New England Sequencing and Timing 2012

Welcome to NEST

SCHEDULE

8:30-9:15 Registration and continental breakfast (provided)
9:15-9:25 Welcoming remarks

9:25-9:50 ZELAZNIK
Synchronization timing in circle drawing with a random, or a random repeating metronome sequence
9:50-10:15 HASUO
The occurrence of the filled duration illusion for short time intervals
10:15-10:40 CHAPMAN
A Constraint Hierarchy Approach to Bimanual Rotation

10:40-11:05 coffee break (provided in lobby)

11:05-11:30 BROWN
Timing and Memory Updating Rely on the Same Executive Attentional Resources
11:30-11:55 KINGSTON
You got to be discriminating to get contrast
11:55-12:20 COELHO
Pursuing the Limits of Hand Preference: Is End-state Comfort the End of Handedness?

12:20-1:20 ***LUNCH*** *(provided in lobby)*

1:20-1:45 GONG
Picking up a close bucket at the cost of transporting it a longer distance: A study of walking and reaching
1:45-2:10 BALASUBRAMANIAM
Crossing the hands confuses the clocks
2:10-2:35 HASSON
Variability, Safety Margins, and Redundancy in a Timing Task
2:35-3:00 TURVEY
Are serial and parallel dynamics alike? A lesson from human odometry

3:00-3:20 coffee break (provided in lobby)

3:20-3:45 HOVE
An fMRI reassessment of modality differences in sensorimotor synchronization *and* two applications of rhythmic stimulation
3:45-4:10 KURDZIEL
Does the cerebellum contribute to non-motor sequence learning?
4:10-4:35 ZIPSE
Can speakers with aphasia entrain their tapping to short rhythmic patterns?

4:35 Closing remarks

5:30ish Drinks at High Horse (Upstairs at 24 North Pleasant Street, downtown Amherst)
6:15ish Dinner at 148 Red Gate Lane, Amherst

ABSTRACTS

Synchronization timing in circle drawing with a random, or a random repeating metronome sequence

H.N. Zelaznik[1] & Breanna E. Studenka[2],
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The event-emergent timing distinction has its major pillar of support in the comparison of timing behavior in tapping (event-like timing) and circle drawing (emergent timing). These comparisons have occurred within the continuation phase of repetitive timing; continuation is when the metronome is turned off. Recently, Studenka and Zelaznik (2011a,b) have shown that synchronization in circle drawing is quite problematic, and in fact does not show the classic phase correction process clearly seen in synchronization in tapping. Studenka and Zelaznik (2011b) show that adding a source of discrete tactile feedback at the timing target in circle drawing produces phase correction behavior. In the present experiment to be reported, we examined whether adding discrete tactile feedback in circle drawing afforded synchronization behavior. Furthermore, we compared synchronization performance when the metronome produced a constant period of either 400 or 600 ms, or when the metronome was a random repeating sequence or a random sequence (with a 7% range). Results were clear. Having discrete tactile feedback greatly improved synchronization performance; however, participants showed no evidence of implicitly learning the repeating fluctuating random sequence. Overall we take this evidence as further support for the idea that event timing does not depend upon discrete movements, but also is invoked with discrete perceptual events.

The occurrence of the filled duration illusion for short time intervals.

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The purpose of the study was to examine the occurrence of the filled duration illusion, in the auditory modality, with short time intervals (40-520 ms). The filled duration illusion in this study refers to the well-established phenomenon in time perception, in which a filled time interval (the duration between the onset and the offset of a continuous sound) is perceived to be longer than an empty time interval (the duration between two very brief sounds) of the same physical duration. We focused especially on the effects of duration range, experimental methods, and individual differences. In Experiments 1 and 2, we measured the subjective duration of each time interval utilizing the method of adjustment. The range of interval duration was 40-360 ms in Experiment 1, and 40-520 ms in Experiment 2. In Experiment 3, we used magnitude estimation to measure the subjective duration of the same stimuli as those in Experiment 2. Experiments 1-3 were conducted in Japan with participants trained to become acoustic engineers. Experiment 4 was the same as Experiment 1, except that it was conducted in Canada with untrained participants. When the method of adjustment was used, the filled duration illusion could not be observed for most of the participants, regardless of the range of duration, while it appeared clearly for a few participants. When the method of magnitude estimation was used, such clear difference between participants does not appear, and on average, the filled duration illusion took place as in previous literature. With untrained, non-Japanese participants, the variability between participants was larger, and the filled duration illusion was more likely to take place than with trained, Japanese participants. The results indicated that there are two different strategies for perceiving duration with auditory stimuli: one would cause the filled duration illusion, and the other would not. The latter strategy seemed to be used more often for short durations and for method of adjustment tasks, and was more likely to be used by trained participants.

A Constraint Hierarchy Approach to Bimanual Rotation

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The essence of skilled performance is the capacity to choose and carry out actions flexibly. For such flexibility to be possible, actors must be able to prioritize constraints for actions differentially according to task demands. Despite such flexibility, there may be a default prioritization of constraints, with some constraints being more important than others as a matter of course. We explored this issue by studying a bimanual rotation task in which participants aligned colored squares positioned at different places by grasping and rotating two wooden handles. We coded participants' initial grasps on the handles, final grasps, degree of rotation, and direction of rotation, to determine the relative importance of these factors. Our analysis suggested that the most important factor was the pair of postures adopted in the final grasps.

Timing and Memory Updating Rely on the Same Executive Attentional Resources

Scott W. Brown & Tammy M. Johnson
Department of Psychology, University of Southern Maine

Two dual-task experiments were designed to assess interference patterns between concurrent serial temporal production and memory updating tasks. Experiment 1 involved updating the value of a 3-digit sequence and Experiment 2 involved updating the value of a letter in the alphabet. Both experiments revealed a strong bidirectional interference effect between the timing and updating tasks. Compared with single-task conditions, dual-task conditions were associated with (a) longer and more variable temporal productions, and (b) less accurate memory updating judgments. In addition, greater numbers of updating operations led to progressively longer and/or more variable timing responses and progressively inaccurate updating responses. The results suggest that timing and updating depend on a common set of executive attentional resources.

You got to be discriminating to get contrast

John Kingston[1] *& Shigeto Kawahara*[2]
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At NEST in 2007, we presented a study of Italian, Norwegian, Japanese and English speakers' categorization and discrimination of a silent interval that varied in duration (see also Kingston, Kawahara, Chambless, Mash, & Brenner-Alsop, 2009). This interval has flanked by vowels in the speech condition and by filtered square waves in the non-speech condition – in the speech condition, the silent interval was perceived as a voiceless stop consonant. The preceding vowel's or filtered square wave's duration was varied orthogonally from the silence's duration. Except when a consonant's and a preceding vowel's durations vary inversely in their native language (Italian and Norwegian listeners) ***and*** the stimuli were speech, listeners judged the silence to be longer when the preceding sound was longer. We described the general finding as a product of listeners' adding the durations of the two intervals together in all other conditions. These findings accord with those reported by Fowler (1992) but not those reported by Kluender, Diehl, & Wright (1988), whose listeners categorized the silent interval as longer when the preceding vowel or square wave was shorter. Fraisse (1963, 1984) and more recently Nakajima, Hoopen, Hilkhuysen, & Sasaki (1992) showed that so long as the duration ratio between successive intervals is close to 1 and doesn't exceed 2, listeners judge the second interval as long after a long first interval, but once the ratio greatly exceeds 2, they judge the second as long after a short first interval. This observation may explain our earlier results because most of the duration ratios in our stimuli were in the 1-2 range.

At this NEST, we will report new results using more extreme ratios, up to 3, which show that listeners discriminate silences better when their durations vary inversely with the durations of the preceding vowels or non-speech sounds. Contrast still did not arise in categorization, even with the largest duration ratios. Kato, Tsuzaki, & Sagisaka (2003) report that listeners treat variation in the onset times of successive vowels but not their offset times as evidence of rate variation. Because manipulating the duration of the silence varied the onset time between successive vowels or square waves in our earlier stimuli, our listeners may have been covertly judging rate rather than the silence's duration relative to the preceding vowel's or square wave's. We may also report the results of an experiment examining this explanation of our earlier results.

Pursuing the Limits of Hand Preference: Is End-state Comfort the End of Handedness?

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People plan for motor tasks by adding and prioritizing constraints, at least when coupling or mechanics cannot solve the degrees of freedom problem. We sought to identify the relative priority of two constraints for an object displacement task -- which hand to use (left or right) and which grasp to use (overhand or underhand). The object to be displaced was a horizontal rod whose left or right end was to be placed into one of five nearer targets. In one condition, we told participants which hand to use and let them to choose either grasp. In another condition, we told participants which grasp to use and let them to choose either hand. When hand was specified, the chosen grasp ensured end-state comfort (thumb up at end). When grasp was specified, the chosen hand again ensured end-state comfort. These results suggest that end-state comfort is more important than handedness.

Picking up a close bucket at the cost of transporting it a longer distance: A study of walking and reaching

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The coordination of walking and reaching has received remarkably little attention in the study of motor control. Furthermore, among those few studies that have been done on this topic, very few studies have explored macroscopic path selection. We asked participants to choose between picking up a bucket on the left or picking up a bucket on the right to carry the picked-up bucket to a far left or far right platform. The far left and right platforms were the same distance (16 feet) from the participant's starting position. The left and right buckets stood 2 feet, 4 feet, 6 feet or 8 feet away from the participant's starting position in all possible left-right combinations. We found that participants did something surprising: When the two buckets were different distances from the starting position, they picked up the nearer bucket even though that meant they had to carry it fa! rther. This result held up regardless of whether the bucket was light or heavy (even as heavy as 7 lbs). The results suggest that some kinematic/cognitive factor was taken into account that offset the cost of carrying the bucket farther.

Crossing the hands confuses the clocks

Ramesh Balasubramaniam[1], Bree Studenka[1,2] & David Shore[1]
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Tapping with fingers of two different hands exhibits less timing variability than tapping with one finger alone. This effect has been termed the bimanual advantage. A leading theory suggests that the bimanual advantage is due to coupled central timekeepers. Alternatively, increased

sensory feedback from two different effectors could also account for enhanced timing precision. Recent work has shown that crossing the arms impairs temporal order judgments and perception of limb position. Therefore with the arms crossed, we expected the reduced tactile sensitivity to diminish the strength of the bimanual advantage. In two experiments, participants tapped with their arms crossed or uncrossed on a tabletop or in the air in both unimanual and bimanual conditions. A significant bimanual advantage was observed for the uncrossed, but not the crossed posture in both tabletop and air tapping, supporting the role of somatosensory information in reducing timing variability. These data bring into question the unitary role of putative multiple coupled clocking mechanisms that have been used to account for the bimanual advantage.

Variability, Safety Margins, and Redundancy in a Timing Task

Christopher J. Hasson[1] and Dagmar Sternad[1,2,3]
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The human body is fundamentally redundant, with many more neurons, muscles, and joints than are necessary to perform most actions. Redundancy also exists at the task-level when there are multiple ways to reach a spatial goal in a given time, as when placing a cup of coffee on a coaster. Although many movement strategies may lead to the same goal, some accommodate task execution variability better than others through larger safety margins. How safety margins are shaped by task redundancy and subjects' variability are important open questions. Two hypotheses were tested using a task that modeled transporting a cup of coffee: With redundancy subjects 1) seek greater safety margins and 2) modulate safety margins across practice according to their execution variability. Using a robotic manipulandum subjects had to transport a virtual shallow semicircular cup containing a ball (an additional degree of freedom representing "coffee") to a goal without losing the ball. We manipulated redundancy by specifying different temporal goals. A first "target-time" group (N=9) had to complete the cup transit in a target-time of 2.0 s; this task is redundant as many strategies satisfy this temporal goal. A second "minimum-time" group (N=9) had to arrive at the goal in minimum time; we consider this task to be non-redundant as subjects perform at the limit of their capacity. The safety margin was defined via the instantaneous local ball energy relative to the energy that would lead to ball escape. Execution variability was quantified by the inter-trial standard deviation of the total ball and cup energy. After practicing 300 trials, the target-time group developed strategies with increased safety margins (Hypothesis 1). As expected, the minimum-time group decreased their safety margins with practice, largely attributable to an increase in movement speed. In the target-time group changes in safety margin were correlated with trial-to-trial variability: subjects with smaller variability decreases had larger safety margin increases and vice-versa (Hypothesis 2). No such correlation was observed in the minimum-time group. These results show subjects learn to exploit redundancy by finding movement strategies with increased safety margins. Moreover, when able to select among many strategies in a redundant task, subjects modulate their safety margins according to their ability to decrease variability with practice.

Are serial and parallel dynamics alike? A lesson from human odometry

Michael Turvey
Center for the Ecological Study of Perception and Action, University of Connecticut and Haskins Laboratories

Bipedal gaits have been classified on the basis of the group symmetry of the minimal network of identical differential equations (alias *cells*) required to model them. Primary gaits are characterized by dihedral symmetry whereas secondary gaits are characterized by a lower, cyclic symmetry. This fact was used in a test of human odometry. Results suggest that when

distance is measured and reported by gaits from the same symmetry class, primary and secondary gaits are comparable. Switching symmetry classes at report compresses (primary to secondary) or inflates (secondary to primary) measured distance, with the compression and inflation equal in magnitude. Lessons are drawn from modeling the dynamics of behaviors executed in parallel (e.g., inter-limb coordination) to model the dynamics of human odometry where the behaviors are executed sequentially. The major observations are characterized in terms of a dynamics of sequentially coupled measure and report phases, with relative velocity as an order parameter, or equilibrium state, and difference in symmetry class as an imperfection parameter, or detuning, of that dynamic.

An fMRI reassessment of modality differences in sensorimotor synchronization *and* two applications of rhythmic stimulation

Michael J. Hove
Max Planck Institute for Cognitive and Brain Sciences, and Tokyo Institute of Technology

In this talk I will present overviews of three recent projects on sensorimotor synchronization and applications of rhythmic stimulation. First I will present an fMRI study reassessing modality differences in sensorimotor synchronization. Participants tapped with isochronous rhythms that were discrete (auditory beeps and visual flashes) and continuous (auditory frequency-modulated pitch sweeps and a visual moving bar). Results indicated strong modality differences for the discrete stimuli (beeps vs. flashes) in both tapping performance and activation in rhythm-related brain areas (especially the putamen); however for the continuous stimuli (pitch sweeps vs. moving bar), the differences in tapping performance and putamen activation nearly disappeared. These results indicate that modality differences in synchronization, and their underlying neural processes, depend less on the modality *per se*, and more on the reliability of perceptual information. Second, I will present a project on Parkinson's gait rehabilitation using an *interactive* auditory metronome developed by Yoshihiro Miyake in Tokyo. Parkinson's patients typically have lower fractal scaling of their stride periods compared to the 1/*f* structure observed in healthy controls. Our results showed that walking with the interactive metronome (but not a fixed-tempo metronome) reinstated healthy gait dynamics for these Parkinson's patients. Finally, rhythmic drumming has long been used to induce trance states of consciousness (e.g., Harner, 1990). We recently ran a simultaneous fMRI-EEG study examining altered states of consciousness in experienced shamanic practitioners. Stay tuned for results.

Does the cerebellum contribute to non-motor sequence learning?

Lauri Kurdziel[1] *& Rebecca Spencer*[1,2]
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While a deficit in motor sequence learning has been repeatedly demonstrated in individuals with cerebellar damage, the source of this impairment is unclear. In a recent study, we illustrated that these individuals are *unimpaired* in a motor sequence learning task when the movements are directly cued (i.e., the cue is also the movement target; Spencer & Ivry, 2009). As such, we have proposed that the cerebellum contributes to motor sequence learning by extracting the stimulus-response mapping from working memory through fronto-cerebellar connections. If the contribution of these connections is to retrieve the mapping for action production, a form of action-based working memory, individuals with cerebellar damage should be unimpaired on a non-motor sequence learning task. Alternatively, if the cerebellum contributes to learning of the perceptual sequence working memory more broadly, these individuals should be impaired on a cognitive sequence learning task. In the present study we examined performance of individuals with cerebellar ataxia and matched controls on a chaining task introduced by Shohamy et al. (2004). Participants learned a sequence of "doors" that would lead them through 4 unique "rooms" to reach a reward in a computer-based task. During acquisition, participants learned to

chain rooms by adding one item to the chain in each trial (i.e., A, B-A, C-B-A, D-C-B-A). Within each room, individuals used trial and error to determine which one of three doors was the "correct" door. Following the acquisition phase, participants were given additional presentations of the sequence of rooms until they reached a criterion of four consecutive correct navigations through the rooms. To verify that door selection was based on the position within the sequence, in the final phase, sequence learning was probed by replacing one door in each room with a correct door from another room. Individuals with cerebellar damage were mildly impaired at sequence acquisition; however, once the sequence was acquired, they performed equivalently to controls. These results suggest delayed acquisition but spared learning of non-motor sequences in individuals with cerebellar damage.

Can speakers with aphasia entrain their tapping to short rhythmic patterns?

Lauryn Zipse[1] & Stefanie Shattuck-Hufnagel[2]
[1]MGH Institute of Health Professions
[2]MIT, Research Laboratory of Electronics

Rhythmic tapping or the use of rhythmic cues are elements of several treatment approaches aimed at increasing fluency in people with aphasia, as well as in those with apraxia of speech. It has been anecdotally noted, however, that the ability to tap to a rhythm is impaired in some individuals with aphasia. This study addresses this apparent contradiction by investigating whether the abilities to detect and produce rhythm are impaired in people with aphasia relative to age-matched control participants. Results show that people with aphasia are impaired relative to controls on some measures of rhythmic processing, particularly measures of variability both when tapping to stimulus rhythms and continuing to tap when the stimulus stops. In addition, the people with aphasia were less successful at discriminating rhythms. We conclude by considering how a particular speaker's rhythmic abilities might impact response to various types of treatment.