NEST 2018

THE NEW ENGLAND SEQUENCING AND TIMING MEETING

Meeting Schedule and Abstracts

NEST 2018 Schedule

Saturday, April 21, 2018

8:30 am to 9:15 am	**-- Registration & Breakfast --**
9:15 am to 9:30 am	**-- Welcome --** ***Speaker***: Yi Wei, Edward Large
9:30 am to 9:50 am	Adaptive Changes in the Dynamics of Visual Attention with Extended Practice in a Rapid Serial Visual Presentation Task ***Speaker:*** Matthew Junker
9:50 am to 10:10 am	Neural Resonance Theory: Testing Dynamical Predictions Using Missing Pulse Rhythms ***Speaker:*** Charles Wasserman
10:10 am to 10:30 am	The Impact of Physical Exercise on Music Appreciation ***Speaker:*** Michael J. Hove
10:30 am to 10:50 am	**-- Coffee Break --**
10:50 am to 11:10 am	Mutual synchronization and predictability enhance spontaneous entrainment when walking with an auditory beat ***Speaker:*** Dobromir G. Dotov
11:10 am to 11:30 am	Oncology Patient Racial Attitudes Influence Motion Synchrony in Patient Physician Dyads ***Speaker:*** Robert Moulder
11:30 am to 12:10 pm	Characterizing Predictive Control in Time and Space in Children with Autism Spectrum Disorder ***Speaker:*** Se-Woong Park
12:10 pm to 1:00 pm	**-- Lunch Break --** Provided On-Site
1:00 pm to 1:20 pm	Chaos control: stabilizing unstable dynamics through movement sonification as a novel task for motor learning ***Speaker:*** Dobromir G. Dotov
1:20 pm to 1:40 pm	The attraction of rhythm: How discrete actions merge into a rhythmic pattern ***Speaker:*** Zhaoran Zhang

1:40 pm to 2:00 pm	Modeling Infants' Perceptual Narrowing to Musical Rhythms with Gradient Frequency ***Speaker***: Parker Tichko
2:00 pm to 2:20 pm	**-- Coffee Break --**
2:20 pm to 2:40 pm	Finding the Common Time: Similarities and Differences in the Temporal Aspects of Speech and Music Perception ***Speaker:*** Jessica E. Nave-Blodgett
2:40 pm to 3:00 pm	Auditory-motor synchronization and early auditory processing ***Speaker:*** Erika Skoe
3:00 pm to 3:20 pm	Choral speaking ***Speaker:*** Lauryn Zipse
3:20 pm to 3:40 pm	**-- Coffee Break --**
3:40 pm to 4:00 pm	Hearing Creatively: Default Network Selectively Synchronizes to Auditory Cortex in Jazz Improvising Musicians ***Speaker:*** Alexander Belden
4:00 pm to 4:20 pm	Can professional musicians intentionally desynchronize? A natural case study of expert percussionists in a natural performance context ***Speaker:*** Michael Schutz
4:20 pm to 5:00 pm	**-- General Discussion --**
5:00 pm to 6:30 pm	**-- Post-Meeting Drinks and Discussion --** Geno's Grille: Storrs Center
6:30 pm to 6:00 am	**-- Reception at Ed's House –** Food Will be Served

Adaptive Changes in the Dynamics of Visual Attention with Extended Practice in a Rapid Serial Visual Presentation Task

Speaker: Matthew Junker

9:30 - 9:50

Environmental stimuli often occur in temporally regular patterns. It would be advantageous to predict the onset of goal-relevant stimuli so that one may adjust one's attention for faster and more accurate processing of stimuli. The purpose of this research was 1) to find evidence for temporal learning, and 2) to investigate the effects of temporal learning on the dynamics of an attentional pulse. Three experiments utilizing the rapid serial visual presentation (RSVP) paradigm were conducted to test for changes in an attentional pulse that occurred after extended practice. The task was to detect a blue letter target among a stream of rapidly presented white distractor letters presented at 12-20 Hz. In Experiment 1, participants reported four consecutive target letters in the order that they were presented. The four targets appeared randomly in one of two fixed serial positions in the RSVP stream. In Experiment 2, participants reported a single target that appeared in one of two fixed serial positions on each trial. In Experiment 3, participants reported a single target that always appeared in the same serial position. Evidence for temporal learning was only reliable in Experiments 2 and 3, but not in Experiment 1, possibly reflecting differences in the degree of explicit learning or task difficulty. These learning effects included changes in target identification rate as well as adjustments in attentional dynamics in terms of amplitude, delay, and variability. Finally, we assessed the degree to which participants gained explicit knowledge of the temporal positions of targets and its relationship to attentional dynamics.

Neural Resonance Theory: Testing Dynamical Predictions Using Missing Pulse Rhythms

Speaker: Charles Wasserman

9:50 - 10:10

Many rhythm perception experiments employ simple isochronous rhythms, in which synchronous neural or behavioral responses are observed. However, responses at the stimulus frequency do not allow one to distinguish whether synchrony occurs as a response to a common input, or as the result of an emergent population oscillation that entrains at a particular frequency. However, It is possible to create a rhythm with no spectral energy at the pulse frequency by manipulating the number of events that occur anti-phase (180°) versus in-phase (0°) with the basic rhythmic cycle. Dynamical analysis predicts neural oscillation will emerge at such a "missing" pulse frequency. Previous studies have shown that subjects tap along to complex rhythms at the missing pulse frequency – a finding that supports the prediction.

This study aimed to investigate whether the sensorimotor system, as measured by 32-channel cortical EEG, would entrain to a complex rhythm at the pulse frequency even when the complex rhythm contained no spectral power at that frequency. The experiment utilized four different rhythms of varying complexity (1 simple, 2 complex, and 1 random rhythm). Fast Fourier Transform (FFT) of the Hilbert envelope showed energy at the repetition frequency (2Hz) for the simple rhythm, but no spectral energy at the missing pulse frequency (2Hz) for the complex rhythms. EEG responses to these stimuli were examined for evidence of neural oscillations and power modulations at the missing pulse frequency predicted by dynamical analysis. We report evidence of 2Hz responses in the EEG to missing pulse rhythms. These data support the theory that rhythmic synchrony occurs as the result of an emergent population oscillation that entrains at this particular frequency. We also discuss generators of the 2Hz response component.

The Impact of Physical Exercise on Music Appreciation

Speaker: Michael J. Hove

10:10 – 10:30

Music's ability to influence exercise performance is well known (e.g., Karageorghis, 2016), but the converse, how exercise influences music listening, remains unknown. Exercise can elevate mood and neurotransmitters such as dopamine (Heijnen et al., 2016). Mood and dopamine/reward circuitry are implicated in musical appreciation (e.g., Salimpoor et al., 2013). In this study, we examined the effects of exercise on music appreciation and test for a modulatory role of mood, arousal, and dopamine levels. Participants rated unfamiliar music clips on enjoyment before and after an exercise session (treadmill running) and a control-day session (podcast). Before and after each session, we collected measures of arousal, positive and negative affect (PANAS questionnaire), and dopamine levels using eye-blink rate (Jongkees & Colzato, 2016). Results indicated that participants' ratings of musical enjoyment increased significantly after running, but not after the control condition. Increased enjoyment scores did not correlate with changes in affect or dopamine levels. In conclusion, we show that exercise can increase the music appreciation, but the mechanism remains to be determined.

Coffee Break
10:30 – 10:50

Mutual synchronization and predictability enhance spontaneous entrainment when walking with an auditory beat

Speaker: Dobromir G. Dotov

10:50 – 11:10

Two persons walking side by side synchronize their steps on some occasions but not on others. How can action be spontaneously and selectively entrained by some sources of perceptual information while other sources are ignored? Predictability, mutual synchronization, and consistency of the relative phase might act as saliency factors. To study there we designed an adaptive auditory stimulus based on the Kuramoto system, a well-known theoretical model of mutual synchronization. An adaptive phase oscillator coupled to footfalls controlled the auditory stimulus (gait to stimulus coupling). We assumed that the reciprocal coupling (stimulus to gait) can be described by a second phase oscillator. The intrinsic frequency of the stimulus was higher than the individual's preferred cadence but coupling strength was sufficient for synchronization. This model was compared to non-interactive predictable stimuli (isochronous or statistically matched to gait) faster than the preferred cadence and to an excessively adaptive stimulus that could not induce mutual synchronization. Healthy and participants with impaired gait due to Parkinson's disease walked along with these stimuli presented in separate trials. No instruction was given to synchronize with the auditory stimulus. The adaptive oscillator based on the Kuramoto model was the most effective in spontaneously entraining gait cadence, equally across patients and healthy participants. To explain this effect, it is worth first considering that the stimulus embodied the following three properties: it was predictable (afforded synchronization), interactive (induced mutual synchronization), and maintained a consistent and positive phase relative to gait. The last property may be responsible for the spontaneous increase in cadence. From a dynamic systems perspective this can be explained with the stability of relative phase in the system comprising walker and stimulus. Conversely, predictive processing would speculate that the auditory and motor systems, jointly responsible for "predicting out" self-generated sounds, failed to distinguish between the regular beats of the stimulus and the expected auditory consequences of footfalls and were thus led to play catch with the stimulus.

Oncology Patient Racial Attitudes Influence Motion Synchrony in Patient Physician Dyads

Speaker: Robert Moulder
11:10 – 11:30

Racial attitudes and beliefs influence communication dynamics between physicians and patients, and may be a component of treatment disparity between patients. However, research on the mechanics of how racial attitudes and beliefs influence communication dynamics is sparse. To better understand these communication dynamics, we conducted an analysis of nonverbal synchrony from 68 video recorded interactions between 68 Black patients and 16 White physicians. Nonverbal synchrony was quantified via Motion Energy Analysis (MEA) and Windowed Cross-Correlation (WCC) analysis. Patient's general trust in their physicians was associated with higher global nonverbal synchrony ($p=.049$) and whether or not a patient had perceived previous discrimination was associated with reduced levels of nonverbal synchrony ($p=0.007$). These differences in nonverbal synchrony may partially explain treatment disparities observed in this patient population.

Characterizing Predictive Control in Time and Space in Children with Autism Spectrum Disorder

Speaker: Se-Woong Park
11:30 –12:10

Anecdotal reports and selected research results suggest that individuals with Autism spectrum disorder (ASD) exhibit difficulties in motor coordination, especially when interacting with dynamic objects, like catching a ball. A recent theoretical framework from our group proposes that the seemingly distinct manifestations of ASD in multiple domains may have a common core: an impaired ability to make predictions. We tested this hypothesis in the motor domain. Specifically, we examined whether individuals with ASD show impaired motor coordination when interacting with moving objects, especially in fast feedforward-controlled actions that rely on internal prediction. A number of studies have already examined predictive abilities of children with ASD, although with inconsistent results due to heterogeneity of ASD samples and task designs. Therefore, we designed a test battery of multiple motor skills with various complexity in time and space and control tasks to take into account potential low-level confounds.

11 ASD children (high-functioning, age 7-12 years) and 25 neuro-typical, age-, gender-, and IQ-matched children (NT) performed 5 interception tasks in a virtual environment. The set-up afforded controlled manipulation of the time window for prediction, while simplifying the coordination challenges for hand movement. Subjects either pressed a button to predict the time or location of a launched ball (low coordination challenge), or they moved a paddle to catch or bounce a ball to hit a target (high coordination challenge).

The gaze profiles during the button-pressing tasks were recorded using an eye-tracker. Additionally, subjects performed naturalistic ball catching, where 3D kinematics of joint movements and muscle activity of arm, leg, and trunk muscles were recorded to quantify anticipatory postural responses. A set of control tasks assessed more elementary motor abilities, such as postural control, reaction time, and smoothness of hand movements in very similar conditions.

Results showed that, in virtual catching, ASD's accuracy decreased disproportionately relative to NTs when the ball trajectory was partially occluded. Also, when bouncing a ball to a target, ASDs exhibited lower accuracy. Motor impairments in ASD became more pronounced during tasks with high coordination challenge. Additionally, ASDs stagnated their gaze when the moving object was occluded; in contrast, NTs continued their gaze in time with the predicted ball trajectory. In naturalistic catching, EMG and the ball-hand distance profiles indicated that ASDs moved abruptly to catch the ball, whereas NTs showed more advanced planning of contact. Importantly, ASDs did not differ from NTs in control tasks such as reaction time, postural control and reaching to a static target.

These results reveal that, despite considerable inter-individual differences, ASD children show impaired motor performance when prediction is an essential component. These findings are consistent with our hypothesis that the ability to predict may be a common denominator across ASD individuals despite their phenotypic variations. Given its broader theoretical embedding, this study has implications for autism beyond motor skills.

Lunch Break
12:10 – 1:00

Chaos control: stabilizing unstable dynamics through movement sonification as a novel task for motor learning

Speaker: Dobromir G. Dotov

1:00 – 1:20

Background: The sonification of limb motion in relation to designated movement patterns has proven useful in refining motor learning. Arguably, multimodal integration exhibited by associative cortical areas enables alternative feedback pathways. Convergent evidence demonstrates, however, that motor skill with real-world relevance requires complex training tasks. Furthermore, the predictive processing approach shows that mutual synchronization can facilitate the learning of complex patterns. To implement all three principles (sonification, complexity, mutual synchronization) we conducted a study with movement sonification where healthy participants learned to stabilize unstable periodic orbits embedded in a chaotic system. This was inspired by case studies in robotics where chaotic CPGs driven by sensory feedback allow mobile robots to adaptively switch among stable manifolds in their body-environment dynamics.

Methods: In this sensorimotor synchronization task the goal was to move the hand controlling the pitch of a continuous pure tone in one auditory channel so as to match the stimulus pitch in the other channel. The stimulus assumed three modes of variation: periodic non-interactive (harmonic oscillator), chaotic non-interactive (autonomous Chua oscillator), and chaotic interactive (Chua oscillator driven by the tilt angle of the hand). Forty eight volunteers were randomly assigned in one of the three groups. To also test for immediate generalization, the experimental design was a pre-test, practice, and immediate post-test where pre/post tests comprised non-interactive harmonic and chaotic stimuli different from the practice stimuli.

Results: Synchronization performance was the cross-correlation *C* and the root-mean-squared-error RMSE between the left and right channels. *C* increased quickly to an early asymptote with the periodic stimulus, did not exhibit any improvement in non-interactive chaotic, and exhibited slow and consistent improvement with the interactive chaotic stimulus. As expected from chaos control and the observed improvement in synchronization, the interactive chaotic stimulus also became more periodic and the transfer entropies from stimulus to participant and from participant to stimulus increased with practice trial. In terms of generalization measured wit the pre/post percent change, the periodic group exhibited improvement on one test, the non-interactive chaotic showed no improvement on any test, and the chaotic interactive group showed improvement in two tests.

Conclusions: Practicing with a periodic stimulus led to stimulus-specific learning with little generalization. Synchronizing with a non-interactive chaotic stimulus proved too hard for our participants, contrary to previous reports. When given the opportunity to interact with the chaotic stimulus, however, an instance of so-called epistemic affordance, participants could learn to stabilize its unstable periodic orbits. This also led to improvement with novel stimuli, a result with implications for motor rehabilitation where generalization is an important desirable.

The attraction of rhythm: How discrete actions merge into a rhythmic pattern

Speaker: Zhaoran Zhang
1:20 – 1:40

It is a well-known, but nevertheless intriguing observation that humans "fall into step": When listening to music, humans spontaneously synchronize their movements to the rhythm; when the audience applauds after a concert, the clapping hands starts to synchronize into a common rhythm. But what if there is no external rhythm? The current study examined how humans spontaneously merge a sequence of discrete actions into a rhythmic pattern, and whether this change correlated with task performance. Two experiments used a virtual throwing task, where subjects performed a long sequence of discrete trials, throwing a virtual ball to hit a virtual target as accurately as possible. In Experiment 1, subjects (n = 15) performed 11 daily sessions with 240 trials on each day (total of 2640 trials). Task performance was measured by hitting error, and continuous kinematic data of the arm trajectory across trials was collected to quantify changing rhythmicity via the inter-throw intervals and the dwell times between successive ball releases. Even though there was no instruction to perform rhythmically, results showed that variability of the inter-throw intervals decreased and dwell times shortened or disappeared with practice. The coefficient of variation of the inter-throw interval was 10%, which is only slightly higher than in rhythmic tapping synchronized to a metronome. Variability of the Poincare map of the orbit in state space decreased indicating periodicity and dynamic stability. Importantly, subjects who achieved higher accuracy in throwing also displayed a higher level of rhythmicity. In Experiment 2, two groups of subjects (n = 8 in each) performed a slightly less challenging task variation for 6 days (total of 720 trials, different target location). The discrete group was instructed to pause their arm between two successive throws while the self-paced control group did not receive any instruction about dwell time, as in Experiment 1. The self-paced group performed significantly better than the discrete group with significantly lower repeatability in their hand trajectories. These results show that subjects are spontaneously "attracted" to rhythmic solutions, even when there is no explicit need to do so. A break of the continuous flow of performance has a disrupting effect on performance, even though there may be more time to evaluate each throw and correct for errors. These findings are discussed in the context of previous neuroimaging results that showed that rhythmic movements involve significantly fewer cortical and subcortical activation than discrete movement activity and therefore may pose a more parsimonious solution.

Modeling Infants' Perceptual Narrowing to Musical Rhythms with Gradient Frequency

Speaker: Parker Tichko
1:40 – 2:00

Ontogeny is a complex, emergent process that arises from interactions between the developing organism and the structures present in the rearing environment (Gottlieb, 2007; Miller, 2007; Turvey & Sheya, 2017; van Geert, 1994, 2003). In the field of infant development, one of the most well-known consequences of organism-environment interactions is the adaption and re-organization of perception-action systems to structural regularities in the environment, a phenomenon called "perceptual narrowing" or "perceptual fine tuning." Previous work suggests that infants' perception of musical rhythms is gradually fine-tuned to culture-specific musical structures over the first post-natal year (Hannon & Trehub, 2005 a,b). To date, however, little is known about the neurobiological principles that underlie this process. In the current study, we employed gradient frequency neural networks (GrFNNs) to model infants' perceptual narrowing to culture-specific musical rhythms (Kim & Large, 2015; Large et al., 2015). We demonstrate that, during a period of unsupervised learning, a single-layer sensory network with Hebbian learning reflects the rhythmic structure of both Western and Balkan musical rhythms through the self-organization of oscillator connections. We further show that these learned connections affect the ability of the network to discriminate between native and non-native rhythms, a pattern of findings that mirrors the behavioral data on infants' perceptual narrowing to musical rhythms (Hannon & Trehub, 2005 a,b).

Coffee Break
2:00 – 2:20

Finding the Common Time: Similarities and Differences in the Temporal Aspects of Speech and Music Perception

Speaker: Jessica E. Nave-Blodgett

2:20 – 2:40

Speech and music share many similarities: they are both forms of auditory communication, they are patterns of sound that occur over time, and they are universal human behaviors. For listeners to comprehend speech and music, they must parse a continuous sound stream into meaningful units such as syllables or notes, words or melodies, and sentences or musical phrases. Meter is a key temporal structure in music (and to some extent, speech) which governs the points in time when a listener would hear emphasis and tap or clap along. When listeners experience meter, they usually perceive one strong beat along with subdivisions and multiples of the strongest beat at additional, hierarchically related temporal periodicities. Is the process of finding the underlying metrical organization of music merely analogous or is it directly homologous to the ability to accurately segment a continuous speech stream?

Research examining the relationship between individuals' beat perception and their language skills, especially during development, is mixed; some studies find links between phonological processing or reading-readiness skills and beat perception, others do not. Often, these studies focus on phonological awareness and phonological processing and not speech segmentation. We have designed a natural-language speech segmentation task in which listeners to identify target words embedded in spoken sentences in familiar (English) and unfamiliar (Turkish) languages. The same American participants performed all of the following tasks: speech segmentation in English and Turkish, a cross-cultural meter perception task examining sensitivity to multiple metrical levels in culturally familiar (American) and unfamiliar (Turkish) music, and tapping to American and Turkish music.

The use of culturally familiar (overlearned) versus culturally unfamiliar stimuli allows us to assess the relative impact of enculturation and experience on speech segmentation and musical meter perception within a task and across tasks and modalities. Preliminary analyses suggest that speech segmentation is influenced by both the target language and sentence language, with participants performing poorer for unfamiliar target words regardless of sentence language, and poorer for all targets embedded in unfamiliar-language sentences. Individuals also took longer to start tapping to culturally unfamiliar than familiar music, and tapped faster to culturally unfamiliar music. Participants also had higher sensitivity to multiple levels of metrical structure in culturally familiar than unfamiliar music.

Auditory-motor synchronization and early auditory processing

Speaker: Erika Skoe
2:40 – 3:00

Many of the sounds we experience in our environment, like the sound of our voice, are self-generated and arise as a consequence of our own motor actions. It's well known that the brain has the capacity to alert sensory systems about planned motor movements, allowing sensory systems to predict the sensory consequences of motor commands and modulate how incoming sensory input is encoded by the brain. The generation of internal motor-based predictions about sensory stimulation may explain why the neural response to self-generated sensory stimulation is suppressed relative to external sounds. This neural suppression has been observed not only for the auditory system but across other sensory systems, as well. Neural attenuation of self-generated sounds can be observed using auditory evoked potentials (AEPs), electrical recordings of the brain's response to sound. Voice-induced attenuation of N1, a cortically-generated AEP component occurring ~100 ms after stimulus onset, has been documented extensively. Neural suppressive effects are also observed for self-produced non-vocal sounds that are generated through a button-press action (Martikainen et al., 2005), suggesting that sensory suppression is not specific to vocal sounds. However, the question remains as to how early in the sensory processing stream this neural suppression occurs. One study suggests that neural suppression of self-generated sounds occurs within the first 40 ms after sound onset (Baess et al., 2009). Other research, using auditory brainstem responses (ABRs), suggests that neural suppression of self-generated sounds may occur even earlier (Papanicolaou et al., 1986), although this study did not adequately control for ABR attenuation due to muscle artifact. ABRs are AEPs that emerge as a series of waves 10 ms after stimulus onset. The current study used a novel experimental technique to record ABRs to a self-initiated train of click sounds that the participant heard each time s/he depressed a button on a button box. Using a with-in subjects design, ABRs were compared between this self-initiated stimulus condition relative to a playback condition where the participant heard the same stimulus sequence but did not control the stimulus delivery via his/her muscle movement. Research on self-produced sounds predicts that ABRs to self-initiated sounds would be suppressed, as part of the same general mechanistic process that gives rise to attenuated cortical AEPs. However, a recent study sets up an alternative possibility, namely that ABRs would be enhanced in the self-generated condition due to a sensory gain mechanism associated with sensorimotor synchronization (Nozaradan et al., 2015). In support of the sensory gain hypothesis, we observe a robust enhancement of ABR amplitudes in the self-initiated stimulus condition relative to the playback condition. By contrast, ABR amplitude attenuation was found for a separate set of conditions where participants' button pressing did not control the sound stimulus, an outcome that is consistent with the prevailing wisdom that ABR recordings are compromised by electrical artifact from extraneous muscle movement. Our study provides a platform for pursuing similar studies on unique populations, such as expert auditory-motor synchronizers (musicians, dancers) as well as persons with motor disorders or disorders characterized by dissociations between "self" and "other".

Choral Speaking

Speaker: Lauryn Zipse

3:00 – 3:20

Choral speaking is used clinically to promote fluency across a number of speech and language disorders, including stuttering, aphasia, and apraxia of speech. To understand why this technique is effective, it would be useful to evaluate how speakers align their speech with an auditory model in various versions of a speech alignment task. In studies of the p-center, i.e. the perceived moment of occurrence of a syllable, it is often assumed that the location of this 'beat' is fixed for a given speech stimulus across different tasks. However, studies examining the p-center have generally focused on perceptual tasks, such as asking a listener to adjust sequences of syllables until the listener perceives them to occur at fixed intervals, or tapping to a sequence of spoken syllables presented auditorally. Few studies have explored the question of whether the location of the p-center differs for perception and production. This question is particularly important information for understanding the effectiveness of choral speech (which involves both perception and production) and its possible benefits for fluency. We report on an experiment testing the prediction that the location of the p-center will differ based on whether individuals are hearing or producing a syllable.

Twenty-five healthy young adults completed a series of tasks in which participants either heard a sequence of periodically-occurring clicks or periodic repetitions of the syllable "pa", with an inter-stimulus interval (ISI) of 500 ms, and responded either by tapping their finger or saying "pa" in synchrony with the stimulus track. Tasks included (1) tap to "pa," (speech perception) (2) say "pa" to clicks, (speech production) (3) tap to clicks (no speech), and (4) say "pa" to "pa " (speech perception and production) Digital audio recordings of the stimulus and responses were time-locked, and the relative placements of the /p/ burst, the onset of voicing, the click, and the tap were extracted for each trial, as applicable for the condition. Results support the prediction that the location of the p-center differs, based on whether an individual is producing or hearing a syllable. Findings also support the idea that the negative mean asynchrony (NMA) reflects neural transit time from the effector organ to the brain, such that NMAs are shorter for speech (movements produced by the vocal tract) than for taps (movements produced by the finger).

Coffee Break

3:20 – 3:40

Hearing Creatively: Default Network Selectively Synchronizes to Auditory Cortex in Jazz Improvising Musicians

Speaker: Alexander Belden

3:40 – 4:00

Jazz improvisation offers a model for creative cognition, as it involves the real-time creation of a novel, information-rich product. Previous research has shown that when jazz musicians improvise, they recruit medial and dorsolateral prefrontal cortices, which are part of the Default Mode (DMN) and Executive Control (ECN) Networks respectively. Here, we ask whether these task-fMRI findings might arise from intrinsic differences in functional connectivity. We compare resting state fcMRI of ECN and DMN among jazz improvisers, classical musicians, and non-musicians. We seeded regions of interest in the medial prefrontal cortex, within the DMN, and the dorsolateral prefrontal cortex from the ECN, and compared the correlation patterns from each ROI across the three subject groups (all results $p<0.05$ cluster-corrected). We found higher resting state connectivity in jazz improvisers than classical musicians between the mPFC and the middle temporal, angular, and postcentral gyri. In contrast, all musicians showed increased connectivity from left dorsolateral prefrontal cortex, a region of the left ECN, to other frontal regions, including the frontal pole and the anterior division of the cingulate gyrus. Results show that long-term training is associated with increasedfunctional connectivity in specific resting state networks. While general musical training is associated with executive control functions, the finding that the Default Mode Network is more synchronized with other cortical regions in jazz improvisers is consistent with the hypothesis that real-time musical creativity relies on access to spontaneous thought processes.

Can professional musicians intentionally desynchronize? A natural case study of expert percussionists in a natural performance context

Speaker: Michael Schutz
4:00 – 4:20

With complex timing demands involving multiple actors, musical performance offers an ideal domain for exploring joint synchronization. Several previous studies have informed our understanding of interpersonal coordination when actors are attempting synchronization (i.e., Goebl & Palmer, 2008; Keller, Novembre, & Hove, 2014). This project offers unique, musically-grounded complement—examining highly trained percussionists attempting to intentionally desynchronize. This offers novel insight into the obligatory nature of joint synchronization that is contrary to highly trained musicians' artistic intentions. Impetus for this project comes from renowned composer Steve Reich's phase composition "Drumming" (1971), asking percussionists to begin a complex rhythmic pattern in synchrony before slowly separating. Although aiming for independence between the parts, we assessed what actually happens in performances by recording an excerpt of this piece on bongos fit with non-invasive customized triggers.

Note onset timings indicate that the "moving" voice averaged 0.25% faster in tempo (approximately .5 ms/beat) than the stationary voice. This small, consistent difference aligns with both the composer's requests and performers' intentions. However the separation and re-alignment of the voices was neither smooth nor monotonic. At least one fifth of the cycle repetitions in the nominally "accelerating" voice actually slowed down. The nominally "steady" voice displayed a similar pattern of tempo fluctuations, suggesting a complex pattern of mutual coordination contrary to the performer's intentions for independence. Additionally, the musicians display a surprising pattern of push and pull despite their stated goals of functioning independently. The complexity of these interactions is best understood through dynamic visualizations of the timing information, which will be shown in this talk. A preview of these animations is now publically available at www.maplelab.net/reich.

This exploration provides insight into a rich data set offering several novel properties. First, it is based on an unaltered excerpt of an acclaimed composition calling for an unusual process of inter-musician desynchronization. Second, this performance was given by two of the world's leading percussionist (Bob Becker and Russell Hartenberger), with significant experience playing this composition. Third, these data were collected in a naturalistic environment (McMaster's LIVE Lab) through the customized construction of individualized non-invasive, internally mounted triggers custom designed by percussion recording expert Ray Dillard. This unique approach has yielded an intriguing data set shedding new light on the process of spontaneous coordination when expert musicians attempt to de-synchronize in a highly practiced, "natural" musical task.