Electrodermal Activity and Behavioral Functioning in Children with ASD

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INTRODUCTION

Measurement of electrodermal activity (EDA), an index of sympathetic nervous system arousal, has been of longstanding interest in research on autism spectrum disorder (ASD), primarily due to efforts to empirically support early theories of sensory dysfunction (see Rogers & Ozonoff, 2005). Regardless of the extent to which EDA profiles in children with ASD might be atypical or unique to the disorder, the measurement of EDA may provide valuable information regarding the form and correlates of individual differences in these children. EDA can serve as a reasonable physiologic index of emotional responses and regulation, processes key to the development of child problems and competence (Mazefsky, Pelphrey, & Dahl, 2012).

Studies of non-ASD samples have demonstrated the utility of relating EDA to broader indices of adaptation and behavioral functioning, with evidence that higher EDA may be linked to more internalizing problems, while lower EDA might suggest risk for externalizing behaviors (El-Sheikh & Erath, 2011). Children with ASD exhibit high rates of comorbidity with both internalizing and externalizing problems, but no known study has examined the degree to which children's EDA might relate to this type of heterogeneity in ASD, or to core autism symptomatology.

RESEARCH AIMS & HYPOTHESES

1. **To examine the feasibility and reliability of electrodermal reactivity measurement using wireless wrist sensors in a wide range of children with ASD**
2. **To characterize the EDA profiles of children with ASD**
   - Heterogeneity was expected, with some children exhibiting very low activity
3. **To examine the association between children's EDA activity during various interactive and regulatory contexts, and broader indices of child functioning.**
   - Greater EDA reactivity was predicted to relate to fewer externalizing problems and higher internalizing problems.
   - Examinations linking EDA to autism symptoms were largely exploratory, given mixed support for this relation.
   - Consideration of the context specificity of EDA was largely exploratory; however, we predicted that compliance contexts may be particularly relevant to externalizing behavior problems.

METHOD

Participants

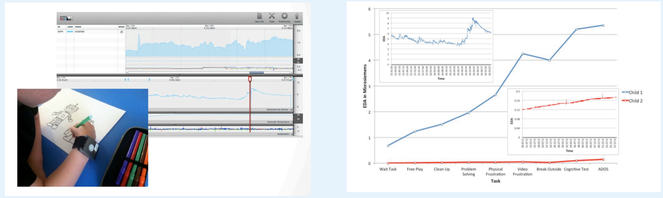
- 26 children aged 4 to 11 years (21 male; M_{Age} = 6.80; M_{IQ} = 84.72; SD_{IQ} = 24.48) and independently diagnosed with ASD participated with their primary caregivers (one father).
- Average annual household income was $50,000 – $70,000, 44% of the children were Caucasian, non-Hispanic, and 80% of mothers were married.

Procedures

- Two-hour university laboratory visit and parent completion of forms.
- Wireless, unobtrusive wrist sensors were worn during: a) parent-child free play, b), parent-child compliance tasks (cleanup and wait tasks), c) problem-solving/regulation tasks with and without the parent, and d) testing of IQ and autism symptoms.

Measures

- ***Electrodermal Activity (EDA)*** was recorded using wireless *Affectiva* Q-Sensors (Poh, Loddenkemper et al., 2010; Poh, Swenson, & Picard, 2010). Participants wore sensors on each wrist and/or ankle. Data from the dominant wrist was considered here. The sensors logged EDA scores in microsiemens each 8hz, which were aligned with task start and stop times. Mean level (*tonic*) and variability (e.g., standard deviation, *phasic*) data were highly correlated, *rs* = .87, thus the latter were prioritized in analyses. Sensor movement and temperature, and children's age, sex, and race were unrelated to EDA, thus were not controlled.



- ***Child Behavior Problems.*** Internalizing and externalizing behavior problems were measured through parent report on the Child Behavior Checklist (Achenbach, 2009). Standardized scores were utilized, with higher scores reflecting more behavior problems.
- ***Child Autism Symptoms*** were assessed directly through the Autism Diagnostic Observation Schedule–2 (ADOS-2; Lord et al., 2012), as performed by a licensed clinical psychologist trained in the system. This instrument yields an overall comparison score, with higher scores indicating more autism symptomatology.
- ***Child IQ*** was indexed with the Abbreviated IQ Battery of the Stanford-Binet 5 (Roid, 2003) as performed by a child clinical psychologist.

RESULTS

Feasibility & Psychometric Support for the EDA data:

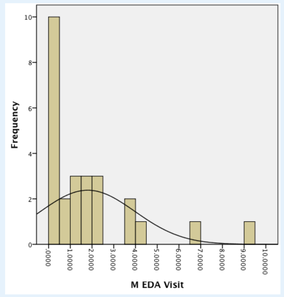
- All but one of the children wore at least one sensor for the entire visit, with most tolerating two.
- Some missing data due to technical problems was present for 25% of the children (10% missing for the sample), ranging from 1 to 4 missing tasks. Each of these children had at least one hour of EDA data obtained. The remaining 75% had complete EDA data for the two-hour visit. The visit for one child was terminated early, thus no CBCL or ADOS scores were obtained.
- EDA data showed good test-retest reliability and internal consistency, with correlations across tasks ranging from *rs* = .35 (Free Play and Regulation Alone) to .93 (Free Play and Delay); average *rs* = .42; alpha = .84. Due to this consistency, partial missing data were estimated for the overall EDA scores, based on existing data for each child.

Data Reduction:

- EDA composites for compliance tasks (alpha = .75) and testing (alpha = .76) were reliable, however EDA data for the problem-solving/regulation tasks were not, thus these scores were treated separately in analysis.

EDA Profiles

- Almost half (46%) of the children with ASD might be considered "hypoactivated," with means and standard deviations less than one microsiemen (although no control group was included).



Correlations between EDA and Behavioral Functioning

- Spearman correlations were performed due to the (traditional) non-normative distribution of EDA data.
- As seen below, child EDA for the locked box, problem-solving task, and testing was significantly, positively associated with ADOS symptomatology, while EDA during free play and compliance tasks was negatively related to child behavior problems.
- Overall visit child EDA was related to more ADOS symptomatology, but was not significantly related to behavior problems.

	Child Electrodermal Reactivity					
	Free Play	Compliance	Problem-Solving	Regulation Alone	Testing	Overall EDA
Internalizing Problems	**-.55***	-.42+	-.07	-.07	-.20	-.35+
Externalizing Problems	**-.45***	**-.51***	.09	.00	-.03	-.19
ASD Symptoms	.09	.01	**.56***	**.47***	**.59***	**.42***

CONCLUSIONS

- The use of wireless wrist sensors appears to be a feasible and reliable way to measure EDA in a diverse sample of children with ASD.
- EDA profiles were heterogeneous, with some support for hypoactivation in certain children with ASD—although a control group will be necessary.
- Physiological measurement may help us understand the high levels of heterogeneity present in ASD, with activation in certain contexts (e.g., compliance and play) suggesting risk for behavior problems, while reactivity in other contexts (e.g., problem-solving/ learning/testing) linked to children's autism symptomatology.
- Replication with a larger sample, counterbalancing of tasks, and consideration of the role of the environment in links between children's psychophysiological and behavioral functioning will be helpful.