al., 2018). Second, MI was highest for word lists at the word timescale (1.1-4.5Hz), and for sentences at the syllabic scale (1.7-26.1Hz), indicating that neural tracking is enhanced for linguistic structures at timescales specific to that structure's role in the unfolding meaning of the sentence.

Taken together, these results show that the oscillatory response is modulated by linguistic information at distinct timescales that are relevant for further processing, consistent with neurophysiologically-inspired models of language comprehension (Martin, 2016; Martin & Doumas, 2017).

Ding, N., Melloni, L., Zhang, H., Tian, X., & Poeppel, D. (2016). Cortical tracking of hierarchical linguistic structures in connected speech. *Nature neuroscience*, 19(1), 158.

Doelling, K. B., Arnal, L. H., Ghitza, O., & Poeppel, D. (2014). Acoustic landmarks drive delta–theta oscillations to enable speech comprehension by facilitating perceptual parsing. *Neuroimage*, 85, 761-768.

Glushko, A. & Wolpert, M., Tavano, A., Poeppel, D., & Steinhauer, K. (2018). Cortical tracking of linguistic phrases: bottom-up and top-down effects of prosodic processing. Poster presented at the annual meeting of the Cognitive Neuroscience Society, Boston, USA, March 24-27, 2018.

Keitel, A., Gross, J., & Kayser, C. (2018). Perceptually relevant speech tracking in auditory and motor cortex reflects distinct linguistic features. *PLoS biology*, 16(3), e2004473.

Martin, A. E. (2016). Language processing as cue integration: Grounding the psychology of language in perception and neurophysiology. *Frontiers in psychology*, 7, 120.

Martin, A. E., & Doumas, L. A. A. (2017). A mechanism for the cortical computation of hierarchical linguistic structure. *PLoS Biology*, 15(3), e2000663.

# Melodic Cells as Complex Categories: Jazz Improvisation and Combinatorial Categorial Grammar

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Philip Johnson-Laird (2002) suggests that tonal, melodic improvisation must be directly linked to a harmonic consensus of interacting musicians that is in turn based on a representation of the underlying compositional constituents of the piece being performed. Modelling harmonic structures by means of using formal methods from computational linguistics is nothing new. However, when specifically looking at jazz from this perspective, melodic improvisation is a major constituant of performance and yet remains mostly unreflected upon – there appears to be no real methodological interface between it and syntactic models of harmonic progressions. Larson (2002) receives linear improvisation as being based on expectation, resolution and surprise which are in turn dependent upon a contextual function of a given melodic unit. From a harmonic perspective, a *combinatory categorial grammar* (CCG, cf. Steedman, 1996; Granroth-Wilding, 2013; Granroth-Wilding & Steedman, 2014) formally integrates this notion. This poster presentation focusses on early ideas regarding potential structural interfaces between harmonic consensus and melodic extrapolation which form the basis of my PhD research. This approach seeks to incorporate the notions that improvised melodies in jazz mostly make *sense* on a cellular level – i.e. in terms of local combinations of short note sequences as proposed by Frieler et al. (2016) – and that by recombining archetypical melodic cells, convincing lines in the jazz idiom can be generated (cf. Ligon, 1996; Vincent, 2015). The main goal of this presentation is to discuss the possibility of understanding these melodic cells as belonging to complex syntactic categories, which directly interface with and are dependent on a structural harmonic representation that can be described by means of the CCG formalism. These concepts will be discussed based on my own analysis and annotations of melodic cells offered by Vincent (2015), as well as transcriptions taken from the Weimar Jazz Database (cf. Pfleiderer et al, 2017).

Frieler, K., Pfleiderer, M., Zaddach, W. G., & Abeßer, J. (2016). Midlevel analysis of monophonic jazz solos: A new approach to the study of improvisation. *Musicae Scientiae*, *20*(2), 143-162.

Granroth-Wilding, M. (2013). *Harmonic analysis of music using combinatory categorial grammar*. Ph.D. dissertation, University of Edinburgh.

Granroth-Wilding, M., & Steedman, M. (2014). A robust parser-interpreter for jazz chord sequences. *Journal of New Music Research*, *43*(4), 355-374.

Johnson-Laird, P. N. (2002). How jazz musicians improvise. *Music Perception: An Interdisciplinary Journal*, *19*(3), 415-442.

Larson, S. (2002). Musical forces, melodic expectation, and jazz melody. *Music Perception: An Interdisciplinary Journal*, *19*(3), 351-385.

Ligon, B. (1996). *Connecting chords with linear harmony*. Hal Leonard Corporation.

Pfleiderer, M., Frieler, K., Abeßer, J., Zaddach, W. G., & Burkhart, B. (2017). *Inside the Jazzomat - New Perspectives for Jazz Research*. Schott Campus.

Steedman, M. (1996). The blues and the abstract truth: Music and mental models. In A. Garnham, & J. Oakhill (Eds.) *Mental models in cognitive science: Essays in honour of Phil Johnson-Laird*, 305-318.

Vincent, R. (2015). *Jazz Guitar Soloing - The Cellular Approach*. Sher Music Corporation.

# Investigating the Neurocognitive Bases of Musical Joint Action with fMRI

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Seemingly simple human interactions such as having a conversation, playing music or carrying a heavy together involve complex predictive and adaptive processes in order to dynamically adjust behaviours to reach the joint action goal (Keller, 2008).

To date, research on the underlying neurocognitive processes of joint action has mainly followed two seemingly mutually exclusive theoretical frameworks: one with focus on interpersonal synchronisation, the other with focus on internal co-representations of others' actions. Recent efforts have started to integrate both approaches by showing that joint actions are characterized by a fine balance between synchronisation and co-representation depending on situational demands (Novembre, Sammler, & Keller, 2016).

In the present project we adopt this view and investigate the underlying neural networks using fMRI. Pianists perform previously rehearsed Bach chorales together. One pianist plays the melodies (right hand) in the MRI, while the other pianist plays the basslines (left hand) outside of the MRI. To manipulate pianists' co-representation of their partner's actions, they are either motorically familiar with their partner's part (i.e. they trained it before) or unfamiliar. Simultaneously, the pianists' task is to adapt to either the same or a different tempo in the second half of the pieces, which influences interpersonal synchronisation (Novembre et al. 2016).

We expect stronger activity in areas related to cognitive control in situations with difficult synchronisation (Fairhurst, Janata, & Keller, 2012), and motor activation with regard to the partner's action (D'Ausilio, Altenmüller, Olivetti Belardinelli, & Lotze, 2006), representing co-representation mechanisms. Furthermore, we hope to find an activation of the theory of mind network, including the temporoparietal junction, resulting of the interaction of the two mechanisms (Stephens, Silbert, & Hasson, 2010). Data from 16 duets replicate the behavioural findings of Novembre et al. (2016). The neural data are currently being analysed, and will be presented on the poster.

D'ausilio, A., Altenmüller, E., Olivetti Belardinelli, M., & Lotze, M. (2006). Cross-modal plasticity of the motor cortex while listening to a rehearsed musical piece. *European Journal of Neuroscience*, *24*(3), 955-958.

Fairhurst, M. T., Janata, P., & Keller, P. E. (2012). Being and feeling in sync with an adaptive virtual partner: brain mechanisms underlying dynamic cooperativity. *Cerebral Cortex*, *23*(11), 2592-2600.

Keller, P. E. (2008). Joint action in music performance.

Novembre, G., Sammler, D., & Keller, P. E. (2016). Neural alpha oscillations index the balance between self-other integration and segregation in real-time joint action. *Neuropsychologia*, *89*, 414-425.

Stephens, G. J., Silbert, L. J., & Hasson, U. (2010). Speaker–listener neural coupling underlies successful communication. *Proceedings of the National Academy of Sciences*, *107*(32), 14425-14430.

# The Role of Cognitive Flexibility in the Emergence of Explicit Knowledge in a Serial Reaction Time Task

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Implicit knowledge results from an unconscious and effortless experience and internalization of statistical regularities inherent to the learned material (implicit learning). Despite a wide range of approaches to evoke implicit learning, one commonality among them is that a subset of participants develops explicit knowledge about the regularities inherent to the task. However, it remains unclear which factors actually contribute to these inter-individual differences. The Unexpected Event Hypothesis assumes explicit knowledge to result from detecting changes in response fluency while performing implicit learning tasks (Frensch, Haider, Rünger, Neugebauer, Voigt, & Werg, 2003). These detection processes may depend on the ability to incorporate environmental cues into one's current mental set (cognitive flexibility). Based on the well-established association between cognitive flexibility and dopamine, we also assessed the spontaneous eye blink rate (sEBR), commonly used as a proxy for central domapinergic functioning. The discussion will take into account possible implications regarding implicit learning mechanisms in the acquisition of language and musicality.

Cools, R., & D'Esposito, M. (2011). Inverted-U–shaped dopamine actions on human working memory and cognitive control. *Biological psychiatry*, *69*(12), e113-e125. 10.1016/j.biopsych.2011.03.028

Frensch, P. A., Haider, H., Rünger, D., Neugebauer, U., Voigt, S., & Werg, J. (2003). The route from implicit learning to verbal expression of what has been learned. *Attention and implicit learning*, 335-366.

**Neural speech-sound discrimination, language development and musical experience in childhood.**

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Total of 75 five-year-old children participated in a longitudinal study for two school-years. Some children attended to professionally guided weekly music playschool sessions, some similarly arranged dance lessons, while some children did not participate in either of these. Both the music playschool and dance lessons were provided to children in kindergarten premises, in separate kindergartens. We measured children's ERPs with a passive multifeature paradigm consisting of speech-sound changes and conducted neuropsychological tests for linguistic, inhibitory and non-verbal intelligence abilities, four times during the follow-up. *Study 1:* Comparing the test results and event-related responses at the end of the first follow-up year we found that children scoring higher in Phoneme processing test had also larger MMN responses for phonemic changes. *Study 2:* We investigated the development of children's neural speech-sound discrimination in passive setting throughout the 20 months and found that it was still maturing during this time: the MMN increased, the LDN decreased and the P3a shifted towards adult-like positivity for several speech-sound features, reflecting enhancement in accuracy of neural speech processing. *Study 3:* According to neuropsychological tests, the development of phoneme processing skills and vocabulary knowledge was enhanced in children who partook in music playschool compared to children participating in dance lessons or having no extra curricular activity in their kindergartens.

# The short-term effects of Active Music Learning on the development of literacy in the first school year

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A wide range of music intervention programs have been developed to enhance children's early literacy skills but the effects of music training are still controversial (Butzlaff, 2000; Gordon, Fehd, & McCandliss, 2015). In Hungary, special emphasis is placed on school music instruction; therefore, we investigated the efficacy of new music educational methods employing movement on language development in primary school contexts. Three school classes were recruited to participate in the new Active Music Learning (AML) program from which two – one with an intensive music and another with a mathematics curriculum – received music lessons involving vocal-movement games to teach musical concepts through directed movement, while students were encouraged to improvise free movement during music listening in another intensive music class. As a control group, we recruited a class with no specialized curriculum. Eighty-eight 6-7-year-old students were tested in the fall and the spring term of the first school year. Reading, phonological awareness and rapid naming tests were used from 3DM-H (Tóth, Csépe, Vaessen, & Blomert, 2014) to measure linguistic abilities. An online test of music perception (Asztalos & Csapó, 2017) was used to test the discrimination of pitch, melody, rhythm, tempo, harmony and visual connection skills. Additionally, sensorimotor entrainment was evaluated by paced and continuation tapping tests. Results showed significant pre- to posttraining enhancement of musical and linguistic abilities. Although we found no significant difference between the classes in literacy skills and rhythmic entrainment, the music classes receiving intensive AML outperformed the mathematics and the control class in musical auditory tests after the training. We conclude that improvements in literacy might be due to the formal elementary school instruction. Further, we propose that intensive AML may facilitate short-term enhancement only in the music domain.

Asztalos, K., & Csapó, B. (2017). Development of musical abilities: Cross-sectional computer-based assessments in educational contexts. *Psychology of Music*, *45*(5), 682–698. https://doi.org/10.1177/0305735616678055

Butzlaff, R. (2000). Can Music Be Used to Teach Reading? *Journal of Aesthetic Education*, *34*(3/4), 167–178. https://doi.org/10.2307/3333642

Gordon, R. L., Fehd, H. M., & McCandliss, B. D. (2015). Does music training enhance literacy skills? A meta-analysis. *Frontiers in Psychology*, *6*, 1777. https://doi.org/10.3389/fpsyg.2015.01777

# Glutamatergic modulation of vocal learning circuits through the dopaminergic projections of the Periaqueductal Gray

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The periaqueductal gray (PAG) is a midbrain area involved in stress modulation and production of innate vocalizations. The PAG works as a gate to the premotor neurons of the brain stem. Lesions in this area damage vocalization in mammals, but not comprehension or voluntary movement (Jürgens, 1994). The PAG receives input from the vocal motor control network, but also affects it through dopaminergic projections. PAG in juvenile zebra finches releases dopamine in the HVC, which regulates song learning (Tanaka, Sun, Li, & Mooney, 2018). Dopamine plays a key role in the auditory feedback circuitry that reinforces the copying of vocalizations (Hoffmann, Saravanan, Wood, He, & Sober, 2016), and the PAG relays extensive dopaminergic efferents to the robust nucleus of the arcopallium (Liao, Wang, Pan, Hou, & Li, 2013).

The PAG receives extensive glutamatergic inputs from limbic and hypothalamic structures, driving dopaminergic feedback to thalamic and hypothalamic structures, and is crucial for the mediation and modulation of the stress response (Jürgens, 1994). In the PAG of *the pale spear-nosed bat*, proposed to be a vocal learner (Rodenas-Cuadrado, Chen, Wiegrebe, Firzlaff, & Vernes, 2015), *Foxp2* regulates expression networks encompassing several genes crucial for glutamatergic signaling. Some of the glutamate receptor genes most highly expressed in these regulatory networks play significant roles in the modulation of stress responses and maintenance of synaptic plasticity, crucial for vocal learning species (Wada, Sakaguchi, Jarvis, & Hagiwara, 2004). Changes to glutamate receptor expression correlate with increased song complexity in domesticated Bengalese Finches, compared to its wild counterpart (Okanoya, 2015) the white-rumped Munia, and have been implicated in domestication and recent human evolution (O'Rourke & Boeckx, 2018).

We provide a mechanistic account of how changes to glutamatergic signaling affect the gating of dopaminergic outputs from the PAG, making this an important step in the evolution of vocal learning.

Hoffmann, L. A., Saravanan, V., Wood, A. N., He, L., & Sober, S. J. (2016). Dopaminergic Contributions to Vocal Learning. *Journal of Neuroscience*, *36*(7), 2176–2189. https://doi.org/10.1523/JNEUROSCI.3883-15.2016

Jürgens, U. (1994). The role of the periaqueductal grey in vocal behaviour. *Behavioural Brain Research*, *62*(2), 107–117. https://doi.org/10.1016/0166-4328(94)90017-5

Liao, C., Wang, S., Pan, X., Hou, G., & Li, D. (2013). Dopamine Modulates the Excitability of Projection Neurons in the Robust Nucleus of the Arcopallium in Adult Zebra Finches. *PLoS ONE*, *8*(12), e82497. https://doi.org/10.1371/journal.pone.0082497

Okanoya, K. (2015). Evolution of song complexity in Bengalese finches could mirror the emergence of human language. *Journal of Ornithology*, *156*(1), 65–72.

O'Rourke, T., & Boeckx, C. (2018). Converging roles of glutamate receptors in domestication and prosociality. *BioRxiv*. https://doi.org/10.1101/439869

Rodenas-Cuadrado, P., Chen, X. S., Wiegrebe, L., Firzlaff, U., & Vernes, S. C. (2015). A novel approach identifies the first transcriptome networks in bats: a new genetic model for vocal communication. *BMC Genomics*, *16*(1), 836.

Tanaka, M., Sun, F., Li, Y., & Mooney, R. (2018). A mesocortical dopamine circuit enables the cultural transmission of vocal behaviour. *Nature*, *563*(7729), 117–120. https://doi.org/10.1038/s41586-018-0636-7

Wada, K., Sakaguchi, H., Jarvis, E. D., & Hagiwara, M. (2004). Differential expression of glutamate receptors in avian neural pathways for learned vocalization. *The Journal of Comparative Neurology*, *476*(1), 44–64. https://doi.org/10.1002/cne.20201

**Hemispheric differences in parietal contributions to auditory beat perception**

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Previous research using continuous theta burst stimulation (cTBS) to down-regulate activity within areas of the dorsal auditory stream has shown a causal relationship between motor regions of the brain and musical beat perception (Ross et al., 2018). Specifically, cTBS of the left posterior parietal cortex (lPPC) interfered with accurate detection of shifts of beat-phase, but not absolute interval timing or tempo discrimination. In the present study, we examined whether the right PPC, which is implicated in many aspects of spatial cognition, is causally involved in beat-based musical timing. We compared the effect of downregulating the left and right PPC in 18 participants to discover hemispheric differences in beat-based musical timing perception. Three aspects of timing perception were investigated: 1) discrete interval timing, as well as two facets of relative beat-based musical timing—discrimination of 2) tempo and 3) shifts in phase. Participants are tested pre- and post- stimulation using a test of sub-second interval discrimination and the Adaptive Beat Alignment Test (A-BAT). Our data suggest a role for the left PPC, in detecting shifts in beat phase, but not tempo or interval discrimination. However, we did not find a strong effect of the right PPC in any aspects of beat timing function. We discuss the results in the context of hemispheric and functional differences across the parietal region of the human brain and the Action Simulation for Auditory Prediction (ASAP) hypothesis.

Ross, J.M., Iversen, J.R., & Balasubramaniam, R. (2018). The role of posterior parietal cortex in beat-based timing perception: A continuous theta-burst stimulation study. Journal of Cognitive Neuroscience., 30(5), 634-643. doi: 10.1162/jocn_a_01237

**Language and Music Cognition in the Classroom**

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Rather than my ongoing research, in this poster session I would like to discuss some content of my course entitled *Language, Music and Text-setting*. In the introductory sessions of the course, language and music are compared from a number of perspectives, whereby a broad overview of their common structural components (i.e. rhythm and melody), cognitive grounding, neurobiology and evolution is provided. The topics (and readings) are usually selected for their relevance to the second part of the course, in which text-setting (i.e. the association of text and tune) in different singing idioms and languages is analyzed.
With regard to evolution, the following theories are discussed:

1) Theories of the musical origins of language, which date back to at least Rousseau (1781/1993), argue that language was preceded by an initial song-like stage of communication (Mithen, 2005; Fitch, 2005). Recently, however, it has been put forth that the origins of this 'protolanguage' may lie in the emergence of a 'protosign' rather than in vocal learning (Arbib & Iriki, 2013).
2) The 'Musilanguage model' (Brown, 2008) as a theory of a common precursor to language and music.
3) The hypothesis that music, like birdsong, evolved as a direct target of natural selection (Darwin, 1871). This idea has been opposed by, among others, Pinker (1997) who maintains that music is a simple byproduct ("ex-aptation") of the mental system, with no proper adaptive function.
4) The alternative view (Cross, 2003; Huron, 2003) according to which music, like language, is a product of both biology and social interaction, and its adaptive features are more evident at the group rather than the individual level.

In this poster, I would like to address the following question: which consequences the adoption of one or the other evolutionary theory has for our understanding of the cognitive foundations of singing?

Arbib, M. A., & Iriki, A. (2013). Evolving the Language- and Music-Ready Brain. In M. A. Arbib (Ed.) *Language, Music, and the Brain* (Strüngmann Forum Reports, vol. 10, pp. 481-497). Cambridge, MA: MIT Press.

Brown, S. (2000). The "Musilanguage" Model of Music Evolution. In N. L. Wallin et al.

(Eds.), *The Origins of Music* (pp. 271-300). Cambridge MA: MIT Press.

Cross, I. (2003). Music, Cognition, Culture and Evolution. In I. Peretz & R. J. Zatorre (Eds.), *The Cognitive Neuroscience of Music* (pp. 42-56). Oxford: OUP.

Darwin, C. (1871). *The Descent of Man and Selection in Relation to Sex*. London: John Murray.

Fitch, W. T. (2005). The Evolution of Music in Comparative Perspective. *Annals of the New York Academy of Sciences* 1060(1). 29-49.
doi: 10.1196/annals.1360.004

Huron, D. (2003). Is music an evolutionary adaptation? In I. Peretz & R. J. Zatorre (Eds.), *The Cognitive Neuroscience of Music* (pp. 57-75). Oxford: OUP.

Mithen, S. (2005). *The Singing Neanderthals: The Origins of Music, Language, Mind and Body*. London : Weidenfeld & Nicolson.

Pinker, S. (1997). *How the mind works*. New York/London: Norton.

Rousseau, J-J. (1781/1993). *Essai sur l'origine des langues*. Paris: Flammarion.

**Music as Metre: A Non-Modular Interpretation of Text-Setting**

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In the last twenty years, significant papers about the relationship between linguistic prosody, verse prosody and music have been published by Hayes and Kaun (1996), Kiparsky (2006), and Rodríguez-Vázquez (2010), among others. The analyses presented in those papers favour a modular view of text-setting, according to which 'song' is "a composite which combines two objects each with its own structure, a text and a tune" (Dell and Halle, 2009). Similarly, Fabb and Halle (2008) state that "there is no necessary connection between the meter of a line of poetry and the way it is set to music". In this poster I present evidence against such modular view of text-setting. I apply metrical and grouping constraints to a corpus of twentieth-century Spanish, Galician and English folksongs in order to consistently explain the text-to-tune association mechanisms at work and prove that the same metrical and grouping constraints are ranked in the text and the tune of the folksongs; the fact that the same lyrics can be sung to different tunes is only a by-product of the recurring meters used in folksong; in traditional genres, the composer/performer of a song does not construct a match between three tiers of rhythmic structure – linguistic prominence, poetic metre, and music rhythm – but between two, namely linguistic prominence and musical rhythm, where the former is subservient to the latter. In other words, the prosody of speech is secondary to the rhythm of the song, which in turn is determined not only by the beat and where it falls, but also by note value, pitch height and cadential action. In sum, the analysis presented in the poster evinces that a folksong is a unit where linguistic prosody and musical rhythm interact so as to fulfil the rhythmic requirements of the metrics of song in a given language.

Dell, F. & Halle, J. (2009). Comparing musical text-setting in French and in English songs. In *Towards a typology of poetic forms*, J.-L. Aroui & A. Arleo (Eds.), pp. 63-78. Amsterdam: John Benjamins.

Fabb, N. & Halle, M. (2008). *Meter in Poetry: A New Theory*. Cambridge: Cambridge University Press.

Hayes, B. & Kaun, A. (1996). The Role of Phonological Phrasing in Sung and Chanted Verse. *The Linguistic Review*, 13, 243-303. doi: 10.1515/tlir.1996.13.3-4.243

Kiparsky, P. (2006). A modular metrics of folk verse. In *Formal approaches to poetry*, E. B. Dresher & N. Friedberg (Eds.), pp. 7-52. Berlin, New York: Mouton de Gruyter.

Rodríguez-Vázquez, R. (2010). Text-setting constraints: a comparative perspective. *Australian Journal of Linguistics*, 29/3, 353-366. doi: 10.1080/07268600903134004

# The Valins Effect in Music – Influences of False Feedback on Aesthetic Appreciation, Emotional Involvement and Empathy

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According to the Valins Effect, which states that the cognitive information provided by a false feedback leads to an interpretation of the alleged physical reaction as an emotion that must have been triggered by the stimulus, in this study such responses to music were investigated. Participants ($N$=52, $M$[age]=27.18) were randomly paired into two groups, both led to believe that their skin conductance responses were recorded during the experiment. The stimulus sets consisted of 15 musical excerpts retrieved from movie scores and popular music pieces. For each of the stimuli participants were asked to describe their emotions, intensity of emotional involvement, familiarity, liking and aesthetic perception of the music. Additionally, participants were asked to describe their empathy using the Interpersonal Reactivity Index, being presented with one half of the questionnaire before and the other half after the reception of the stimuli. The Valins Effect could be found in each of the 15 stimuli with significant effects. A $t$-test ($t$=-6.15, $p$<.001) performed on overall means of intensity of emotional involvement showed a significantly higher perceived emotional involvement among the participants who received high skin conductance responses. Another $t$-test showed a significant increase of self-reported "Empathic Concern" among participants in the high response condition during the experiment, whereas the empathy score slightly decreased in the low response condition during the experiment. The data indicate the false feedback of emotional reactions to music leads to higher perception of emotional involvement as well as higher perception of actual physical reactions and higher self-assessment of empathic abilities.

# Probing sensorimotor learning in speech induced by formant perturbations

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Speaking is one of the most complicated motor behaviours. Fluent speech production requires fine coordination of many muscles and integration with simultaneous auditory and somatosensory feedback. It is possible to examine the role of auditory feedback in speech motor control using a learning paradigm involving speech adaptation (Houde & Jordan 1998). Study 1 investigated the relationship between the changes in the first two formants of vowels by manipulating the auditory feedback for F1 (Experiment 1) and F2 (Experiment 2) separately in two groups of 20 participants. In Experiment 1, our results showed that participants who experienced feedback in which F1 frequency was shifted up exhibited a significant decrease in F1 produced alongside an increase in F2 frequency over the sensorimotor learning. The combined F1-F2 changes moved the new produced utterances closer to a known pattern of speech production for an existing vowel category. In Experiment 2, we further showed that a downshift in frequency of F2 feedback also induced compensatory changes of both the perturbed (F2) and the unperturbed formant, F1 in opposite directions. However, the combined F1-F2 changes did not move the produced speech closer to a known pattern of speech production for an existing vowel category as seen in Experiment 1 rather they were driven by the large increase in F2 to compensate for the perceived shift. We are now exploring the neural basis of speech motor learning using the paradigm from Study 1 coupled with transcranial magnetic stimulation, which temporarily inhibits function in specific brain areas. We predict temporary disruption of the articulatory representation, but not the hand representation in primary motor cortex will impair speech adaptation not only in the perturbed formant (F1), but also in the unaltered formant (F2).

Houde, J. F., & Jordan, M. I. (1998). Sensorimotor adaptation in speech production. *Science, 279*(5354), 1213-1216.

# From syllables to words: Language perception and language acquisition of young children with cochlear implants

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The cochlear implant (CI) is a neuroprosthetis that provides access to auditory stimuli by electrically stimulating the auditory nerve. This technology benefits deaf infants and children who are in a language-sensitive phase. Yet, it is still poorly understood how a prolonged absence of auditory stimulation, a delayed exposure to language and the altered input from the implant affects language acquisition. Two longitudinal EEG studies aimed at filling this knowledge gap by investigating which low-level but language-relevant features are available to young children during the first months after implantation, thus establishing the conditions under which language acquisition takes place with a CI. A third study looked at the development of word acquisition during the second year of hearing, which is the most dynamic phase of word acquisition in typically hearing children. The first two studies showed that word boundary cues (vowel length and stress pattern) are perceived early but not immediately after implantation. This implies that sensory experience and adaptation to CI input is necessary for such linguistic cues. In the third study investigating the children's semantic word learning, however, the implanted children were actually faster than typically hearing children. It appears that more matured cognitive abilities at the beginning of language exposure (e.g. attention, memory) compensate the delayed hearing onset. Deaf implanted children thus provide insight to which features are important at various stages of language acquisition. Whereas the perception of linguistic cues is influenced mainly by sensory experience, word acquisition depends heavier on the maturation of higher-level cognitive domains. In an ongoing study we ask how musical features like timbre and intensity are processed early after implantation and whether we see a correlation between the processing of linguistic and musical stimuli. The ultimate goal is to understand how the auditory modality is experienced by deaf children with cochlear implants.