Title: Did Someone Say My Name? Examining the Congruency between Behavioral and Cardiac Responses to Name in 12-month-old Infants

Authors: Wei Siong Neo & Bridgette Kelleher

Introduction: Retrospective and prospective studies of infants diagnosed with autism spectrum disorder (ASD) have consistently demonstrated a diminished response to name in early development (Miller et al., 2017; Palomo, Belinchón, & Ozonoff, 2006). While most studies have relied on parent reports and behavioral observations to understand this early risk marker for ASD, an emerging literature has investigated underlying physiological mechanisms and responses (Thomas et al., 2019), which may potentially serve as a more sensitive measure, particularly given potential biases and inconsistencies associated with informant and behavioral methods, respectively. To date, such research has primarily focused on neural measures that require sophisticated equipment that limits scalability for field-based early detection efforts. Cardiac measures have also been found to be robust indices of attention and information processing in well-controlled experimental studies and are often less costly, less intrusive, and more amenable to naturalistic data collection settings. For example, heart rate decreases from a baseline level when orienting and paying sustained attention to a stimulus (Reynolds & Richards, 2008) and this phenomenon has been applied to measure infant cognition in computerized and play-based tasks. Yet, no studies to date have used heart rate decelerations to characterize whether and how young children respond to their names. Investigating the congruency between behavioral and cardiac responses to name will be an important first step toward informing whether heart rate decelerations could serve as a more sensitive metric of response to name than behavioral looking alone, especially for children with motor and social-communication delays. Thus, the present study (1) examined the congruency between behavioral and cardiac responses to name during semi-structured interactions and (2) contrasted congruency across different methodological options – specifically, the selection of baseline parameters – to optimize methods for quantifying cardiac responses.

Method: Participants were drawn from an ongoing longitudinal study of early development and included 21 infants (10 females and 11 males) between 10 and 14 months of age (M = 12.13, SD = 0.85) with no known developmental concerns. Here, we report data from the Orient to Name press in the Autism Observation Scale for Infants (AOSI; Bryson, Zwaigenbaum, McDermott, Rombough, & Brian, 2008), which was designed to examine infants’ tendency to orient to the examiner when their name was called. Per administration protocol for the AOSI, each infant participated in up to six trials and was considered to have responded behaviorally for a given trial if he/she successfully oriented to his/her name within two seconds. Throughout the AOSI, participants wore the Actiwave Cardio heart rate monitor (CamNtech Inc., Boerne, TX) that recorded electrocardiography (ECG) signals. Following administration, we identified ECG fiducial points (i.e., R- or S-waves) in QRSTool (Allen, Chambers, & Towers, 2007) to obtain interbeat interval (IBI) data and further edited IBI data in CardioEdit (Brain-Body Center, 2007) to correct for remaining artifacts. Informed by earlier work on heart rate-defined phases of attention (Reynolds & Richards, 2008), five seconds of IBI data before and after the name call were extracted for each trial. A cardiac response was indexed by a minimum of five consecutive IBIs, each of which was longer than the baseline IBI, which was operationalized in one of three ways: median IBI of five consecutive IBIs (BL-5), median IBI of three consecutive IBIs (BL-3), or one IBI (BL-1) immediately before the name call. To reduce interpretational difficulties associated with temporally close trials (e.g., a cardiac response to an earlier trial being misattributed to a closely following trial), analyses involving cardiac responses were constrained to trials without a subsequent name call within five seconds (n = 50). We used Fisher’s exact tests to examine whether behavioral and cardiac responses were congruent for each of the three definitions of baseline IBI.

Results: Infants exhibited varied behavioral responses. Specifically, four (19%) and five (24%) infants were consistent behavioral responders and non-responders, respectively. However, the majority of infants (57%, n = 12) responded behaviorally on some trials but not on other trials, suggesting a degree of independence between trials from a behavioral perspective. Across all three definitions of baseline IBI, behavioral and cardiac responses were congruent in at least 60% of trials (BL-5: 64%; BL-3: 66%; BL-1: 60%). Fisher’s exact tests indicated that behavioral and cardiac responses were significantly associated for the BL-3 definition (p = 0.044), marginally associated for the BL-5 definition (p = .086), and not associated for the BL-1 definition (p = .254). Supplemental
Fisher’s exact tests revealed a high degree of consistency amongst the three definitions of baseline IBI in classifying cardiac responses, \( ps < .001 \).

**Discussion:** During semi-structured interactions, infants demonstrated congruent behavioral and cardiac responses in a substantial proportion of trials when their name was called, highlighting the potential for extending the use of cardiac measures beyond the scientific laboratory to naturalistic contexts. Our findings suggest that, consistent with prior research, heart rate decelerations may provide a useful objective metric of cognitive response; however, optimizing methods for naturalistic presses will be crucial. Specifically, nuanced differences in the degree of congruency as a result of differing definitions of baseline IBI indicates the need to further examine how cardiac measures are quantified, including definitions of baseline heart activity, dimensions of cardiac responses (e.g., depth and duration), and temporal windows of interest. For example, our results suggest that using a longer baseline IBI may reduce the impact of random variation in IBIs but increase susceptibility to the effects of additional unrelated stimuli. Future research should incorporate other statistical and machine learning techniques to explicitly model the nested and non-linear nature of cardiac responses frequently encountered in naturalistic research as well as explore means to optimize the congruency between behavioral and cardiac responses. Given its low-cost, non-invasive, and passive nature, cardiac measures hold promise as a viable methodology for assessing psychophysiological constructs that are especially relevant for children with neurodevelopmental disorders in their day-to-day environments and interactions.

**References:**


\(^1\) Purdue University