How Easy Are Children to Engage during Child-Adult Play? Using Electrodermal Activity as a Marker

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Background:
Measuring the attention level of children during social interactions can assist with the identification of developmental delays such as those present in people diagnosed with Autism Spectrum Disorder. Although research has shown that physiological measures map onto observable behavior in the context of attention, this has rarely been studied in young children during live social interactions. The availability of modern wearable physiological sensors provides an opportunity to automatically monitor not only outwardly sensed behaviors but also physiological states that help study social-communication development early in life.

Objectives:
This work explores whether we can successfully leverage modern biosensors to recognize how easily children engage with adults during social interactions by focusing first on typical development. In particular, we explore the utility of electrodermal activity (EDA) within 51 child-adult interactions. Furthermore, we explore the recognition value of several standard features extracted from the child's EDA responses, and several other features capturing the physiological synchrony of the dyad.

Methods:
Child-adult dyads wore Affectiva Q^{TM} EDA sensors on the left wrist during a short social interaction (3-minute on average) in which the adult engaged the child in several activities such a rolling a ball back and forth, and tickling. For each of the activities, the adult rated the child's engagement, ranging from 0 (easy to engage) to 2 (difficult to engage). The final subset of data consisted of 51 sessions of typically developing children (27 females) with an average age of 21 months (SD = 5.23). The sample was divided into: 1) *easier to engage* (n = 29), consisting of children who scored zero on all activities; and 2) *harder to engage* (n = 22), consisting of the children who scored 1 or 2 for at least one of the activities. These groups were used as classes to be recognized in a binary classification problem with Support Vector Machines. EDA responses from both the child and the adult were normalized and decomposed into tonic and phasic components. Several features characterizing the general activation of the child (e.g., number of peaks) as well as the physiological synchrony of the dyad (e.g., correlation) were used for the analysis. Sequential Forward Feature Selection was used to select the most discriminative features.

Results:
The position of the maximum value of the tonic component of the child was the most discriminative single feature in automatically differentiating the two groups, yielding a classification performance of 69.61%. Among several features that captured the physiological synchrony between the child and adult, the difference between the amount of phasic peaks between the child and the adult achieved a classification performance of 69.29%. Finally, the combination of standard features extracted from the child's responses and features capturing the physiological synchrony of the dyad yielded the highest classification performance, 92.95%.

Conclusions:
Measurements of child physiology and its synchrony with the adult's physiology enabled high discrimination between observed ratings of engagement levels provided by the adult. Our findings represent an important first step towards providing new measures to reliably and objectively quantify social behavior, an important advancement for the study of child development.