Chapter 43
Affect-Sensitive Computing and Autism

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ABSTRACT

This chapter covers the application of affective computing using a physiological approach to children with Autism Spectrum Disorders (ASD) during human-computer interaction (HCI) and human-robot interaction (HRI). Investigation into technology-assisted intervention for children with ASD has gained momentum in recent years. Clinicians involved in interventions must overcome the communication impairments generally exhibited by children with ASD by adeptly inferring the affective cues of the children to adjust the intervention accordingly. Similarly, an intelligent system, such as a computer or robot, must also be able to understand the affective needs of these children - an ability that the current technology-assisted ASD intervention systems lack - to achieve effective interaction that addresses the role of affective states in HCI, HRI, and intervention practice.

INTRODUCTION

Autism is a neurodevelopmental disorder characterized by core deficits in social interaction, social communication, and imagination (American Psychiatric Association, 2000). These characteristics often vary significantly in combination and severity, within and across individuals, as well as over time. Research suggests prevalence rates of autism has increased in the last 2 decades from 1 in 10000 to as high as approximately 1 in 110 for the broad autism spectrum (CDC, 2009). While, at present, there is no single universally accepted intervention, treatment, or known cure for Autism Spectrum Disorders (ASD) (NRC, 2001; Sherer and Schreibman, 2005); there is an increasing consensus that intensive behavioral and educational intervention programs can significantly

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improve long term outcomes for individuals and their families (Cohen et al., 2006; Rogers, 2000).

Affective cues are indicators, external or internal, of the manifestations of emotions and feelings experienced in a given environment. This research utilizes and merges recent technological advances in the areas of robotics, virtual reality (VR), physiological signal processing, machine learning techniques, and adaptive response technology in an attempt to create an intelligent system for understanding various physiological aspects of social communication in children with ASD. The individual, familial, and societal impact associated with the presumed core social impairments of children with ASD is enormous. Thus, there is a need to better understand the underlying mechanisms and processes associated with these deficits as well as develop intelligent systems that can be used to create optimal intervention strategies.

In response to this need, a growing number of studies have been investigating the application of advanced interactive technologies to address core deficits related to autism, namely computer technology (Bernard-Opitz et al., 2001; Moore et al., 2000; Swettenham, 1996), virtual reality environments (Parsons et al., 2004; Strickland et al., 1996; Tartaro and Cassell, 2007), and robotic systems (Dautenhahn and Werry, 2004; Kozima et al., 2009; Michaud and Theberge-Turmel, 2002; Pioggia et al., 2005; Scassellati, 2005). Computer- and VR-based intervention may provide a simplified but exploratory interaction environment for children with ASD (Moore et al., 2000; Parsons et al., 2004; Strickland et al., 1996). Robots have been used to interact with children with ASD in common imitation tasks and can serve as social mediators to facilitate interaction with other children and caregivers (Dautenhahn and Werry, 2004; Kozima et al., 2009). In the rest of the chapter, the term "computer" is used to imply both computer- and robot-assisted ASD interventions.

Even though there is increasing research in technology-assisted autism intervention, there is a paucity of published studies that specifically address how to automatically detect and respond to affective cues of children with ASD. Such ability could be critical given the importance of human affective information in HCI (Picard, 1997; Prendinger et al., 2005) and HRI (Fong et al., 2003) and the significant impacts of the affective factors of children with ASD on the intervention practice (Ernsperger, 2003; Seip, 1996; Wieder and Greenspan, 2005). A computer that can detect the affective states of a child with ASD and interact with him/her based on such perception could have a wide range of potential impacts. Interesting activities likely to retain the child's attention could be chosen when a low level of engagement is detected. Complex social stimuli, sophisticated interactions, and unpredictable situations could be gradually, but automatically, introduced when the computer recognizes that the child is comfortable or not anxious at a certain level of interaction dynamics for a reasonably long period of time. A clinician could use the history of the child's affective information to analyze the effects of the intervention approach. With the record of the activities and the consequent emotional changes in a child, a computer could learn individual preferences and affective characteristics over time using machine-learning techniques and thus could alter the manner in which it responds to the needs of different children. This chapter presents the results of investigations which assess what effects there are on physiological response for children with ASD during performance-oriented and socially-oriented tasks. The ability to detect the physiological processes that are a part of impairments in social communication may prove an important tool for understanding the physiological mechanisms that underlie the presumed core impairments associated with ASD.