Analysis and Visualization of Longitudinal Physiological Data of Children with ASD

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Background:
Individuals diagnosed with Autism Spectrum Disorder (ASD) who have written about their experiences almost always describe immense stress and anxiety. Traditional methods of measuring these responses consist of monitoring the Autonomic Nervous System (ANS) of participants who behave compliantly in artificial laboratory settings. To the best of our knowledge, the study here is the first to conduct long-term monitoring and analysis of ANS in daily school activity settings with minimally-verbal individuals on the autism spectrum. ANS data obtained under natural circumstances can be very useful to provide warning indications of stress-related events and life-threatening events.

Objectives:
In this work we first test the feasibility of a longitudinal study in classroom environments using state-of-the-art biosensors to monitor ANS responses in minimally-verbal children with ASD. More specifically, we sought to explore the relationships between contextual events (i.e., different settings and activities), naturally occurring clinically relevant behaviors (e.g., aggression, self-injury, elopement), and physiological response patterns both within and between people over time.

Methods:
We conducted a two-month study (i.e., 60 continuous school days of recording for each child) with five minimally-verbal children (9-20 years old) at a non-profit school for individuals with ASD. In order to comfortably monitor ANS responses, we utilized the wireless Affectiva Q^{TM} biosensor, which simultaneously measures electrodermal activity (EDA), 3-axis accelerometer activity, and skin temperature levels. Beginning each school day, a sensor was placed on one of the ankles of each student and remained there until he or she departed. Teachers used a clipboard and a stopwatch (time synchronized with the Q sensors) to record settings (e.g., classroom, gym), activities (e.g., educational, physical activity), and clinically relevant behaviors (e.g., tantrums, aggression, elopement).

Results:
Over 60 days of recording, we obtained approximately 1,300 hours of physiological data and 6,000 annotations from teachers. In order to explore the large amount of data, we designed and developed a visualization tool that enables researchers to qualitatively analyze physiological data around different types of settings, activities, and before, during, and after observed behavioral episodes. Our presentation will demonstrate the Q sensor and our visualization tool, and provide preliminary findings within and between students relating to (1) heterogeneity in baseline arousal states over time; (2) relationships between autonomic changes and different observed behavior problems; and (3) associations between autonomic changes and cognitive demands of different activities.

Conclusions:
To the best of our knowledge, ours is the first attempt to gather long-term physiological data in a natural environment, in a population who usually has difficulty participating in laboratory studies, who frequently engages in challenging behaviors, and who struggle to provide any verbal self-report. To support the exploration of such a massive dataset, we engineered a new tool to enable more efficient data visualization. This visualization tool is used to help identify portions of the records that hold significance and that require further quantitative analysis. We will provide a sample of our initial analyses showing both differences and clusters of similarity across individuals' ANS data over the two-month period.