Title: Stability of Metrics of Audiovisual Integration in Children with Autism Spectrum Disorder

Authors: Kacie Dunham1,2, Jacob I. Feldman1, Margaret Cassidy1, Yupeng Liu1, Evan Suzman1, Prachy Mahbub3, Julie G. Conrad1, Alexander Tu3, Pooja Santapuram1,4, David M. Simon1,2, Neill Broderick4,5, Mark T. Wallace1,5, and Tiffany Woynaroski1,4,5

1Vanderbilt University, 2Vanderbilt Brain Institute, 3Mount Holyoke College, 4Vanderbilt University Medical Center, 5Vanderbilt Kennedy Center

Introduction: Children with autism spectrum disorder (ASD) demonstrate atypical responses to multisensory stimuli. For example, past work has shown that, relative to typically developing children, children with ASD demonstrate wider temporal binding windows (TBWs) for audiovisual stimuli, particularly for audiovisual speech, reduced susceptibility to the McGurk effect, and limited perceptual gains when presented with audiovisual versus auditory-only stimuli. These disruptions in multisensory integration may produce cascading effects on language and communication development. Accordingly, there is increased interest in exploring whether metrics of multisensory integration may be valid for predicting language and communication development and/or sensitive to early effects of interventions intended to impact distal language and communication outcomes. However, to date we know little about the stability of commonly used metrics of multisensory integration. This is important because the stability of a metric places a ceiling on its validity (e.g., the predictive validity of a metric cannot exceed the square root of the its stability). The purpose of this study was therefore to a) test the stability of several metrics of audiovisual speech perception and integration and b) determine the number of observations needed to reach acceptable levels of stability for these metrics.

Method: Twelve children (8 male) ages 7-16 years old ($M_{\text{age}} = 10.5$ yrs) with ASD participated in this study. Participants completed several psychophysical tasks, including a simultaneity judgment task for audiovisual speech (i.e., wherein participants reported whether they perceived synchronous and asynchronous speech as occurring at the “same time” or “different time”), tasks designed to elicit the McGurk effect, and listening in noise tasks (i.e., wherein participants listened to single words presented with a signal to noise ratio of $-3\text{dB}$ and $-6\text{dB}$). Each participant completed these tasks three different times (once per day) within a one-week period. From these repeated tasks, the following metrics were derived: TBW for audiovisual speech, proportion of reported McGurk illusions when presented with auditory “ba” and visual “ga”, proportion of reported McGurk illusions when presented with auditory “pa” and visual “ka”, and whole-word accuracy during audiovisual speech at each signal to noise ratio (SNR). Participants also completed (a) an event-related potential (ERP) task that indexed processing speed and efficiency in response to audiovisual versus auditory only speech and (b) an eye tracking task that measured attention to audiovisual speech. Generalizability (G) and Decision (D) studies were conducted to evaluate the stability of metrics derived from these tasks and the number of observation periods needed to obtain stable estimates for each metric of interest (i.e., $g \geq 0.8$).

Result: Results on the stability of the psychophysical tasks were mixed. The most stable metrics were TBW for audiovisual speech ($g$ for a single observation = 0.74) and Pa/Ka McGurk illusions ($g = 0.90$). The D studies indicate that these metrics are acceptably stable after two observations and one observation, respectively. The remaining metrics, Ba/Ga McGurk illusions ($g = 0.37$) and whole-word recognition of audiovisual speech presented at $-3\text{dB}$ SNR ($g = 0.18$) and $-6\text{dB}$ SNR ($g = 0.22$), were less stable. The D studies indicate that it would take 6 or more observations to achieve acceptable stability for these metrics. Stability results for ERP and eye gaze metrics will be presented at the Gatlinburg Conference.

Discussion: These results have several implications for those studying audiovisual integration in children with ASD. Foremost, these results indicate that the stability of metrics from tasks tapping multisensory integration is highly variable, and that the psychometrics of these measures must be examined at the metric level, rather than at the task or paradigm level. Additionally, researchers should be aware that repeated observations may be required in order to obtain acceptably stable estimates, and thus to increase the likelihood of detecting effects of interest, as it relates to multisensory integration in children with ASD. Limitations of the study and additional implications for research will be discussed.

References/Citations: