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Sensory Input in Music, Speech, and the Vestibulo-Motor System

Session Moderator: Ludo Max, Speech & Hearing Sciences

288 MGH

3:45 PM to 5:15 PM

* Note: Titles in order of presentation.

Effects of Music on the Stress Hormone Cortisol

Mariah Aurora (Mariah) Bell Stuart, Senior, Anthropology
Mary Gates Scholar
Mentor: Kathleen O'Connor, Anthropology

Previous studies have shown that music can raise or lower the "stress" hormone, cortisol. This project builds on this work by examining whether specific components of the music—the tempo and the lyrics—are responsible for modifying cortisol levels. The first part of the study tested whether different tempos affect cortisol. The second part tested whether angry lyrics raise cortisol levels while happy lyrics lower them. 46 participants (aged 18 to 28 years) were split into two groups. The first group listened to music without words that were either slow or fast tempo. The second group listened to music with words portraying a happy or angry message. Saliva specimens were collected from the participants before, during, and after listening to one of the four types of music. After an hour break, participants listened to the second corresponding type of music and provided three more samples. Saliva specimens were assayed for cortisol using an enzyme immunoassay. 46 individuals (29 females and 17 males) completed the study with 276 total saliva specimens. The mean age of the sample is 21.304 years. The average intra and inter assay coefficients of variability were 6.61% (high control) and 6.57% (low control). The hypothesized trends of significant increase or decrease of cortisol across the time span from baseline to post music salivary specimens are not evident in preliminary analyses. The highest baseline average was for the angry music group (3236.08 ng/ml), and the largest decline, though not statistically significant, was in the angry music group. All forms of music appeared to lower cortisol, although this was not statistically significant. Contrary to expectations, listening to angry music may reduce stress levels more than happy, slow or fast music. Future work with larger samples and more controlled conditions may reveal stronger associations.

The Effect of Presentation Mode on Memory for Western and Chinese Music Performances

Jacob Cameron (Jacob) Bloom, Senior, Neurobiology
Mentor: Steven Morrison, Music
Mentor: Steven Demorest, School of Music

Previous research has shown that adults demonstrate better memory for novel music from their own music culture as opposed to music from a foreign culture. This passive learning imprinted upon kids as they grow up in a certain musical culture its known as "enculturation". Visual information has also been shown to impact musical memory in adults. Pertinent visual images may augment the encoding process of music and lead to greater recall abilities. In this study, we will include a visual component to the audio information presented. This addition will test the facilitation of visual information to the musical memory of culturally unfamiliar music in adults. Using four video/audio excerpts of musicians performing music in a classical Chinese style and four video/audio excerpts of musicians performing western (classical) style music, we tested the audio and visual memory of adult human subjects in culturally unfamiliar and familiar music. To test them we used twenty-four test items (twelve true tests and twelve false tests) in audio or video format. These different test items can be prepared in three different combinations: audio/audio, AV/audio, AV/AV. Preliminary data demonstrated significantly better overall memory for culturally familiar music. However, music memory scores were higher in the audio condition than in the AV condition in culturally unfamiliar music tests. These results indicate that adding visual information does not aid in musical memory of culturally unfamiliar music. Dichotomous from our initial hypothesis, it is possible that this occurred due to the dominance of visual memory in encoding, or that auditory and visual stimuli provided too much novel information for effective recall.

Speech Adaptation to Formant-Shifted Auditory Feedback in Stuttering Versus Non-Stuttering Children

Wai Ying (Cathy) Cho, Senior, Speech and Hearing Sci (Com Disorders)
Mentor: Ludo Max, Speech & Hearing Sciences

Stuttering is hypothesized to be a disorder resulting from underlying sensorimotor deficits. Here we investigate whether children who stutter (3-9 years of age) differ from their nonstuttering peers in the integration of auditory feedback in the planning of speech movements. Studies with nonstuttering speakers have shown compensatory adaptation when the formant frequencies in the auditory feedback signal are shifted up or down with an effects processor. Our laboratory has found a lack of such sensorimotor adaptation to formant-shifted feedback in adult stuttering subjects. We have also found reduced adaptation in stuttering children's arm movements when performed with altered visual feedback. In the present study, we investigate speech adaptation in response to formant-shifted feedback in stuttering vs. nonstuttering children. Subjects spoke monosyllabic consonant-vowel-consonant words in baseline (unaltered feedback), perturbed (formants in the feedback signal shifted 2.5 semitones up), and after-effects (unaltered feedback) phases of two conditions. In an "abrupt" condition, the formant perturbation was introduced suddenly at full strength. In an "incremental" condition, the formant perturbation was gradually ramped up over several minutes. Subjects heard the auditory feedback in real-time through insert earphones. Data collection and analysis are ongoing at the present time. Our hypothesis is that children who stutter will show reduced adaptation as compared with children who do not stutter. Findings from this work may have important implications for typical speech development as well as developmental speech motor disorders such as stuttering.

Dependency of Stimulation-Evoked Eye Velocities on Orbital Eye Position

Joel Thomas (Joel) Fandel, Senior, Neurobiology
Mentor: Amy Nowack, Otolaryngology
Mentor: James Phillips, Oto-HNS
Mentor: Leo Ling, Otolaryngology

The vestibular system is responsible for maintaining stable vision and posture by interpreting accelerations of the head in various planes. Impaired function of this system can cause debilitating vertigo, as seen in Meniere 's disease. Our lab has developed a prosthesis that aims to counteract these deleterious pathologies through electrical stimulation, and our research is directed towards improving the effectiveness of this device. In order to stabilize gaze, the vestibular system must incorporate demands from several neural inputs, many of which are dependent on direction of the line of sight. Additionally, the effectiveness of electrical stimulation may be altered by the background activity of the activated neural pathways, which vary with orbital eye positions. Therefore, in this study, I am focusing on the dependency of stimulation-evoked eye velocities on initial position of the eye. I have collected data from two Rhesus Macaques by stimulating the right lateral, posterior, and superior semicircular canals at different eye positions. My data shows linearly graded velocities depending on stimulus amplitude, so it is clear that eye position must be taken into account when evaluating eye velocities. Speculation into the cause of this phenomenon will help to better customize our implant's effectiveness according to the physiology of the patient in consideration.

Dissolution of Perineuronal Nets to Aid Adaptation to a Vestibular Prosthesis

Surobhi (Rummi) Ganguly, Junior, Biology (Molecular, Cellular & Developmental)
Mentor: James Phillips, Oto-HNS
Mentor: Leo Ling, Otolaryngology
Mentor: Amy Nowack, Otolaryngology

Perineuronal nets (PNNs) are a matrix of proteins that surround nerve cells and reinforce the most often used synaptic connections between neurons, essentially hard-wiring neural connections made as a child into permanent pathways that respond to specific stimuli. By dissolving these PNNs, we recreate the plasticity characteristic of a young developing brain, granting us the ability to rewire the brain with respect to any stimulus. In this study, we are looking at PNNs within the vestibular system – the sensory system that, under natural conditions, is primarily responsible for maintaining images on the fovea during movement. Hair cells within the semicircular canals of the vestibular system register head accelerations and then send reflex signals through vestibular afferent nerve endings to extra-ocular eye muscles that drive eye movements. This vestibular ocular reflex aids the maintenance of stability of images on the retina. As a therapy for vestibular loss, our lab has developed a vestibular prosthesis that electrically stimulates the afferent nerve endings of the vestibular system, thereby simulating natural vestibular response to movement. This electrical stimulation, however, spreads to untargeted as well as targeted vestibular afferents and cause inaccurate eye movements as a result. By dissolving the PNNs in the vestibular nuclei and then allowing them to regrow during a period of adaptation, we hope to suppress inappropriate eye movements in response to our prosthesis' electrical stimulation. If our lab can prove that electrically elicited eye-movements become more accurate after the dissolving and guided re-growing of PNNs, we can show that it is possible to restore plasticity to the brain and shape its neural connections through controlled electrical stimulation to the target system. By extension, such results will ascertain if it is possible to use this method to re-wire a physiological system to accept prosthetic stimulation in place of a non-functioning system.