NEST 2026

New England Sequencing & Timing

The 34th Annual Meeting

April 11, 2026
University of Connecticut
Weston A. Bousfield Psychology Building
Room A106

Please use this **Live Stream link** for virtual conference attendance:
http://www.kaltura.com/tiny/lg2d6

Gala reception with cocktails, dinner, and jam will occur at Ed Large's home after the event.

Music Dynamics Lab
UCONN
https://musicdynamicslab.uconn.edu/

Registration & Breakfast: 9:00-9:20		
9:20	**Edward Large** University of Connecticut	Welcome
Session 1: 9:30-10:30		
9:30	**Jirachaya "Fern" Limprayoon** Yale University	Exploring Robot-Led Activities between People Living with Dementia and Family Care Partners
9:50	**Rakshith Lokesh** Northeastern University	Effect of Velocity-Curvature Relation on Physical Human Interactions with a Compliant Robot
10:10	**Leonora Blodgett** Northeastern University	Movement Patterns as a Vital Sign for Predicting Neurological Health and Development in Preterm Infants
10 Min BREAK		
Session 2: 10:40-11:40		
10:40	**Anthony Bruno** Brown University	Optimal Integration of Auditory and Visual Timing Cues
11:00	**Krishna Sarvani Desabhotla** Northeastern University	Synchronization with Object Dynamics in a Manipulation Task: Insights from Able-Bodied and Post-Stroke Individuals
11:20	**Xenia-Valerie Schmitz** Northeastern University	Altered Postural Control during Arm Movements in Autism: Behavioral, Physiological, and Modeling Results
10 Min BREAK		
Keynote 1: 11:50-12:35		
11:50	**Dobromir Dotov** University of Nebraska Omaha	Interaction with Large Musical Generative Models and Small Dynamical Systems
LUNCH & POSTERS: 12:35-2:00		
Session 3: 2:00-3:00		
2:00	**Anna Palumbo** New York University	Continuous Evaluation of Social Motor Synchrony During Music Therapy Among Children with Autism: A Feasibility Case Study
2:20	**Eva Luna Munoz Vidal** New York University	Cracking the Rhythm Code in Parkinson's Disease Through a Personalized Music-Based Tapping Task
2:40	**Frédérick Deschenes** Heidelberg University	Prediction and Resonance: What Relation Between the Hearer and the Heard?

10 Min BREAK		
Session 4: 3:10-4:10		
3:10	**Oscar Bedford** Montreal Neurological Institute	Mu Suppression Reveals Auditory-Motor Predictions after Short Musical Training
3:30	**Ji Chul Kim** University of Connecticut	Musical Rhythm as Coordinated Movement: A Dynamical and Embodied Approach to Rhythm Perception
3:50	**Connor Spiech** Concordia University	Neuromagnetic Oscillations are Sensitive to Metric Complexity
10 Min BREAK		
Keynote 2: 4:20-5:05		
4:20	**Justin London** Carleton College	How ***Not*** to Study Groove: A Report on Some Null Results, Along with Some Questions for the Standard Definition of "Groove"
POSTERS: All Day		
	Aleksei Krotov Northeastern University	Hitting a Target with a Bullwhip: Internal Models and Their Cognitive and Physical Determinants
	Silvia Buscaglione Northeastern University	Physical Human-Human Interaction in Postural Balance
	Kimberly Gowell Bridgewater State University	True or False? Music Tempo Unconsciously Impacts Response Times
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Abstracts

Session 1

9:30 **Exploring Robot-Led Activities between People Living with Dementia and Family Care Partners**
Jirachaya “Fern” Limprayoon (Yale University)

Background: Engaging in shared activities like deep breathing and singing can help people living with dementia (PLWD) and care partners stay connected, but emotional distress from communication barriers and responsibilities of daily care can make it difficult to initiate these activities. Social robots can lead shared activities to promote shared engagement.

Methods: We adapted Ommie to lead deep breathing and singing activities for PLWD and their care partners. We refined the robot’s behaviors through two interaction design sessions mediated by an occupational therapist, followed by a study with 17 pairs in one-hour sessions.

Results: We observe that participants engaged with the robot and each other, finding the sessions calming, familiar, and easy to follow. They often held hands, shared memories, and/or used humor to stay connected. We highlight three design opportunities: the robot as a tool for synchronization, an instrument for joint play, and a balance between familiarity and variety.

Conclusion: Overall, our findings serve as a starting point for continued exploration of how social robots can support shared engagement in care relationships between PLWD and their care partners by adapting to the changing needs and relationship dynamics of each pair.

9:50 **Effect of Velocity-Curvature Relation on Physical Human Interactions with a Compliant Robot**
Rakshith Lokesh (Northeastern University)

In physical human-robot interaction, humans and robots need to adapt to each other’s movements to ensure fluent and effortless collaboration. However, humans have limitations, such as the speed-accuracy trade-off and the so-called 1/3 power law. This study examined the role of the latter constraint, which states that humans slow down at curved path segments, while speeding up at linear segments. This observation manifests in a power-law relation between tangential velocity and radius of curvature. In this experiment, humans moved a mass collaboratively with a robot along an elliptical path in the horizontal plane. Human-preferred velocity-curvature relation was first identified when the participants performed the task alone. During the collaborative task, the robot imposed one of three velocity profiles with respect to ellipse radius of curvature under two mechanical impedance levels: obeying the human-preferred velocity-curvature relation, constant velocity, and exaggerated velocity modulation. Results from eleven participants showed that with the low-impedance robot, humans tended to reestablish toward their preferred exponent and exerted less tangential force in the preferred velocity condition compared to the constant and exaggerated conditions. Modeling the human as an impedance controller, simulations reproduced the experimental trends in the power-law exponent and forces. These findings show that human movement preferences and their physical interactions with a robot can be systematically analyzed leveraging the power-law relationship.

10:10 **Movement Patterns as a Vital Sign for Predicting Neurological Health and Development in Preterm Infants**
Leonora Blodgett (Northeastern University)

Background: Nearly 10% of all infants in the United States are born preterm, which is defined as <37 weeks' gestational age (GA). Preterm infants are at increased risk for developing neurological disorders, including cerebral palsy, autistic spectrum disorder, and attention deficit/hyperactivity disorder. Our research objective is to show that quantitative monitoring of movements in preterm infants in the Neonatal Intensive Care Unit (NICU) may aid in earlier identification of typical versus abnormal neurophysiological development. The goal is to develop normative maturation trajectories from movement recordings representing healthy motor development and identifying infants with complications.

Methods: Physiological signals including photoplethysmography (PPG) were collected from 65 subjects (<31 weeks GA) over their 8-10 week stay in the NICU. Subjects were divided into two cohorts; an uncomplicated cohort (n=47) defined as having no significant health issues, and a complicated cohort (n=18) with severe neurological complications. We utilized two novel methods for quantification of movement: Method 1 captures movement bouts from motion artifacts in the routinely measured PPG signal. Method 2 uses custom-designed, wireless wearable IMU sensors (LIMBITs) for continuous recording of limb movements.

Results: Using method 1, we quantified the distribution of movement bout duration across several weeks. A power law function fitted to the histogram of movement durations in uncomplicated infants rendered exponents across weeks that exhibited a steady increase across 8-10 weeks, indicating longer movement durations with increased maturation. Further, the activity distributions over 24 hours revealed increasingly stronger circadian cycle and additional 3-hour cycles in the uncomplicated cohort, aligned with their feeding schedule. Infants with neurological complications or feeding disorders showed deviating power law trajectories and a diminished or complete lack of ultradian motor rhythms. Method 2, applied to 7 infants, revealed differences in the occurrence of bilateral versus individuated limb movement.

Conclusions: The affected health of infants with complications are reflected by their respective motor patterns, supporting that movement can serve as a clinical tool for tracking development and quantifying emerging rhythms in motor activity. These clinical advancements may lead to earlier interventions that ultimately improve neurological outcomes in preterm infants.

Session 2

10:40 **Optimal Integration of Auditory and Visual Timing Cues**
Anthony Bruno (Brown University), Jovan Kemp (NYU Abu Dhabi), Fulvio Domini (Brown University), Leslie Welch (Brown University)

When watching an orchestra perform, humans might integrate the auditory and visual information to perceive the timing of the music precisely. If multimodal information is available, improvement from integrating is greatest when precision with the cues is comparable. Research in time perception often relies on flashing visual stimuli and auditory tones to define time intervals, but discrimination performance with these stimuli is significantly worse in vision compared to audition (e.g., Burr, Banks, & Morrone, 2009). Prior attempts to measure audiovisual integration relied on a perceptually-weakened auditory cue (Burr et al., 2009; Hartcher-O'Brien, Di Luca, & Ernst, 2014), but equating the strength of auditory and visual cues can be challenging and tedious. This begs the question, are discrete stimuli appropriate for studying how cues are optimally integrated to produce improved audiovisual timing? Previously, we showed that time discrimination performance with a continuous bouncing stimulus was significantly better than with a discrete visual stimulus (Bruno & Welch, 2022). Performance with the bouncing stimulus was comparable to performance with a continuous auditory stimulus, a tone that modulated in intensity to define time intervals. In another experiment, participants made time interval judgments with continuous visual, auditory, and audiovisual stimuli. Participants' performance with the audiovisual stimulus was significantly better than either of the single-cue stimuli. To investigate how auditory and visual cues were integrated to result in improved performance, we compared performance with the audiovisual stimulus to two cue-integration models. One model predicts that auditory and visual interval estimates are perceived in parallel and then integrated, while the other predicts that auditory and visual event-markers are integrated from which a unified interval estimate is produced (Hartcher-O'Brien et al., 2014). Performance was predicted better by the time-interval integration model, which suggests the optimal integration mechanism brings together separate auditory and visual time-interval estimates to produce improved audiovisual timing.

11:00 **Synchronization with Object Dynamics in a Manipulation Task: Insights from Able-Bodied and Post-Stroke Individuals**

Krishna Sarvani Desabhotla, Silvia Buscaglione, Sidharth Annapragada, Rakshith Lokesh, Julie DiCarlo, Caroline Lambert, Susan Goedeken, Kelly Rishe, David Lin, Dagmar Sternad (Northeastern University)

Synchronization is ubiquitous in living and non-living systems. Humans tap to a metronome and coordinate their limbs into simple integer frequency ratios. This behavior has been modeled using coupled oscillators, where stable performance tends to settle onto single frequencies or integer ratios. Beyond this explicit coupling to external cues or the well-documented interlimb coordination, many human activities require interacting with complex objects, such as drinking a cup of coffee, that create interaction dynamics in the sloshing coffee. Our previous work has shown that participants tend to make such object interactions predictable and stable. Here, we asked whether this stability in the human-object dynamics rests on synchronizing components of this complex task. With the additional goal to shed light on dyscoordination in post-stroke individuals, we ask if their diminished performance is due to impaired synchronization. 20 able-bodied and 15 post-stroke individuals transported a cup with a ball rolling inside (a simplified cup of coffee) along a whiteboard, while an overhead camera recorded the object's kinematics (the "MAGIC Table" system). This cup-ball system was designed to match a spherical cart-pendulum model, enabling estimation of system forces from recorded kinematics. Conventional kinematic measures (movement time and smoothness) were complemented by measures of the interacting forces of cup and ball. We assessed cup-ball interaction in terms of its predictability of interaction (mutual information) and synchronization between the oscillatory forces of the cup and the ball. Results showed that able-bodied participants synchronized their cup forces with the ball forces, exhibiting 1:1 and 1:2 frequency ratios. Post-stroke participants exhibited more complex frequency-locking, especially when performing the task with their more-affected hand. Furthermore, post-stroke participants generated less predictable interactions with the object in both kinematic and dynamic domains. Correlation analyses revealed that kinematic and dynamic measures were interrelated in able-bodied participants, while in post-stroke individuals, none of the kinematic measures correlated with force synchronization. These results demonstrate that synchronization is also inherent to complex interaction dynamics. While able-bodied humans exploit stable frequency ratios to achieve stable behavior, post-stroke individuals exhibited a reduced ability to synchronize with the self-generated dynamics in the object.

11:20 **Altered Postural Control during Arm Movements in Autism: Behavioral, Physiological, and Modeling Results**
Xenia-Valerie Schmitz (Northeastern University)

Everyday actions require the precise sequencing of muscle activity across multiple body segments while maintaining postural stability. This temporal organization is particularly evident in anticipatory postural adjustments (APAs), where postural muscles activate in advance of voluntary movement to counteract predictable destabilizing forces. Through this predictive organization, the motor system links the timing of limb dynamics and postural stabilization to produce efficient and stable whole-body movement. Among neurodevelopmental conditions, autism spectrum disorder (ASD) provides a particularly salient example of an interplay between movement challenges and interactions with the environment. Although ASD is formally defined by challenges in social communication and repetitive behaviors, differences in motor coordination are commonly reported. The present study examined the temporal coordination of whole-body movement in autistic and non-autistic children during a rapid arm-raising task performed while standing. Rapid arm movements generate predictable mechanical disturbances to posture, requiring anticipatory postural muscle activation to maintain stability. By simultaneously measuring arm and trunk kinematics, center-of-pressure (CoP) dynamics, and EMG activity, we characterized how limb movement, postural control, and muscle activation were temporally organized through movement.

Significant group differences emerged: Autistic children exhibited longer movement times driven by a prolonged deceleration phase, despite achieving comparable peak arm velocities. Consistent with these kinematic differences, postural dynamics were more variable in the autistic group, as reflected by increased entropy in CoP velocity, most markedly in the deceleration phase. These signs of higher variability are likely ascribed to delayed onset of muscle activity in trunk muscles, suggesting reduced anticipatory coordination between limb movement and postural stabilization. Together, these findings point to differences in the temporal organization of motor control. When anticipatory coordination between limb and postural systems is imprecise, destabilizing forces generated by the arm movement may accumulate before compensatory adjustments are fully engaged. Such temporal mismatches become most apparent during movement termination, when the motor system must precisely coordinate limb deceleration with postural stabilization. Simulations using a simplified skeletal model corroborated that the observed motor differences in autism may stem from shorter prediction horizons, which increases reliance on reactive feedback contributing to motor coordination challenges in neurodevelopmental conditions. By focusing on the timing relationships between muscle activation, limb dynamics, and postural stability, this work highlights how subtle alterations in predictive temporal organization can shape whole-body coordination. Understanding these timing processes may help clarify the mechanisms underlying motor differences in autism and contribute to broader accounts of how predictive control supports coordinated behavior.

Keynote 1

11:50 **Interaction with Large Musical Generative Models and Small Dynamical Systems**
Dobromir Dotov (University of Nebraska Omaha)

Music is an inherently social activity that allows people to share experiences and feel connected with one another. There has been progress in neural network architectures that implement large-language-like generative models producing realistic musical scores, but less progress has been made to enable social experiences for a human playing interactively along with an artificial partner. Playing music socially sometimes works better without a score: Each participant must complement the ideas of other musicians. We investigated whether a generative model trained for passive production of musical scores, not for interaction, could enable social interaction with high quantitative measures of experience. The model, a variational autoencoder pretrained on a very large corpus of digitized and quantized piano scores, was adapted for a timed call-and-response task with a human partner. Human participants played piano with another human and separately with artificial partners parameterized for different time spans, tendencies for variation, and imitation of the human. Improvisation was not required from the humans, but it was encouraged. After each trial, participants rated the performance quality and their experience of self–other integration. Overall, the artificial partners failed at enabling convincing improvisation but were seen as adequate for basic practice. Performance differences among configurations of the artificial partner suggested paths for the future evolution of such partners. The ones with the simplest architecture and highest similarity were rated highest and were not statistically different from the human partners on realism, ease to interact with, and self–other integration. We discuss what principles may be needed, including open-ended evolution in Artificial Life, to arrive at artificial partners that enable genuinely interactive experience.

(Part 2)
When we walk, our footsteps generate rich acoustic information about foot timing, dragging, loading rate, etc. Its role as endogenous auditory feedback for gait control remains underexplored. Building on delayed auditory feedback (DAF) for speech, we investigated whether manipulating the delay and amplification of self-produced footstep sounds modulates gait dynamics. Thirty healthy young adults walked overground while receiving real-time lateralized playback of the sound produced by their feet. Auditory feedback was delivered with no delay, low delay (12.5% step duration), or high delay (25% step duration), and at either full or half amplification. There was a masked hearing condition with pink noise. Spatiotemporal gait parameters, namely cadence,

speed, stride length, and coefficient of variation, were analyzed as change relative to baseline. We found that amplification without delay reduced variability by almost 10% on average, consistent with strengthened sensorimotor coupling via enhanced perceptual access to foot–ground interaction dynamics. A second finding was that delay increased the cadence of walking instead of reducing it, contrary to our expectations. We discussed how this effect can be explained by both predictive and anticipatory dynamic systems with delayed feedback. We developed a theoretical model with anticipatory dynamics, with implications for closed-loop gait rehabilitation tools.

Session 3

2:00 **Continuous Evaluation of Social Motor Synchrony During Music Therapy Among Children with Autism: A Feasibility Case Study**
Anna Palumbo (New York University)

Social motor synchrony (SMS) is reduced in autistic individuals, contributing to challenges with social communication. Music interventions enhance SMS and social communication among autistic children; however, identifying the mechanisms of these effects is an essential step towards optimizing interventions. Here, we present a case study from a larger ongoing study examining the effects of Nordoff-Robbins Music Therapy (NRMT) on SMS, music engagement, and social communication in autistic children. SMS was evaluated using cross correlation of accelerometry signals collected from clients and therapists over the course of 15 weeks of treatment. Open sources smart watches (Bangle.js) recorded accelerometry signals using the BEATmonitor dashboard. The Music Engagement Scale (MES) evaluated changes in music engagement in each session on a 9-point Likert Scale. Social affiliation, social reciprocity, and vocabulary were evaluated before and after 15 weeks of treatment using the Stanford Social Dimensions Scale, the Autism Impact Measure, and the MacArthur-Bates Communicative Development Inventory (MB-CDI), respectively. Findings demonstrate that the client improved from non-interactive to interactive music making on the MES, a significant clinical development in music therapy. There was also improvement in vocabulary comprehension and production on the MB-CDI. We will present video examples of clinical progress as well the association over time between clinician indexed moments of interest and changes in SMS. This is the first study to our knowledge using wearable technology to evaluate SMS continuously during music therapy sessions. Findings show feasible measurement of SMS, music engagement, and social communication in a clinical setting.

2:20 **Cracking the Rhythm Code in Parkinson's Disease Through a Personalized Music-Based Tapping Task**
Eva Luna Munoz Vidal (New York University)

Therapeutic strategies based on rhythmic auditory cues and entrainment can improve motor function in individuals with Parkinson's disease by engaging motor and reward-related dopaminergic systems affected by the disorder. However, considerable individual variability in symptoms and treatment responsiveness highlights the need for more personalized therapeutic approaches. Critically, there is scarce research on the characterization of behavioral correlates of music reward, groove and rhythm perception and production in either Parkinson's disease or healthy adults. This study aims to validate a novel and accessible music-based finger-tapping task that leverages individualized, rewarding music to optimize motor therapeutic outcomes in Parkinson's disease. Using a 3×4 factorial design, we manipulated three song conditions (no song, self-selected song, and researcher-selected song) and four levels of superimposed rhythm complexity (steady beat, low syncopation, medium syncopation, and high syncopation). Thirty-six healthy adults completed the finger-tapping task on a millisecond-precision pad. The task included 28 trials (20 seconds each) in which participants tapped along with the beat of the stimulus. Tapping accuracy and consistency were recorded for each trial. Participants also rated affective responses—including pleasure, groove, physical and cognitive challenge, and familiarity—using a 7-point Likert scale. Linear mixed-effects models showed that tapping accuracy and consistency were influenced only by superimposed rhythm complexity, with the steady beat condition producing the lowest error and highest consistency. In contrast, pleasure and groove ratings were influenced by song condition, with self-selected music receiving the highest scores regardless of superimposed rhythm complexity. Consistent with prior work, an inverted U-shaped relationship between rhythmic complexity and pleasure and groove ratings was observed when melody was absent. These findings suggest that combining self-selected songs with a steady beat maximizes reward and groove while maintaining high tapping accuracy and consistency, making it the most effective condition for the task. Future work will extend this paradigm to individuals with Parkinson's disease and matched controls.

2:40 **Prediction and Resonance: What Relation Between the Hearer and the Heard?**
Frédérick Deschenes (Heidelberg University)

TBA

Session 4

3:10 **Mu Suppression Reveals Auditory-Motor Predictions after Short Musical Training**
Oscar Bedford (Montreal Neurological Institute)

Auditory-motor coupling is a bidirectional neural mechanism that supports speech and music, with evidence of motor system activation during passive listening to both spoken language and learned melodies. Such activation is anticipatory, occurs in non-musicians, and can be elicited at the single-note level. These findings support the idea that motor activity guides auditory perception by relaying predictive timing information. However, the neural processes underlying this activity are not fully understood. EEG studies in musicians have linked it to mu-band suppression, but the temporal scale and the generalizability to the broader population remain unclear. We recruited 25 non-musicians who learned to play a simple melody on a piano-like keyboard. Before and after training, participants passively listened to the trained melody and control melodies. Offline, EEG data from the motor training were used to create a time-frequency mask with which to identify mu suppression occurring during passive listening. Significant mu suppression emerged before each note only during post-training exposure to the practiced melody. Results suggest that mu suppression occurs at the single-note level following short motor training and is not dependent on prior musical experience. Our findings support the notion that motor activity aids perception by anticipating the unfolding of learned auditory-motor sequences.

3:30 **Musical Rhythm as Coordinated Movement: A Dynamical and Embodied Approach to Rhythm Perception**
Ji Chul Kim (University of Connecticut)

In this talk, I will introduce a new theory of music perception called Embodied Dynamics of Music (EDM) and discuss how rhythm perception can be reconceptualized from the perspectives of EDM. Cognitively oriented theories treat music as an external signal and describe how musical structures are encoded and represented in the brain. EDM takes a dynamical and embodied approach and treats music as a dynamic pattern of coordinated action distributed over the brain, the body, and the environment. From this view, perception of musical rhythm engages the same kind of coordinated action that produces musical rhythm which involves overt body movement and covert inner motion, the latter in the form of trajectories of neural activities. Alternative characterizations based on EDM will be given for main ideas and concepts in rhythm perception, including beat (as regular anchor points for coordinating movements), meter (a mode of coordinated movement), rhythmic accent, attention and expectation (heightened sensitivity and anticipation in perception-action coupling), syncopation (potentially destabilizing force in coordinative structure), and groove (stabilization of coordinative structure with body movement). The new embodied dynamic conceptions will be compared with current views, and experimental strategies for testing EDM will be discussed.

3:50 **Neuromagnetic Oscillations are Sensitive to Metric Complexity**
Connor Spiech (Concordia University)

The pleasurable urge to move to music (termed “groove” by music psychologists) varies with rhythmic complexity. In common meters like 4/4, moderate rhythmic complexity evokes the greatest groove in Western listeners, but in non-4/4 meters (e.g., 7/8), low rhythmic complexity evokes the greatest groove (Spiech et al., 2025). Neural resonance theory explains that the more complex integer ratios found in many non-4/4 meters are more difficult for oscillators in the motor cortex to entrain to without substantial exposure in a process called attunement (Large & Snyder, 2006; Kim & Large, 2021; Tichko & Large, 2019). While the behavioral evidence clearly suggests that Western listeners’ synchronization and preferences favor 4/4 over non-4/4 meters (Snyder et al., 2006; Spiech et al., 2025), it has yet to be shown that neural oscillations are sensitive to these metric differences as neural resonance theory predicts. Thus, this study leverages the high spatial and temporal resolution of source-resolved magnetoencephalography (MEG) to determine whether oscillators in the motor cortex are sensitive to metric complexity. Participants first rated the groove of 26 musical clips of varying rhythmic complexity in either 4/4 or an uncommon meter. Afterwards, participants tapped to the same musical clips to confirm that they exhibited superior synchronization performance for clips in 4/4. Subsequently, participants listened to each musical clip a further nine times in the MEG scanner before T1-weighted anatomical MRI scans were acquired for source localization. Preliminary behavioral analyses replicate past findings, with moderate rhythmic complexity exhibiting the greatest groove only in 4/4 where synchronization performance was stronger. Preliminary MEG analyses of evoked and induced activity in the delta (i.e., beat-related frequencies) and low-alpha (i.e., sensorimotor mu) bands mirror the groove ratings with moderate rhythmic complexity tracks in 4/4 evoking the greatest spectral power and inducing the most stable oscillations. Taken together, these early findings confirm neural resonance theory's prediction that neural oscillations are sensitive to encultured, metric structures.

Keynote 2

4:20 **How *Not* to Study Groove: A Report on Some Null Results, Along with Some Questions for the Standard Definition of "Groove"**

Justin London (Carleton College), Anne Danielsen (University of Oslo)

As most NEST attendees will know, "groove studies" are a flourishing area in music perception and cognition. And you are also likely to know that most operational definitions of "groove" run along the lines of "the pleasurable urge to move along with the music" (Janata, Tomic, & Haberman 2012; Witek et al. 2014; Camara & Danielsen 2018; Senn, et al. 2020; etc., etc.). And finally, we all have the intuition that some music is groovier than others, as documented in many studies which involve ratings of grooviness, starting with Janata, et al (2012). This led a group of us at the RITMO Centre for Interdisciplinary Studies in Rhythm, Time and Motion to explore quantity of movement that groovy sounds and rhythms elicit. Our hypothesis was that groovy music should make you move more than non/less-groovy music, and so we started with both individual sounds and rhythmic patterns with varying degrees of complexity.

Here we report on two experiments with null results. The first is a mocap experiment where participants moved along (using a shaker or just holding a similar mass) to a set of musical examples that presumptively varied in grooviness, where we measured the movement trajectories as well as the total quantity of motion. The second involved a version of RITMO's "standstill" project, which is just what you might think it is: an experiment in which participants try and stand still while listening to silence as well as a range of stimuli. In both pilot studies we didn't get any significant results. In the first, once participants started playing the shaker along with the music, their movement characteristics were pretty much the same for all stimuli. In the second, groovier sounds didn't make any difference than non-groovy sounds.

We obviously need to do more studies/better experiments, but we also have some provisional takeaways. First, while we may think that some sounds are groovier than others, groove seems to reside in patterns of sounds, along with their articulation, timing, and other factors—one dimension is not enough to reliably measure groove. Second, while we know that familiarity and listener preference may influence groove (see Bechtold, Curry, & Witek 2025 for a recent overview), the listener's own movement can make a "meh" rhythm seem pretty groovy, suggesting that groove may be an emergent property that comes from the interaction between the music and the listener's kinematic engagement with it. Finally and most of all, we question whether grooviness can be correlated with overt movement at all: to the extent that any rhythmically regular stimulus gives rise to neural resonance/entrainment of the sensorimotor system, movement naturally follows. Thus we may need a better psychological construct for groove, if movement is not a reliable measure of it.

Posters

Hitting a Target with a Bullwhip: Internal Models and Their Cognitive and Physical Determinants

Aleksei Krotov (Northeastern University)

Internal models of the body and the environment are considered necessary for controlling goal-directed movements. However, the evidence during interactions with complex objects (many DoFs and nonlinear dynamics), is lacking. This study examines possible internal models – cognitive or embodied – underlying interactions with a bullwhip.

Seventeen novices used a 1.6-m whip to hit a target at 2.2-m distance repetitively 150 times per day, for 13 sessions over 1 month, as their body and whip kinematics were recorded. Prior to recording, all subjects completed a fitness and sport-experience questionnaire. Half of them were additionally primed in physics of the whip and the task.

With practice, all participants improved their target-hit rates from 5% to 35-60%. While neither cognitive nor athletic factors predicted performance, so did the experience with overarm sports (volleyball or tennis). To further explore this throwing-related effect, we projected the whip CoM at the target plane at every point of its trajectory. The projected distance-to-target reached a minimum together with CoM's speed maximum. It also strongly predicted performance and similarly decreased with practice. Humans therefore may embody a simplified representation of the complex whip dynamics based on the throwing and aiming experience. Such representation may help CNS in motor control.

Physical Human-Human Interaction in Postural Balance

Silvia Buscaglione, Marta Russo, Dagmar Sternad (Northeastern University)

From toddlers learning to walk to individuals requiring physical support while standing or walking, humans naturally rely on assistance from others to maintain their postural balance. Despite the increasing accessibility of intelligent support systems, canes remain the preferred assistive device for individuals with postural balance deficits. However, canes are also perceived as difficult and risky to use due to their mechanical instability, leading to frequent abandonment. Understanding how humans physically support each other by simply holding hands could inform the development of human-like intelligent assistive technologies. These devices should mimic the actual and perceived stability experienced when holding hands with a human partner. Haptic information in postural control has been investigated but only with earth-fixed surfaces, and the potential benefits of bidirectional coupling between individuals remain largely unexplored. As a preliminary step toward understanding human-human physical interaction for balance enhancement, this study examined the effect of holding hands on standing balance between partners of equivalent or different skill levels.

Novice undergraduate students (n=10) and experts (ballet dancers, n=14) stood in tandem stance on a narrow beam (width 3.65cm, height 7.62cm). Dancers executed the task alone without support, coupled with novices, and coupled with another dancer. Novices performed alone and with a novice partner. During the coupled conditions,

both participants stood side by side on the beam, facing forward, while holding the same handle of a compliant robot. Vision of the partner was occluded. We recorded the robotic handle force, whole-body kinematics, and ground reaction forces of one focal participant. Performance was assessed by the percent time they had stepped off the beam, the center of mass (CoM) velocity, and the CoM's positional sway estimated by the 95% confidence ellipse. Additionally, we quantified movement coordination between partners by correlating their CoM timeseries through mutual information.
In the single conditions, novice participants showed worse performance than experts for all dependent measures. Yet, when 'holding hands' with a novice partner, their performance improved, reaching expert values. Counter expectations, experts were neither perturbed by a novice partner, nor stabilized by another expert. Expert dyads exchanged information mainly along the less important anterior-posterior direction, whereas novice dyads equally exchanged information in both the anterior-posterior and medio-lateral direction, but relied on medio-lateral communication significantly more than two experts.

Our findings revealed the critical role of bidirectional haptic feedback in enhancing postural stability and demonstrated the central nervous system's ability to effectively exploit haptic information. By characterizing principles underlying balance support in human-human interaction, this study highlighted the importance of incorporating appropriate force feedback control in intelligent assistive devices, according to task challenges and user skill, and thereby advance the design of physical human-robot interaction for postural support.

True or False? Music Tempo Unconsciously Impacts Response Times
Kimberly Gowell, Melissa Brandon (Bridgewater State University)

Research on music and exercise suggests that to be stimulative, music should have a faster tempo, and to be sedative, music should have a slower tempo (Karageorghis & Priest, 2012). Numerous theories in music cognition suggest that attention can be selective and that structural elements of music, such as tempo, can align with or disrupt perceptual focus and attentive behaviors (Nadon et al., 2021). These findings have raised the question of whether tempo would show a significant effect on cognitive task performance and response time (RT). The goal of this project was to examine whether tempo impacts processing speed during an everyday task — specifically, answering basic true/false general knowledge questions. A sample of 90 New Englanders was recruited to complete the task of answering true/false questions whilst listening to different tempo background music (BGM). The study involved a control group that listened to brown noise, and two experimental groups that listened to either a slow-tempo Irish funeral dirge or a fast-tempo Irish jig, chosen due to their relative unfamiliarity. We hypothesized that the fast-tempo condition would produce faster response times. Results from a univariate ANOVA revealed no significant difference between conditions ($p > .05$). A ceiling effect was observed (mean accuracy > 93%). When examining the RTs by condition, we found the mean timing patterns across conditions to counter our hypothesis. Cohen's d was calculated to further investigate between-condition differences. A medium effect size difference ($d = .508$) indicated longer mean RTs in the fast-tempo condition than the slow-tempo condition. These findings are discussed in relation to study limitations, with implications for future methodological refinements in assessing tempo-related differences in RT.

Local Arrangements

Registration

Registration fee ($40 for faculty, $25 for students/postdocs) can be paid on site by cash, check or Venmo (breakfast, lunch and dinner will be provided).

Technology

Presenters will be asked to share their slides via the standard HDMI port. Please bring any dongles you need!

A **Live Stream** link for virtual presentations is available here: http://www.kaltura.com/tiny/lg2d6

Wi-Fi is available via the UConn-Guest network or EDUROAM network.

Venue

University of Connecticut
Bousfield Psychology Building, Room A106
406 Babbidge Rd, Storrs, CT 06269
Google Maps: https://maps.app.goo.gl/NUXT1UnKjdjJ78Rq9
Apple Maps: https://maps.apple/p/XhKJ04QjDbZHM6

Evening cocktails & dinner will occur at Ed Large's home.

Parking

Parking is available in the following lots:

- South Parking Garage (there will be signs to the conference site; see here for parking fee; payment is required at the time of entry and can be made via the Flowbird mobile app or at the kiosk near the elevator on the first floor.)
- There are also a limited number of on-street parking spaces on Whitney Road that are free on Saturdays.
- Lot S (free on Saturday)
- Fine Arts Lot 1 (free on Saturday)

Handicap Parking is available at the back of the Bousfield Building & in the South Garage.

If you need transportation from the parking lot, please contact the UConn Accessible Van Service: **(860) 486-4991** to make arrangements.

Other parking venues can be found on UConn's parking map (interactive, PDF). Please make sure **not** to park in spots marked as restricted or limited: you WILL get a ticket!

Food & Refreshments

Registration costs will cover breakfast, lunch, and dinner.

If you need to purchase your own meals, a few restaurants within walking distance offer vegan/vegetarian, gluten free, and other options. Here are some of our favorites (links go to Google maps):

- Dog Lane Cafe (Vegetarian, GF options)
- Kathmandu Kitchen & Bar (Vegan/vegetarian options)
- Little Aladdin Mediterranean (Halal, vegetarian options)
- Moe's Southwestern Grill (Vegan/vegetarian, GF options)

A CVS pharmacy and Price Chopper are also available within walking distance.

Acknowledgements

UConn Music Dynamics Lab

PI: Dr. Edward Large

Conference Organization/Programming/Communications:

Dr. Ji Chul Kim
Susan Tilbury, MT-BC

Conference Volunteers:

Zachary Buck
Frédérick Deschenes
Avarie Kim
Nandini Patel
Shaili Patel
Chloe Vargo
Angelica Whitney
Karli Zerek

Special Thanks

UConn Center for the Ecological Study of Perception & Action (CESPA)
UConn Department of Psychological Sciences
UConn Institute for the Brain & Cognitive Sciences

And all our friends and colleagues in NEST who continue to contribute to this wonderful meeting!