

**Title:** A Comparison of Respiratory Sinus Arrhythmia in Children with Autism or Typical Development Across Communicative and Cognitive Contexts: A Pilot Study

**Authors:** Katherine J. Bangert, Ph.D., CCC-SLP<sup>1</sup> & Lizbeth H Finestack, Ph.D., CCC-SLP<sup>2</sup>

**Introduction:** Respiratory Sinus Arrhythmia (RSA) serves as a biological indicator of adaptive autonomic nervous system (ANS) functioning and response. It is a measure of variability between heartbeats that is due to breathing via parasympathetic output to the heart. It has been found to differ in children with ASD, and to be associated with an increase in ASD-like symptoms, social adaptiveness and expressive and receptive language ability.<sup>1-8</sup> However, the relationship between RSA and social-behavioral functioning is still not well understood, and is confounded by variables related to the environment and individual characteristics. This study examines RSA in children with ASD across contexts in an attempt to disentangle targeted measures of parasympathetic activity related to cognitive or linguistic demand in a social environment. We further looked at relationships between RSA across contexts and developmental characteristics.

**Method:** Participants included 12 children with ASD and 8 children with typical development (TD) between the ages of 5-8. All children completed the Clinical Evaluation of Language Fundamentals-4 (CELF-4), the Matrices subtest of the Kaufman Brief Intelligence Test-2 (KBIT-2), and Pragmatic Language subtest of the Comprehensive Assessment of Spoken Language-2 (CASL-2: PL). All children in the ASD group were also administered the Autism Diagnostic Observation Schedule-2 (ADOS-2). Parents completed the Behavior Rating Inventory of Executive Functioning (BRIEF). While connected to ECG equipment, children completed a baseline task, two language tasks, and executive functioning (EF) tasks. For the baseline activity, the children sat quietly and watched a 5-minute video clip. For the language tasks, they completed a narrative language (described a wordless picture book), and a conversational language sample (conversed with an examiner for approximately 10 minutes). For the EF tasks, the children completed the Card Sort and Flanker Inhibition tests from the NIH Toolbox on an iPad. Nonparametric Wilcoxon signed rank tests were used to analyze differences across groups and contexts, and Kendall's rank coefficients were used to investigate relationships between RSA and developmental characteristics.

**Results:** Between group differences: there were not significant differences between baseline and RSA during conversation ( $p = .169$ ,  $\delta = .42$ ). The TD group had significantly higher RSA during the narrative task ( $p = .005$ ,  $\delta = .81$ ), and EF task ( $p = .005$ ,  $\delta = .78$ ) than the ASD group. Within group differences: For the TD group, baseline RSA was significantly higher than RSA during conversation ( $p = .016$ ,  $\delta = .35$ ), but was not significantly different from RSA during narrative ( $p = .688$ ,  $\delta = .15$ ) or EF tasks ( $p = .375$ ,  $\delta < .001$ ). For the ASD group baseline was significantly higher for all three conditions (conversation:  $p = .016$ ,  $\delta = .64$ ; narrative:  $p = .005$ ,  $\delta = .55$ ; EF:  $p = .006$ ,  $\delta = .47$ ). Associations: There were no significant associations between any RSA measures and measures of language, cognitive, or behavior in the group of children with TD. In the ASD group, RSA during the narrative task was positively associated with autism symptom severity ( $\tau_b = .61$ ,  $p = .033$ ). RSA change from baseline to the narrative context and baseline to EF context were both significantly correlated with EF ability on the BRIEF Global Executive Composite and Metacognition Index, with greater change to each context associated with poorer EF ability (Narrative: GEC  $\tau_b = .93$ ,  $p < .001$ ; MI  $\tau_b = .86$ ,  $p = .004$  | EF: GEC  $\tau_b = .76$ ,  $p = .002$ ; MI  $\tau_b = .75$ ,  $p = .004$ ).

**Discussion:** In our sample, children with ASD showed a different pattern of response to executive functioning and narrative language activities compared to baseline and conversational activities than children with typical development. RSA was higher during the narrative language and executive functioning task in children with TD. Further, within children with ASD, RSA level during the narrative task was associated with autism symptom severity, and changes from baseline to narrative and EF contexts were associated with global measures of executive functioning. Narrative language, in contrast to conversational language was more closely related to executive functioning ability which likely required a different response. These findings warrant the need to further investigate RSA across contexts in this population.

## Key References

1. Van Hecke AV, Lebow J, Bal E, et al. Electroencephalogram and heart rate regulation to familiar and unfamiliar people in children with autism spectrum disorders. *Child Dev.* 2009;80(4):1118-1133. doi:10.1111/j.1467-8624.2009.01320.x
2. Bal E, Harden E, Lamb D, Van Hecke AV, Denver JW, Porges SW. Emotion recognition in children with autism spectrum disorders: Relations to eye gaze and autonomic state. *J Autism Dev Disord.* 2010;40(3):358-370. doi:10.1007/s10803-009-0884-3
3. Lory C, Kadlaskar G, Keehn RM, Francis AL, Keehn · Brandon. Brief Report: Reduced Heart Rate Variability in Children with Autism Spectrum Disorder. *J Autism Dev Disord.* Published online 2020:1-8. doi:10.1007/s10803-020-04458-8
4. Corbett BA, Muscatello RA, Baldinger C. Comparing stress and arousal systems in response to different social contexts in children with ASD. *Biol Psychol.* 2018;140:119-130. doi:10.1016/j.biopsycho.2018.12.010
5. Ming X, Julu POO, Brimacombe M, Connor S, Daniels ML. Reduced cardiac parasympathetic activity in children with autism. *Brain Dev.* Published online 2005. doi:10.1016/j.braindev.2005.01.003
6. Klusek J, Martin GE, Losh M. Physiological arousal in autism and fragile X syndrome: Group comparisons and links with pragmatic language. *Am J Intellect Dev Disabil.* 2013;118(6):475-495. doi:10.1352/1944.7558-118.6.475
7. Klusek J, Roberts JE, Losh M. Cardiac autonomic regulation in autism and fragile X syndrome: A review. *Psychol Bull.* 2015;141(1):141-175. doi:10.1037/a0038237
8. Watson L, Branek G, Roberts J, David F, Perryman T. Behavioral and Physiological Responses to Child-Directed Speech as Predictors of Communication Outcomes in Children with Autism Spectrum Disorders. *J Speech Lang Hear Res.* 2010;53:1052-1064.

<sup>1</sup>University of South Carolina, Columbia

<sup>2</sup>University of Minnesota, Minneapolis