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Heart Rate Variability and Electrodermal Activity in Children with Atypical Sensory Processing: Exploratory Pattern Analysis

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Background: Atypical sensory processing can cause significant functional impairment and is widely reported in persons with autism. The Sensory Processing Disorder Foundation has designed and carried out carefully controlled experiments for eliciting and measuring Autonomic Nervous System (ANS) responses to six types of sensory stimuli (i.e., pure tone, auditory, visual, olfactory, tactile, and vestibular). Electrodermal activity (EDA) and heart rate variability (HRV) data have been gathered from a number of children with and without sensory processing problems while systematically exposed to these stimuli.

Objectives: We sought to evaluate how accurately various pattern recognition algorithms discriminate children with sensory processing challenges (SEN, n=34), including those with autism (n=21) and those with idiopathic sensory difficulties (n=13), from typically developing children (TYP, n=10) using EDA and HRV reactivity to the sensory exposure protocol mentioned above. We also evaluated which small set of features derived from raw EDA and HRV waveforms were most effective at distinguishing SEN and TYP in order to gain insight into what is different about autonomic responsivity in these two groups.

Methods: We first selected 17 out of 500 possible EDA and HRV features obtained from the six different sensory stimuli (8 trials each) as well as rest (time between sensory domains) and recovery (no stimuli condition at end of experiment) periods. We followed this step with an automated process to find a smaller subset of features optimized for discriminating the two groups. We chose a process that cascades two kinds of feature selection techniques – a variation of principal components analysis designed for classification, followed by sequential floating feature selection. The selected features were grouped into three different categories (EDA only, HRV only, and EDA plus HRV) and used as input with four powerful machine learning classifiers: Linear Discriminants, K-Nearest Neighbor, Decision Trees, and Support

Vector Machines, resulting in a total of 12 different classifiers. These classifiers have the ability to distinguish complex high-dimensional patterns in multimodal data. We ran the twelve classifiers on data from 44 individuals (34 SEN, 10 TYP).

Results: We used leave-one-out cross-validation for training and testing on separate subsets of the data (leave out one person's data, train a model on the data from 43 people, then test the trained model on the person left out). Eight of the twelve classifiers achieved greater than 80% specificity and sensitivity in separating the SEN and TYP groups. The support vector machine, applied to a selected set of both EDA and HRV features, achieved almost perfect sensitivity and specificity in separating the two groups.

Conclusions: Across machine learning classifiers, we identified a small subset (six) of combined HRV and EDA features that accurately separated the SEN and TYP groups (>90% sensitivity, >80% specificity) for 44 participants. The discrimination of these features should be replicated on an independent sample. If findings are confirmed, these features may serve as diagnostic criteria and intervention outcomes in the future. This poster will present the discriminatory EDA and HRV features and detailed findings of the study.

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