

## Organization, Design, Methodology, and Outcomes

### Primary Research Questions:

1. To comprehensively assess sensory processing in children with and without autism spectrum disorder (ASD) via several questionnaire and laboratory-based measures.
  - a. Procedure: The Sensory Challenge Protocol, a well-validated psychophysiologic laboratory procedure for measuring responsivity to multiple sensory domains, was administered to each participant, alongside continuous tonic and phasic measurement of heart rate, respiratory sinus arrhythmia, and electrodermal activity. Several questionnaire measures of sensory and anxiety symptomatology were also administered to participants and their parents.
  - b. Outcomes: Individuals with ASD exhibited significantly greater levels of sensory and anxiety symptoms, based on both child and parent report, than their typically developing (TD) peers. Across research groups, children endorsed greater levels of sensory and anxiety symptoms than their parents. Importantly, in the ASD group, child report (but not parent report) of symptoms significantly correlated with measures of sympathetic arousal, underscoring the validity of self-report. Data from the Sensory Challenge Protocol is still being analyzed, however preliminary findings suggest that individuals with ASD may exhibit a defensiveness response to sensory stimuli, while those in the TD group exhibit a more-adaptive orienting response to these same stimuli.
2. To investigate the impact of aversive sensory stimuli on stress reactivity and cognitive performance in ASD. We aimed to investigate specific adaptive functioning consequences of atypical sensory processing for individuals with ASD by targeting an important area of functioning for individuals of all ages, cognitive performance. We did this within a carefully controlled design by experimentally manipulating noise and cognitive task difficulty level, and measuring task performance as well as autonomic responses.
  - a. Procedure: We investigated the relationship between noise and performance through a 2 x 2 experimental manipulation of noise levels (quiet vs. 75dB intermittent broadband noise) and cognitive task difficulty, measured using a visually presented number span task. The noise type and volume were chosen to mimic the sound characteristics of an average classroom. ECG, respiration, and electrodermal activity were recorded throughout the tasks to explore the potentially mechanistic role of the stress response during the cognitive task conditions. Please see the attached research papers (**Keith** et al., in press, *J Abnorm Child Psych*; **Keith** et al., under review, *J Autism Dev Disord*) for a more detailed description of study methods.
  - b. Outcomes: Analyses revealed a significant noise x difficulty interaction on performance, and a significant group x noise x difficulty interaction on sympathetic arousal. Correlational analyses indicated an adaptive effect of noise and increased arousal on performance in the easier condition for the control group and a detrimental effect of noise and increased arousal in the harder condition for the ASD group.

### Deviation from original plan:

- We deviated from our original proposal in our measurement of sympathetic arousal. We had initially proposed using impedance cardiography as an index of sympathetic arousal. However, we decided that the way the sensors are attached in this method (i.e., with a band around the throat) would be too aversive to our participants with ASD. Instead, we used both electrocardiography (ECG) and electrodermal activity (EDA) to index sympathetic arousal.

### Differences in outcomes:

- The primary difference in outcomes was the absence of a significant 3-way interaction (noise x difficulty x group) within the cognitive performance data. We had hypothesized that individuals with ASD would be differentially affected by noise in the more challenging Backward Span task, showing differentially greater decreases in performance relative to the TD group. Another somewhat unexpected finding was the relationship between child-reported sensory and anxiety data and autonomic arousal, which highlighted the importance of including self-report in research and clinical practice with individuals with ASD.

### **Practical Findings:**

- a) Person with autism: This study has many practical implications for an individual with autism. For one, it provides support for the inclusion of self-report from individuals with autism in research and clinical settings. This may contribute to self-advocacy efforts that aim to include individuals with ASD in any research or clinical decisions that are made about them. Additionally, our findings indicate that having to manage sensory stimuli, either on its own or when paired with a cognitive task, is a significant stressor for individuals with ASD. Importantly, our data also suggests that evidence of this stress reaction does not always manifest clearly in communicative or challenging behaviors or poor performance on a task. Thus, in best supporting individuals with autism, it will be important to include multiple forms of measurement (e.g., self-report, autonomic arousal) when considering the impact of sensory stressors in a variety of environments.
- b) Parent of person with autism: Our data suggests that parents may be, understandably, limited in their ability to detect the internal experiences of their children. While it is very likely that parents are already aware of this limitation, this evidence may help parents to consider the stress response, in particular, when gauging their child's needs in a given situation. Additionally, our findings suggest that self- or emotion regulation interventions may be particularly helpful in mitigating negative effects of sensory dysfunction in autism. Parents are typically a critical component of effective self-regulation interventions, so this information may help parents find new ways to work with their child.
- c) Teacher of a person with autism: The focus on education and cognitive performance in this study makes it particularly applicable for teachers of individuals with autism. Our findings suggest that the effects of sensory dysfunction in a classroom may not be readily available via performance indices. Importantly, these results further indicate that despite these performance findings, individuals with ASD may still experience greater levels of stress than their typically developing peers. These results are likely compounded in real-life classrooms, where sensory stimuli are numerous, dynamic, and more complex. While it may not always be possible to limit these sensory stimuli, teachers can aim to monitor stress reactivity (either by checking-in with the individual or through wearable technology that measures arousal) and incorporate self-regulation strategies in the classroom (e.g., periodic breaks with breathing exercises, quiet time).

### **Faculty Comments:**

Jessica did an outstanding job with her master's thesis study! The additional support from the OAR grant allowed her to expand the scope of her project and, importantly, to expand her knowledge base and methodological skills. Jessica's project integrated her long-standing interests in sensory processing with her commitment to understanding how differences in this and other areas can affect the everyday experiences of people with ASD. By examining her participants' autonomic responses during situations with high sensory stress (noise), she made several important contributions to the research and clinical literatures. In particular, she showed that everyday aversive noise can have a larger effect on stress reactivity in individuals with ASD compared to neurotypical peers, particularly during challenging cognitive tasks. In a second aim of her study, she convincingly demonstrated the validity of self-reported symptoms from adolescents with ASD for both anxiety and sensory symptoms, a finding that has critical implications for both research and clinical practice. Jessica submitted both papers for publication; the first is in resubmission, and the second was just accepted for publication. Jessica is a truly gifted clinical scientist, who has exceptional promise for a successful career in the field of autism research. I am delighted that she plans to expand on the OAR grant project for her dissertation research, which she will be proposing in several months.