Analyzing the Physiological Synchrony of Children with Autism and their Parents with Signal Processing Techniques

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Background

Child-parent synchrony has been broadly studied in psychology (Field 1994, Cole et al 2004, Lindsey and Caldera 2006). There are indications that synchrony between a child and his/her caregiver is also present in physiological mechanisms and is affected by various pathological conditions (Feldman 2007). Children with autism tend to be less expressive than their typically developing peers and have difficulty exchanging information and conveying their affective state. Studies have indicated that overt signals of these children might be inconsistent with their physiology (Goodwin et al., 2006, Picard 2009). In light of this observation, analyzing child-parent physiological synchrony could provide new insights into the mechanisms of their interaction and affectivity, which are not always obvious through traditional observational methods.

Objectives

Electrodermal Activity (EDA) is a physiological signal linked with the sympathetic nervous system and measured by the electrical changes of the skin surface. Our goal is to analyze physiological signals of children with ASD with relation to the corresponding signals of their parents when interacting with and without the presence of an Embodied Conversational Agent (ECA), using novel signal processing techniques.

Methods

The data for this study come from the "USC Rachel ECA Interaction Corpus," which contains recorded interactions between a child, his/her parent and an ECA named "Rachel." The experiments were designed to elicit affective and social behavior of children with autism. They include four sessions, each separated into a Rachel- and a parent-moderated part. To measure physiological signals, we used two pairs of Affectiva Q Sensors for the child and his/her parent, worn on the opposite wrist and the ankle of each person. The sensors provide measures of EDA, temperature and x,y,z-axis acceleration. Our goal is to get informative features by applying noise removal techniques and

deriving descriptive features of those signals, such as statistical moments, derivatives, number of zero-crossings and peaks. We examine child-parent physiological synchrony by using correlation and coherence metrics and measures related to information theory, like mutual information.

Results

We have collected data from 9 verbally fluent subjects (7 boys, 2 girls). Our results indicate that there is significant amount of physiological synchrony between child and parent in both interaction conditions (ECA presence vs. absence), suggesting that data collected from ECA interactions are representative of natural child-parent interactions. These findings are similar to those of a related study on the same corpus based on expressive communication cues (Mower et al. 2011). The measured internal child-parent synchrony in the ECA presence condition implies that the parent is also actively engaged in the experiment even though the ECA is designed to interact with the child directly. A detailed description of our findings will be discussed at the conference.

Conclusions

Technology has the potential to measure and interpret physiological signals of children with ASD, signals which are not expressed through verbal, non-verbal, or gestural channels. In this research, we automatically sense, process and model physiological signals to analyze the synchrony measures between a child with ASD and his/her caregiver. This work is supported by NSF and NIH.