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**With a Little Help from your (Virtual) Friends:  
Social Skills Assessment for Autism Spectrum Disorder**

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## **I. Narrative**

My research career has focused on constructing theories of the interaction between verbal and nonverbal behavior in social interaction. For the past decade I have concentrated particularly on the ways in which technology can play a role in those theories. I have built computational models of gesture in discourse (in the form of autonomous gesturing Embodied Conversational Agents (ECA)<sup>i</sup>, or virtual humans), and computational tools that employ nonverbal behavior to bootstrap language and literacy learning by children from different cultural contexts (in the form of virtual playmates that model collaborative storytelling). More recently I have become interested in how technology can play a role in the lives of people who have language and cognitive abilities, but who themselves have no theory of the interaction between verbal and nonverbal behavior in social interaction – that is, people with *High-Functioning Autism Spectrum Disorder* (HFA). My student Andrea Tartaro and I have demonstrated in this recent work that children with high-functioning autism display more advanced social skills when interacting with virtual playmates than real playmates, meaning that the verbal and nonverbal behavior that they display in everyday interaction does not reflect their actual level of knowledge (Tartaro & Cassell, 2007). In the work that I am submitting to the Hiatt, I am proposing to take that research one step further, and develop a new way of, and innovative technological supports for, *assessing* the social skills of children with HFA.

Autism Spectrum Disorder (ASD) is a developmental disorder which covers a wide continuum of deficits, including three core-defining features: impairments in social skills, impairments in verbal communication, and restricted and repetitive patterns of behaviors (APA, 1994). The prevalence rate for ASD has increased worldwide over the past decade, and current estimates indicate 60/10,000 individuals are diagnosed with ASD each year (Fombonne, 2003), with current annual economic costs of \$35 billion in the United States alone (Ganz, 2006). Early identification of the disorder is considered crucial for access to the early intervention which is so important for positive long-range outcomes (Filipek, et al., 1999). However, because the autism diagnosis covers such a wide range of deficits, more specific *skill-assessments* are needed for tailoring effective interventions (Merrell, 2001). Usually, several professionals are involved in the evaluation and later in treatment: speech-language pathologists, occupational therapists, and clinical psychologists. Unfortunately, *social functioning*, one of the core symptoms of ASD, is not the sole purview of

any of these professions and may be assumed to be assessed and treated by all three intervention agents. This ambiguity, and the resultant lack of targeted social skills interventions for children with ASD, has led to a wide-spread call for a better understanding of social-skill functioning in children with ASD.

And yet, while the past decade has been marked by important advances in diagnostic tools (i.e., the ADI Autism Diagnostic Interview (Rutter, et al. 2003); and ADOS Autism Diagnostic Observation Scale (Lord, et al. 1999)) as well as increased public awareness, only two assessment tools, both of which are questionnaires to be filled out by parents or teachers, have been developed solely to measure the social behaviors of children with ASD: the CSBQ Children's Social Behavior Questionnaire (Luteijn et al., 2000) and the SRS Social Responsiveness Scale (Constantino, 2002). While both scales provide a reliable quantitative measure of the *severity* of autistic social impairment, they do not consider the social context in which the behavior is being displayed. As Dodge and Murphy (1984) argue, however, a three-step assessment process must precede any effective treatment plan targeting social competence: (1) identify the child as having an impairment; (2) identify the particular social context, task or situation in which the child displays abnormal behaviors; and (3) assess the child's component skills in each of these situations.

This deficiency in assessment tools is particularly salient when considering the importance of social context for children with HFA and Asperger's Syndrome (AS), who usually attend mainstream educational systems and are expected to respond to and initiate social interactions with typically-developing children in a variety of social contexts. Some interventions teach specific social skills in the therapeutic context (McConnell, 2002; Rogers, 2000). However, the benefits often do not generalize, leading to a gap between the level of functioning within the therapeutic setting and in real life. Gresham et al. (2001) concludes that a major weakness of social skills interventions is the failure to target maintenance and generalization. In addition, these researchers posit that the ineffectiveness of many social skills programs is a result of the clinician's failure to match the social skills strategy to the type of skill deficit presented. It should be clear, then, that being able to assess a child's behaviors in different settings is a crucial part of progress and successful integration in mainstream schools for children with HFA.

One possible method for evaluating different levels of social-functioning across settings is direct observation. Despite the empirical evidence and acknowledged advantages of using naturalistic behavioral

observation over questionnaires, overwhelming drawbacks exist in terms of practicality: it is extremely time-consuming, in both preparation (training the observers, developing coding systems) and in data collection (observing, and annotating). For example, Doll and Elliot (1994) note that in order to reliably measure a child's social behavior, as many as six observations may be necessary. As many have noted, then, it remains important to develop an assessment of social-functioning that differentiates among different social contexts, and allows scoring of actually observed behavior (in contrast to parent/teacher questionnaires) without being as time- or resource-intensive as direct observation. Fortunately, advances in interactive technologies now permit the development of new methods of evaluation that are capable of comprising both complexity and frugality, and it is this solution that I propose to investigate.

The application of interactive technologies to HFA assessment is a natural development in my own research program. I have previously demonstrated that ECAs can engage in social dialogue with people, eliciting trust and rapport (Cassell & Bickmore, 2002). In later work, my students and I created a child-like Virtual Peer (VP)<sup>ii</sup> which can engage in natural peer collaboration, sharing real toys, and responding to children's input (Cassell, 2004). VPs leverage the appeal of computers to children, while providing an environment for learning about language and social interaction, and we have demonstrated that interaction with VPs increases the amount of proto-literacy language children produce. Given the success of this past work, we are currently using the VP to study the reciprocal social interaction skills of children with HFA. The first phase of this research compares the behaviors of these children when interacting with the VP to their interactions with typically-developing peers (Tartaro & Cassell, 2007). This is also a crucial first-step for developing an assessment tool for children with HFA using VPs or similar technologies. The second phase of our current research consists of designing an Authorable VP, where children can control the behaviors of the VP as a way of testing hypotheses about those behaviors, with the goal of helping children with HFA develop their reciprocal social interaction skills (Tartaro & Cassell, 2006). While we are still analyzing the data, initial results are promising. And our experiences demonstrate that children with HFA enthusiastically engage in storytelling with VPs, and that the VP can accurately depict both verbal and non-verbal information (Cassell & Tartaro, 2007). For the goals of the current research, then, we

hypothesize that in addition to serving as an effective *intervention*, the VP can effectively serve as a representation of peer interaction, with the goal of developing an *assessment* tool of social functioning.

The goal of the present research, then, is to develop, in collaboration with a clinical psychologist post-doc<sup>iii</sup>, a prototype of a social-functioning assessment tool, in the form of a virtual peer that engages children in a variety of tightly controlled social interactions, and to pilot its usability for children with HFA. As well as being motivated by our own previous research on VPs, a body of literature exists demonstrating that children with HFA are drawn to virtual representations of humans such as robots (Dautenhahn & Weery 2004; Michaud & Theberge-Turmel, 2002), avatars in chat rooms (Kerr et al., 2002), and animated cartoon faces (Bosseler & Massaro, 2003). None of these projects, however, provide representations of peers nor of fully embodied verbal and nonverbal behavior in interaction, both of which are key missing aspects of the social competence of children with HFA. In addition, none of these technological projects target *assessment*, although recent work by Mikami et al. (2007) does use chatbots in a chat room to assess social skills in children with ADHD.

We believe that the research proposed here will have several important outcomes. First, it will allow us to reach a better understanding of the social-functioning deficits of children with HFA. Second, it will allow more tailored treatment plans for each child, while directing treatment toward appropriate existing interventions. Finally, the results of our experiments with the VP as an assessment tool will allow us to refine our theories of the role of new media technology in children's development.

## **II. Research design and timetable:**

Phase 1: task development: October 2007 – March 2008: In the first phase of our research, we will develop a series of tasks and procedures for the technologically-based assessment system. These tasks will be based on the combination of two existing and well-validated questionnaires of social skills: SRS and TOPS (Taxonomy Of Problem Situation, (Dodge, McClaskey et al. 1985)). Since the SRS evaluates symptom severity, and the TOPS evaluates the situations and tasks most likely to lead children to experience social difficulties, a combination of the two will address the goals of the present study. The social *contexts* will represent the main social tasks that pose problems: group entry, peer provocation, response to failure, response to success, awareness of social norms, and responding to authority. The social *skills* that will be evaluated are: social awareness, social cognition, social communication, and social motivation. An example of a task based on the TOPS and the SRS is: a VP will invite the child to play a board game. During the game, the VP will take the child's turn (social context: peer provocation). The child's verbal and non-verbal response will be coded on a 3 point Likert scale, based on the SRS. Thus, a score for social motivation and social communication will both be assigned. Note that, as the ADOS is required for publication in this field, it will serve as the general framework for designing the social tasks.

Phase 2: system development: January 2008 – June 2008: We envision adapting the virtual peer paradigm to engage children with HFA in true-to-life situations in a controlled environment requiring multi-modal communication. To this end, we will develop a prototype of several VPs as well as a series of interactions for the VP with other VPs and with the real child, as well as different backgrounds to both convey social context and to simulate the information overload (visual and auditory noise) typically characterizing social contexts. Thus, for example, one can imagine two life-size virtual peers displayed on a large screen, playing ball with one another. In the scene, other virtual children (non-player characters) are playing in the background, making a normal amount of social noise. The real child's first task will be to join in the game of ball using appropriate verbal and non-verbal behaviors. Based on the child's response, the task will result in one of several different outcomes: The child will either join the game or the VPs will go play with someone else. Since the scenes are being played out by virtual rather than real peers, each social context can be tightly controlled, and described to follow the key parameters of the assessment.

Phase 3: collecting data: June 2008 – October 2008: We currently have IRB approval for children with HFA to interact with the VPs. After we receive modified IRB approval for this new task, thirty children (ages 7-12 years) will be recruited for pilot testing of the prototype, with 10 children in each of the following categories: (1) diagnosed with HFA or AS, (2) typically developing (matched in age and gender), (3) children with social deficits who are not HFA. While the third group of children with social deficits are not on the autistic spectrum (i.e., children with non-verbal learning disorders and children with ADHD), they are also characterized by significant social impairment. Including them in the present design will help to illuminate the common social characteristics across the disorders, and the unique profile of HFA.

Because the purpose of the pilot study is to evaluate social skills tasks that are optimal for children with HFA, an iterative design process will be employed. Thus, after analyzing these preliminary results, any necessary changes to the prototype will be made, and a second pilot sample of participants will be tested. Parents of all participants will be asked to complete the SRS and TOPS questionnaires. Statistical correlation between the scores of these questionnaires (which has standard and normative scales) to the scores on the technologically-based assessment, will allow us to establish an initial normative scale with pathological cut-off points for the new generated social functioning profile. Based on these two studies, we will apply to NIH to run a larger study to evaluate test-retest reliability, internal consistency, and construct-related validity, as well as to extend the assessment to less high-functioning children with ASD.

The importance of the research described here is two-fold. Children with High-Functioning Autism or Asperger's Syndrome are most likely to get the intervention they need if the specific nature of their communication and social deficits are identified accurately. An assessment tool that can be deployed without the need for massive time, human, and financial resources is apt to make early intervention a lot more likely for this at-risk population. In addition, this project represents an important step in the young but growing field of innovative technologies for autism, which is a strand in the study of emerging new media technologies that challenge traditional disciplinary boundaries.

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#### **IV. Endnotes**

<sup>i</sup> Key to abbreviations (which are rampant in this field):

ADHD = Attention-Deficit/Hyperactivity Disorders  
ADI = Autism Diagnostic Interview  
ADOS = Autism Diagnostic Observation Scale  
ASD = Autism Spectrum Disorder  
ECA = Embodied Conversational Agent (virtual human)  
HFA = High Functioning Autism  
SRS = Social Responsiveness Scale  
VP = Virtual Peer

<sup>ii</sup> Here are two images of our life-size virtual peers (with and without a real child), to give a sense of what the technology resembles



<sup>iii</sup> Short biography of the post-doctoral fellow is included under Budget