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Demonstration and evaluation of avatar assistant: Encouraging social development in children with autism spectrum disorders.

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DEMONSTRATION AND EVALUATION OF AVATAR ASSISTANT: ENCOURAGING SOCIAL DEVELOPMENT IN CHILDREN WITH AUTISM SPECTRUM DISORDERS

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PSYCHOLOGY

ABSTRACT

The current study assessed the efficacy of a computer-based social skills training program for children with Autism Spectrum Disorders (ASD). Previous research has highlighted deficits in social relations and non-verbal communication in children with ASD. Specifically, earlier studies have shown that children with ASD perform significantly worse on tasks involving emotion and facial recognition as compared to typical children. The overall purpose of the current study was to use recent advances in research, theory, and technology to develop, implement, and evaluate an avatar tutor for social skills training in children with ASD. "Face Say" was developed as a colorful program that contains several different activities designed to teach children specific social skills, such as eye gaze, joint attention, and facial recognition. This study indicates that providing children with autism and Asperger Syndrome opportunities to practice attending to eye gaze and recognizing faces and emotions in a controlled, structured, and interactive environment through computer simulation improved their social skills abilities. Altogether, the children with autism demonstrated improvements in two areas of the intervention: emotion recognition and social interactions. The children with Asperger Syndrome demonstrated improvements in all three areas of the intervention: facial recognition, emotion recognition, and social interaction. The findings of this study are of great importance. It provides information about the benefits of computer-based

training for children with ASD. The knowledge gained from this study could be used to create more effective and cost efficient therapies for improving the cognitive-emotional skills of children with developmental disabilities.

DEDICATION

This dissertation is dedicated to Caleb, my soul mate and best friend.

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This dissertation is the result of the collective efforts of a number of important and valued people who have directly or indirectly assisted and supported me during my doctoral studies and in this present endeavor. To these people, I owe my gratitude and thanks. I would like to thank my mentor, Dr. Fred Biasini, for providing inspiration, encouragement, guidance, and support throughout my graduate experience. I would also like to thank Dr. Franklin Amthor for providing the idea to this project. I am grateful to the participating committee members who gave their time and assistance with this research.

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LIST OF ABBREVIATIONS

ANOVA	analysis of variance
ANCOVA	analysis of covariance
ASD	Autism Spectrum Disorders
CARS	Childhood Autism Rating Scale
IQ	intelligence quotient
KBIT	Kaufman Brief Intelligence Test
SSO	Social Skills Observation
SSRS	Social Skills Rating System

INTRODUCTION

Johnny sees a group of children playing soccer at the neighborhood park. He is excited and wants to play too. How should he approach them? Should he run over to Derek, expressing his exuberance by grabbing the soccer ball and begin kicking it? Should he edge over to the group and wait until he is invited to play? Should he approach Mike, who has turned his back to him, or Jessica, who is smiling at him?

Johnny is facing a key social situation, initiating social contact. As this example makes evident, emotions are primary elements in social interactions. Johnny's ability to express and experience his own emotions and to recognize the emotions of others involved will determine whether his strategy in this situation is successful. Emotions are central elements in social interactions. First, they are a significant source of information to both the person communicating and the person receiving the communication. Emotional content (communicated verbally, facially, or through other channels) often determines the meaning of an interaction. Second, emotions are integral to social interactions; as dynamic processes they create and are created by relationships with others (Campos, Campos, & Barrett, 1989).

The development of social competence is an important goal for all children. However, some children are at risk for failure in social competence domains because of deficient social skills (Gresham, 1981). One of the hallmark symptoms of Autism

Spectrum Disorders (ASD) is impairment in the development of reciprocal social interaction skills (American Psychiatric Association, 1994). Individuals with ASD display marked impairments in the use of multiple nonverbal behaviors, such as eye-to-eye gaze, facial expressions, body posture, and gestures to regulate social interaction (Hobson, 1986). In addition, individuals with ASD often fail to monitor the effect of their conversations or behaviors on other people. For example, they frequently monopolize conversations or walk away while others are trying to interact with them (Bailey, 2001).

Difficulties with social interactions result from atypical social development, unusual interests that are not shared by peers, and information-processing impairments that lead to difficulty understanding social cues. In general, children with ASD do not show a typical progression of social development. From the first few years of life, young children with ASD do not respond to social stimuli such as hearing their named called (Hobson, 1986). As a result, at relatively young ages these children fall behind their peers in the development of their social interactions. A devastating effect of these difficulties is their failure to establish strong positive peer relationships at home, at school, and in other settings. In addition, children with ASD usually experience abnormalities in the development of their cognitive skills. The types of cognitive problems encountered, such as executive dysfunction (Ozonoff, Pennington, & Rogers, 1990), impairments in theory of mind (Baron-Cohen, 1995), and difficulties disengaging and shifting attention may further hinder social interactions.

ASD includes autism, Asperger Syndrome and pervasive developmental disorder not otherwise specified. Autism and Asperger Syndrome are both recognized neurodevelopmental disorders that are defined primarily in behavioral terms. Both are distinct categories within ASD as defined by the *Diagnostic and Statistical Manual of Mental Disorders* criteria (American Psychiatric Association, 1994). According to this current conceptualization Asperger syndrome differs from autism in terms of language and cognitive functioning, which are not associated with early delay, but, as in autism, a severe impairment in social functioning and range of interests remains.

Joint Attention

As a form of communication, eye contact has been found to have a subtle, yet powerful effect on shaping social interactions. Eye contact is used to emphasize information, regulate turn-taking, convey intimacy and exercise social control. For the young infant, eye contact is an important tool of communication. Most children begin to use eye contact at an early stage in development. However, this is not the case for children with ASD. Joseph and Tager-Flusberg (1997) found that children with ASD attended less to the face of their mothers than children with Down Syndrome. On the other hand, Dawson, Hill, Spencer, Galbert, and Watson (1990) found that children with ASD did not differ from controls in the amount of eye contact with their mother. However, the children with ASD were less likely to combine eye contact with an appropriate facial expression. This suggests that children with ASD do not use eye contact as a way of communicating with others.

Around six months of age, children learn to use eye contact for the purpose of joint attention, the ability to coordinate one's attention to an object with another person. For example, a young infant will smile at her mother and at an object of interest in an attempt to enlist the mother's gaze and assumed attention to the object. Spontaneous displays of joint attention are less common in children with ASD (Lewy & Dawson, 1992). When joint attention is employed by children with ASD, it is usually for purposes of requesting assistance rather than for purposes of communicating a shared experience.

One of the most dramatic developments in communicative functioning occurs in typically developing infants between 9 and 12 months of age. Prior to this age, communication consists mainly of face-to-face turn-taking episodes that involve sharing of affect. Thereafter, two emergent forms of communication are observed. First, infants begin to use gestures to request aid in obtaining access to objects or events. Second, they display joint attention, indicating their own attentional focus by pointing and also accommodating their own focus to coordinate it with others. In individuals with ASD, both of these forms of nonverbal communication occur less frequently than in either typically developing infants or infants with developmental delay. Joint attention is especially impaired (Mundy, 1995) and this deficit is particularly good for discriminating ASD from other conditions associated with developmental delay (Lewy & Dawson, 1992).

A deficit in joint attention appears to be characteristic of individuals with ASD throughout their lives, although the specific form of the deficit may vary with intellectual ability and developmental level. For example, Mundy, Sigman, and Kasari (1994) found that children with low mental ages exhibited more pronounced deficits in lower level components of joint attention (e.g. eye contact) than children with higher mental ages.

Researchers agree that joint attention deficits may be one of the key symptoms of ASD. First, joint attention has been theorized to be a critical precursor to developing an understanding of other persons and to intentional communication in typical development (e.g. Mundy, Sigman, & Kasari, 1994). Second, joint attention deficits in ASD are robust, early appearing, and universal. Third, many other deficits in ASD are similar to joint attention, or are plausible developmental consequences of them.

Several suggestions regarding the causes of joint attention exist in the literature. Perhaps the most well-known of these is "theory of mind". According to this view, joint attention deficits in children with ASD are an early manifestation of their failure to grasp that other people are able to represent the world mentally (Baron-Cohen, 1995; Frith, 1989; Leslie, 1987). Joint attention behaviors, such as gaze following and pointing, are directed at achieving a connection with another mind. Without an appreciation of others' mental states, such behaviors would be unlikely to occur because their purpose would not be grasped.

The impaired ability to take another person's perspective on one's own behavior may lead to social relationship difficulties. One consequence is likely to be awkward, inappropriate, or impolite social behavior that may jeopardize relationships. Indeed, individuals with ASD are well known for their tendency to disregard tact and social conventions unknowingly (Frith, 1989). It is also likely that impaired social perspective taking interferes with the development of intimacy in adolescent and adult relationships.

Theory of Mind

Difficulty relating socially to other people is a characteristic of ASD. This important and constant symptom is significant in diagnosis of the condition. Individuals with ASD may appear to lack the ability to attribute mental states to others, resulting in difficulties interpreting the social behavior of others. There now exists much evidence that individuals with ASD have difficulty conceptualizing the intentions and mental states of others, and thus fail to attribute beliefs to others (Baron-Cohen, 1995; Frith & Happe', 1999; Kleinman, Marciano, & Ault, 2001; Rieffe, Terwogt, & Stockman, 2000; Tager-Flusberg & Sullivan, 1999).

Theory of mind, defined as the ability to infer the mental states of others (e.g. their knowledge, intentions, beliefs, desires), is a concept that was developed to address questions related to understanding how we attribute mental states and beliefs to others (Baron-Cohen, 1995). It refers to the ability to predict and clarify the behavior of others by making assumptions about beliefs or mental states. This ability appears to be a basic element of a typical social interaction. In everyday life people make sense of each other's behavior by attributing mental states to others. Theory of mind is also fundamental to communication and possibly the acquisition of language. Individuals frequently make sense of statements by reference to what the speaker intended to express rather than what is actually said (Baron-Cohen, 1995).

Difficulties in theory of mind have been proposed as one of the possible explanations for the social and communication difficulties experienced by children with ASD. Individuals who fail to appreciate that people have mental states would clearly have trouble interacting with others and understanding the essential nature of communicating either for social reasons or to exchange information. For example, individuals with ASD frequently do not to know the social rules of interpersonal communication (e.g. how to start a conversation, choose a topic of disclosure, take turns, or end a conversation) nor can they correctly impute motives to others, understand another's goals, or respond with alacrity to the nonverbal signals of others.

It is well established that the capacity of individuals with ASD to perceive and/or understand that others may have a perspective different from their own is very limited (Bauminger & Kasari, 1999; Baron-Cohen, 1995; Frith & Happe', 1999; Kleinman, Marciano, & Ault, 2001; Rieffe, Terwogt, & Stockman, 2000; Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998). The inability of individuals with ASD to appreciate others' thoughts and beliefs and to understand the relationship between mental states and behavior has been widely studied with the theory of mind paradigm (Frith & Happe', 1999). Baron-Cohen and colleagues have demonstrated that the ability of children with ASD to attribute mental states to others is significantly impaired. Baron-Cohen, Leslie, and Frith (1985) found that 80% of children with autism were unable to correctly predict the beliefs of others, whereas most individuals with mental retardation and mental aged matched normal controls were able to do so.

Theory of mind is viewed as emerging in late infancy, with its development extending beyond the preschool years. The roots of understanding the intentions of human action lie in infants' strong interest in people as evidenced by their attention to human faces and language, and their ability to respond to affective expressions within the first few months of life. Studies of the early characteristics of children with ASD highlight problems with eye contact, affect, orienting and responding to others and attention to language, all suggesting severe difficulties in relating to other people (Tager-Flusberg, Joseph, & Folstein, 2001).

In regard to processing social information, individuals with ASD show selective impairments in recognizing mental states from faces. Baron-Cohen, Wheelwright, and Jolliffe (1997) found that mental states that were signaled by the eyes (e.g. states such as flirtatiousness) were not recognized normally in individuals with autism. In addition, Hopkins and Biasini (2005) found that children with autism were impaired in their ability to recognize emotions from stimuli showing only the eyes compared to typically developing children. However, their ability to recognize emotions when provided with stimuli showing the mouth region was equal to that of the controls.

Emotion Recognition

Studies in typically developing children have shown that the observation and subsequent decoding of facial, gestural, or vocal displays of emotion enables typical children to fine-tune their behavior relative to that of others (Zahn-Waxler, Radke-Yarrow, & Wagner, 1992). As early as the first weeks of life, babies orient differently toward various human faces and voices. By the end of the first year, infants respond differently to facial expressions of emotions in others, and can use eye gaze to make predictions about what another person is attending to. Children with greater attention to affective cues at 2 years of age are more socially responsive with peers at both 2 and 5 years of age (Iannotti, 1985).

When Kanner (1943) first identified autism, he described it as a "disturbance of affective contact". The view that a deficit in processing and responding to emotions is central to ASD is still influential (e.g. Hobson, 1993). A number of studies have attempted to determine which aspects of emotional functioning that may be impaired. Results suggest that children with ASD have difficulties perceiving and understanding emotion (Hobson, 1986; Hopkins, & Biasini, 2005; Iannotti, 1985).

Basic to understanding another's mind is the ability to discriminate and label facial expressions of emotions. This ability is likely one of the building blocks necessary to the development of a mature understanding of emotions and, consequently, the ability to empathize with others. Emotions are also closely linked to beliefs and wishes (Baron-Cohen, 1995). For example, facial expressions often reveal information about whether a person's need has been satisfied or unfulfilled. It has been found that individuals with ASD show particular deficits in discriminating facial expressions of emotions, which may be related to their deficits in theory of mind (Hobson, 1986).

The ability to recognize emotions in others is a crucial component of social development and developing a theory of mind (Hobson, 1986). Impairment in this skill severely reduces one's ability to participate in or interpret social interactions. In order to establish the extent to which emotion recognition skills develop in children with developmental disabilities, previous research has tended to focus on children with ASD for whom impaired social development is seen as a key feature. Differences have been found between children with ASD and typically developing children. For example, Baron-Cohen, Wheelwright, and Jolliffe (1997) developed a theory of mind task where the participants looked at photos of either an entire face or just a region around the eyes to determine emotions. The researchers found that individuals with autism performed significantly worse on the task than age and IQ matched participants without autism. In addition, individuals with autism had marked deficits in their performance in the eyes-only condition. These results support the idea that theory of mind and emotion recognition deficits are key characteristics in understanding the social deficits of individuals with ASD.

In summary, children with ASD show certain deficits in perceiving and understanding emotions. Lack of skills in perceiving and responding to emotional signals in ASD is likely to be one of the most important obstacles in smooth interactions and successful social relationships. In infancy and early childhood, the inability to send clear signals and to respond to the signals of others is likely to affect caregiver-child interactions in ways that could negatively impact the attachment relationship. Parents are likely to have difficulty learning to tailor their responses to their child's needs and children are likely to have difficulty anticipating their parents' behavior, leading to awkward and difficult interactions.

Emotion processing deficits may not be specific to emotions, but may reflect more general information processing deficits. For example, difficulties in processing emotional expressions in ASD may stem from more general difficulties in processing faces (Boucher & Lewis, 1991) or still more general perceptual difficulties related to the processing of relational information (Shah & Frith, 1993). Davies, Bishop, Manstead, and Tantam (1994) performed two experiments designed to tease apart these various possibilities. Their results support the conclusion that emotion processing and face processing deficits in ASD can be attributed to more general impairment in processing of relational information. Participants in their study showed similar deficits in processing emotional, facial, and nonfacial stimuli.

Central Coherence

Much interest in perceptual and attentional difficulties in children with ASD has been inspired by the conceptualization by Frith (1989) of these abnormalities as "weak central coherence." Her hypothesis postulates a weakness in the operation of central systems that are normally responsible for drawing together or integrating individual pieces of information to establish meaning. This weakness results in a cognitive bias toward processing local parts of information rather than the overall context. The theory maintains that there is a reciprocal relationship between global and local processing. Thus, Central Coherence Theory predicts that individuals with ASD will perform well on those tasks where piecemeal processing is advantageous, but perform poorly on tasks that require global processing, or the integration of information in context (Frith & Happe, 1994). This may provide at least a partial explanation for the facial recognition difficulties of individuals with ASD found in previous research.

Most of the evidence for weak central coherence in individuals with ASD has been reported at the visuospatial level. An example of this is the exceptionally good performance of individuals with ASD on the embedded figures task and the block design subtest of the Wechsler intelligence scales (Shah & Frith, 1993). In the embedded figures test, participants need to find a hidden shape (e.g. a triangle) embedded in a large complex design. Block design requires participants to construct a design from three-dimensional painted blocks. Individuals with ASD find both tasks relatively easy and their performance is thought to arise from an enhanced ability to analyze local information (Shah & Frith, 1993; Jolliffe & Baron-Cohen, 1997). A preference for processing details is also found on copying tasks, where individuals with ASD are more likely to reproduce a figure by drawing the local features first, unlike typically developing individuals who begin with the outline of the overall form (Ropar & Mitchell, 2001).

At the heart of the weak central coherence theory is the idea that individuals with ASD have deficits in the ability to integrate contrasting features in order to derive the overall global configuration of the stimulus. This kind of deficit has clear implications for the way in which the meaning or significance of stimuli can be interpreted. The significance of a stimulus is rarely determined by a single distinct feature, but rather a particular configuration of features. An example that is of relevance in ASD and in the current study is recognizing emotional significance of a facial expression. Different expressions share some features, but their particular configurations denote certain emotional expressions. For example, a down-turned mouth configured with a frown denotes sadness, a frown with narrow eyes denotes a mixed expression, and a down-turned mouth with narrow eyes indicates disgust.

Face Processing

Faces are remarkably homogenous as a class of visual stimuli in that they share a highly similar structure, always consisting of the same set of parts (e.g. eyes, nose, and mouth) in the same basic configuration (e.g. nose centered below the eyes and above the mouth). Yet, despite this basic similarity, most people can easily recognize and discriminate among hundreds of faces. The ease with which humans are able to distinguish between faces has been widely argued to depend on holistic perceptual and encoding processes (Bartlett & Searcy, 1993; Mundy, 2003; Rhodes, 1988).

The face is a complex, dynamic, visual configuration, and a fundamental source of social stimuli. Recognition of faces as "faces", person identity, and responsiveness to expression, are critical in normal social development and the development of social cognition (Herba & Phillips, 2004). Facial expression is "as crucial to human society as the vocal channel – if not more so" and is the primary source of social communications, preverbally, and subsequently (Turner, 1997, p. 116). Understandably, some theories of

ASD have proposed primary dysfunctions in face processing (e.g. Mundy, 2003; Shultz, Gerlotti, Klin, Kleinman, Van der Gaag, & Marois, 2003).

Typically developing individuals use holistic or configural perceptual processing to inspect a face compared to feature-based processing used to inspect objects. Inverting a face impairs processing much more than inverting objects (Valentine, & Bruce, 1986). Inversion appears to hinder face processing by disturbing the relational information between face parts (e.g. the distance between the eyes, nose, and mouth). In contrast, the effect of inversion on the processing of individual features appears to be more limited (LeGrand, Mondloch, Mauer, & Brent, 2003). Also, the recognition of face parts is sensitive to their natural configuration whereas this is not the case for objects (Tanaka & Farah, 1993).

Individuals with ASD appear to process faces by relying more on local facial features than on configural aspects of faces (i.e. the relationship between the different parts). Persons with autism showed much less of an inversion effect (i.e. their performance was not impaired for recognition of upside down faces versus upright faces) compared to controls when presented with inverted faces (Langdell, 1978). The lack of inversion effect is taken as a sign of a local rather than a configural processing of faces because only local information is available in inverted faces.

People with ASD can discriminate between faces (Ozonoff, Pennington, & Rogers, 1990). However, as the demands are increased, or elements of emotion are included, performance is impaired for individuals with ASD (Davies, Bishop, Manstead, & Tantam, 1994). Joseph and Tanaka (2003) found evidence of holistic strategy use by children with autism, but, unexpectedly, only when face recognition depended on the mouth. Marked deficiencies in recognition occur when identification is dependent on the eyes. Hopkins and Biasini (2005) also found that children with autism recognized schematic face stimuli by relying on lower facial features only. The same conclusion was drawn when using photographs of faces. The Joseph and Tanaka (2003) finding is consistent with Hopkins and Biasini (2005) study: children with autism focus on the mouth when attending to faces and are poor at recognition involving eyes.

Langdell (1978) demonstrated abnormalities in the way that children with autism process faces by showing them pictures of their classmates' faces with different features covered by a mask. Children with autism were superior in recognizing their classmates from pictures of their classmates' mouths compared to typically developing children. On the other hand, children with autism had difficulty recognizing their classmates from their upper part of the face. Thus, children with autism adopted a more feature-based strategy for face processing and focused more on the mouth than the whole face, in sharp contrast to the preference for the eyes demonstrated by typically developing children.

Klin, Jones, Schultz, Volkmar, and Cohen (2002) measured the visual fixation patterns using eye-tracking technology of males with and without ASD viewing social scenes from the movie, *Who's Afraid of Virginia Wolf.* While the control group monitored the interactions of the actors by viewing the actors' eyes, individuals with ASD were much more focused on the mouth. Thus, it is possible that individuals with ASD do not find the eyes meaningful or informative. It is not clear whether this is a developmental or a more neural based deficit like the proposed central coherence.

Additional evidence of abnormal face processing in ASD comes from brain imaging research. Functional magnetic resonance imaging (fMRI) studies have consistently demonstrated that perception of faces in typically developing individuals evokes activity in an area of the ventral temporal cortex known as the "fusiform face area" (Haxby, Horwitz, Ungerleider, Maisog, Pietrini, & Grady, 1994; Kanwisher, McDermott, & Chun, 1997). Several fMRI studies of individuals with ASD have reported abnormally weak fusiform face area activation during face viewing tasks. For example, a study using fMRI demonstrated that individuals with ASD, in contrast to normal controls, exhibited a pattern of brain activity during face discrimination that is typical of object perception and consistent with feature-based strategies (Schultz, Gaultier, Fulbright, Anderson, Volkmar, Skudlarski, Lacadie, Cohen, & Gore, 2000). These findings indicate that individuals with ASD attend to the local aspects of faces rather than the whole structure. These differences in face processing may arise as a result of reduced social interest in individuals with ASD who do not regard the face as socially important (Klin, Sparrow, de Bildt, Cicchetti, Cohen, & Volkmar, 1999).

Social Skills Interventions

Children with ASD show impairments in the domains of theory of mind, emotion recognition, joint attention, eye gaze, facial recognition, social skills, and communication (Frith, & Happe', 1999). The long-term implications of these deficits can be extremely serious. Interpersonal relationships with family members and friends may suffer. Additionally, the ability to obtain and maintain employment may be difficult. Successful employment depends largely on the ability to get along with others. In fact, deficiencies in social skills are much more likely to cause termination of employment than are nonsocial factors (Webb, Miller, Pierce, Strawser, & Jones, 2004).

Although high-functioning children with ASD display impairments in social skills, many of these children appear to have a desire for social involvement and recognize it when lacking. Specifically, studies show that children with ASD may experience perceptions of poor social support and loneliness. For example, Bauminger and Kasari (1999) found that high-functioning children with autism report having significantly fewer friends compared to typical peers. In addition, when the quality of their relationship with a best friend was examined, children with autism reported diminished quality in several pivotal categories compared to typical peers (i.e. companionship, security, and help).

Teaching social skills and paying attention to the reciprocal interaction skills that people with ASD need to learn are important aspects of individuals' lives. Ruble and Dalrymple (1996) found that for individuals with autism, doing activities with others and being an active participant are important aspects of their lives. In addition, individuals with autism reported that holding a job was important. Their degree of independence or what they did was not as important as the relationships they had at work and how others valued what they did. In fact, they communicated more about the people in the work settings than about the job. Therefore, as teachers, parents, and others are planning individual programs for people with ASD, it is imperative that social skills be taught and fostered throughout the school years and beyond.

Several studies have used school-based interventions to improve social skills for children with disabilities. Notably, most school-based social skills interventions for children are implemented multiple days per week for short time periods. A school-based method for increasing the social interactions of children with ASD involves educating and training typical peers to encourage children with ASD to engage in social exchanges (Goldstein, Kaczmarek, Pennington, & Shafer, 1992). In this type of peer-mediated intervention, children are taught skills (e.g. establishing mutual attention, commentating, turn taking) to help them better interact with their classmates. The typical peers master these strategies through role-plays with adults. Then, when prompted, the typical peers use these facilitative strategies with classmates who have ASD. Peer-mediated approaches have been shown to improve social interaction between children with disabilities and typical peers (Kamps, Leonard, Vernon, Dugan, & Delquadari, 1992). This strategy has also been shown to be effective in increasing the social interactions of young children with ASD. However, many studies find that typical children show larger increases in social skills following intervention than children with ASD. In addition, although generalization has been established using the peer-mediated approach, the social skills learned often do not generalize to settings with unfamiliar peers (Gonzalez-Lopez & Kamps, 1997).

The peer-mediated approach is based on the Social Learning Theory by Bandura. It emphasizes the importance of observing and modeling the behaviors, attitudes, and emotional reactions of others. Bandura argued that behavior can be learned through observation (vicarious learning) and that behavior can be prompted and shaped. The component processes underlying observational learning are: (1) Attention, including modeled events (distinctiveness, affective valence, complexity, prevalence, functional value) and observer characteristics (sensory capacities, arousal level, perceptual set, past reinforcement), (2) Retention, including symbolic coding, cognitive organization, symbolic rehearsal, motor rehearsal), (3) Motor Reproduction, including physical capabilities, self-observation of reproduction, accuracy of feedback, and (4) Motivation, including external, vicarious and self reinforcement (Bjorklund, 2000; Bornstein & Lamb, 1999).

Certainly, the school setting is amenable to teaching social skills given the frequent contact and interaction with peers. However, the approach is costly and time consuming for both teachers and trained peers. Therefore, a technology that uses the peer-mediated approach such as an avatar assistant may be cost-effective and valuable in teaching specific social skills.

The Current Study

Recent statistics suggest that autism is the fastest growing developmental disability in the United States, with an estimated annual cost of $90 billion (Autism Society of America, 2003). This growth, combined with the likely long-term implications, necessitates an immediate effort to improve social skills among children with ASD. Any technology that could teach individuals with ASD necessary social skills would not only be invaluable for the individuals affected, but would also affect a massive saving to society in treatment programs. Such a technology appears to exist in rudimentary form as avatars; computer embodied virtual people that have a knowledge base and the ability to converse with humans in natural language.

Computers are successful teaching instruments for children with ASD (e.g. Chen & Bernard-Opitz, 1993; Colby, 1973; Panyan, 1984). Multisensory interactions, controlled and structured environments, use of multilevel interactive functions, and the ability to individualize instruction are some of the features that can assist children with ASD when working with computers. Those functions have been found to be successful for various computer-based interventions (e.g. Bernard-Opitz, 1989; Chen & Bernard-Opitz, 1993; Panyan, 1984; Yamamoto & Miya, 1999).

Computers have software and can be developed that creates an intrinsically interesting learning environment that appeals to children with ASD. For instance, Chen & Bernard-Opitz (1993) found that students with autism provided more accurate answers, performed more often, and demonstrated improved behavior skills after using computer-based instruction than after using traditional instruction. Heiman, Nelson, Tjus, and Gillberg (1995) found that the interactive environment provided by the computer enhanced the reading and writing skills of children with ASD.

One important aspect of creating intrinsically interesting learning environments involves the use of perceptually salient production features, such as sound effects and action, that are likely to elicit children's attention to, and processing of information (Calvert, 1999). These features may be especially helpful to young children or to those that have developmental delays. For example, computer software that features action or animation increases poor readers' memory of nouns by providing a visual, iconic mode that children can use to represent content (Calvert, Watson, Brinkley, & Penny, 1989).

Computer-based instruction is emerging as a relevant method to train and develop vocabulary knowledge for individuals with ASD (Yamamoto & Miya, 1999). "Baldi" was developed as a three-dimensional computer-animated talking head. It provides realistic visible speech that is almost as accurate as a natural speaker. Baldi also has teeth, tongue, and palate to simulate the inside of the mouth, and the tongue movements have been trained to mimic natural tongue movements. This technology has shown to help individuals with language delays. In addition, computer-based training programs using Baldi to carry out language tutoring for children have been found to facilitate language learning in children with ASD (Bosseler & Massaro, 2003).

Computers have been found to be effective for teaching children with ASD across various instructional skills (Higgins & Boone, 1996; Panyan, 1984). Yet, there is still a need to investigate whether children with ASD could learn specific social skills within a structured and controlled environment and then transfer those skills to a natural setting. Only a few studies have investigated the effectiveness of computers for enhancing social skills (e.g. Bernard-Opitz, Sriram, & Nakhoda-Sapuan, 2001; Tanaka, Lincoln, & Hegg, 2005).

It is important to note that the current computer training program is not meant to be a substitute for human interaction. However, for children with ASD, there are several advantages for the computer-based approach. An incentive to employing computer-controlled applications for training is the ease with which automated practice and feedback can be programmed. Other advantages of the program include: the unique ability to control and manipulate the visual and auditory components of spoken language automatically; using visual images and text in the lessons to provide additional cues for social skills learning; employing enough variation in the learning environment to facilitate generalization of what is learned; and using a one-on-one format between the child and the computer. Presenting materials via computers can also potentially diminish the social difficulties, such as anxiety, some children with an ASD experience when interacting with a teacher or researcher.

The current study has many potential benefits. It assesses important intervention strategies for developing social skills for children with ASD. Given that social skills are necessary for a regular classroom education placement and for many employment opportunities, an effective intervention will give children with ASD more possibilities in society. Studies have found that individuals with ASD value social interactions both in the community and in the workplace. Therefore, successful social skills interventions may also increase children's value of their life.

OBJECTIVES

The overall purpose of the current study was to use recent advances in research, theory, and technology to develop, implement, and evaluate an avatar tutor for social skills learning in children with ASD.

Aim 1: The study investigated the social skills effects of an avatar assistant for children with Asperger Syndrome and autism. More specifically, the goal was to examine the effect of an avatar assistant on children's emotional cognition. It was expected that all children who participated in the training program would attain cognitive emotional skills (emotion recognition and emotion understanding) following the intervention (Hypothesis 1). Also, given the demonstrated effectiveness of computer-based social skills training (e.g. Bernard-Opitz, Sriram, & Nakhoda-Sapuan, 2001), it was predicted that children with autism or Asperger Syndrome who participated in the training would have improved facial recognition following the training program (Hypothesis 2).

Aim 2: The study also investigated the overall social skills effects of the intervention. It was predicted that children with autism or Asperger Syndrome who received the intervention would demonstrate improvements in observed and reported social skills following the intervention (Hypothesis 3).

RESEARCH DESIGN AND METHODS

Design

The current study involved a 2 (Training) x 2 (Group) x 2 (Time) mixed factorial design. The within factor was Time, which had two levels (baseline and post-intervention). The between factors were Group, and it had two levels (autism and Asperger Syndrome) and Training, and it had two levels (Avatar Training and Control).

Participants

Forty-nine children with autism or Asperger Syndrome participated in the project. The children had previously received a diagnosis of autism (n=25) or Asperger Syndrome (n=24) according to the criteria specified by the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 1994). The children were recruited from several sources, including the Autism Society of Alabama, Glenwood Inc, Mitchell's Place, and local elementary schools.

Materials

Kaufman Brief Intelligence Test

Cognitive functioning for all groups was obtained using the Kaufman Brief Intelligence Test, Second Edition (KBIT, II) (Kaufman, & Kaufman, 2004). The KBIT, II assesses general cognitive abilities and generates verbal, non-verbal, and composite domain scores. The verbal component consists of two subtests. The first is a picture-naming task (Verbal knowledge). The second is the Riddles subtest, in which the participant must determine a word given three verbal clues. The non-verbal component consists of the Matrices subtest, which is composed of a set of visual stimuli that vary from matching category and functionality of concrete objects and solving abstract visual matrices. The KBIT, II correlates highly with the Wechsler Scales intelligence tests (r=.84). The K-BIT, II has demonstrated an internal consistency coefficient of .92 and test-retest reliability coefficients of .90. (Kaufman & Kaufman, 1990).

Childhood Autism Rating Scale

The Childhood Autism Rating Scale (CARS) was completed to determine if the children met criteria for an ASD. The CARS is a widely used instrument developed to distinguish children with autism from those with other developmental disabilities or normal functioning (Schopler, Reichler, & Renner, 1988). It contains 15 scales that measure behavior relevant to ASD, including relating to others, communication, sensory functioning, emotional reactions, and resistance to change. Each scale can be rated from 1 (normal for age) to 4 (highly abnormal for age and characteristic of ASD). These scores combine to form a composite score that ranges from 15 to 60. Scores of 30 or above are considered indicative of ASD.

The CARS has been shown to have high reliability (.81). Internal consistency of the CARS is also high, with an alpha coefficient of .94, indicating the degree to which all of the 15-scale scores constitute a unitary phenomenon rather than several individual behaviors (Perry, Condillac, Freeman, Dunn-Geier, & Belair, 2005). Criterion-related validity has been determined by comparing CARS diagnoses to diagnoses made independently by child psychologists and psychiatrists. Diagnoses correlated at r = .80, which indicated that the CARS diagnosis was in agreement with clinical judgments. The CARS has also been shown to have 100% predictive accuracy when distinguishing between groups of children with autism and children with mental retardation (Teal & Wiebe, 1986).

Emotional Cognition

To measure children's ability to recognize emotional expressions before and after the training, twelve black and white photographs that illustrate one man and one woman, each with six emotional expressions (anger, disgust, fear, happiness, sadness, and surprise) were selected from Ekman and Friesen's (1975) faces of emotional expressions. Models were trained for these photographs and were instructed to activate certain muscles to pose for the photographs. The photographs are contained in *Unmasking the Face*, the result of years of research in an attempt to produce a series of photographs that would yield highly reliable agreement from viewers of the emotions being expressed (Ekman & Friesen, 1975) and have been used in various studies (e.g. Hopkins & Biasini, 2005; Sullivan, 1996). The measure has been found to have strong reliability (.89-.91) and validity (.71-.86; Ekman & Friesen, 1975). The children were presented with photographs and schematic drawings of emotions. An array of six faces was presented and the children heard a label (angry, disgusted, scared, happy, sad, or surprised). The children were asked to match the emotion label by touching the appropriate face.

Facial Recognition

To measure the children's facial recognition skills, the Benton Facial Recognition test (Short Form) was administrated. The Benton test is a standardized 27-item task for assessing the ability to identify and discriminate photographs of unfamiliar human faces. The test has been normed for children and adults. The internal-consistency reliability has been found to be 0.71, with a test-retest reliability of .66 (Benton, 1980). Male and female faces are used, and the faces are closely cropped so that no clothing and little hair are visible. The faces are centered within a black background, and the entire image is 6.5 cm by 6.5 cm. For the first six items, only one of the six test faces displays the target individual, and the target image and the test image are identical. In the next seven items, three of the test faces match the target face, and the poses for the test images are different from the target image. No time limits are placed on individual items or the test as a whole.

The children completed the Benton test before and after the training. On each item, the children were presented with a target face above six test faces, and they were asked to indicate which of the six images matched the target face. For the purpose of this study, the task was slightly modified in that the target face was presented as a card instead of as a picture in the stimulus booklet. The children were asked to match the card with the correct test image in the booklet.

Social Skills Rating System

The Social Skills Rating System (SSRS) (Gresham & Elliott, 1990) was administered as both a pre- and posttest measure. It is a standardized, norm-referenced 38-item parent-report questionnaire that measures a wide range of social skills, including the broad domains of cooperation, assertion, responsibility, and self-control. The SSRS has been found to have an internal-consistency of .87-.90 and test re-test reliability of .87 (Gresham & Elliott, 1990). Children with ASD have been shown to have impairments on the SSRS when compared to the normative sample (Gresham, 1981).

The SSRS encompasses the following four social skills subscales on a 3-point frequency scale (never, sometimes, often): *Cooperation* with 10 items such as "uses free time at home in an acceptable way," "attempts household tasks before asking for your help," "keeps room clean and neat without being reminded" (α =.87); *Assertion*, with 10 items such as "joins group activities without being told to do so," "invites others to your home," "joins ongoing activity or group without being told to do so" (α =.80); *Responsibility*, with 10 items such as "acknowledge compliments or praise from friends," "answers the telephone appropriately," "attends to speakers at meetings such as church or youth groups"(α =.87); and *Self-Control*, with 10 items such as "controls temper in conflict situations with you," "speaks in an appropriate tone of voice at home," "cooperates with family members without being asked to do so"(α =.83). The total score on the 38-items yields a Social Skills standard score, which has demonstrated a test-retest reliability coefficient of .87 (Gresham & Elliott, 1990). (See Table 1). The parents were blind to their child's group assignment (i.e. training or control).

Table 1
Social Skills Rating System (SSRS) Subscales

Name of Subscale	*Description*	*Sample Item*
Cooperation	Helping others, sharing, complying with rules	"Uses free time at home in an acceptable way"
Assertion	Initiating behaviors, responding to the actions of others	"Joins group activities without being told to do so"
Responsibility	Taking responsibility of one's actions, taking initiative	"Invites other to your home"
Self-Control	Responding appropriately in conflict situations	"Controls temper in conflict situations with you"

Social Skills Observation

To measure children's social skills on the playground, an observation of the child was conducted. At baseline, and following the intervention, each child was observed for two 5-minute assessment periods during school recess. The child was observed interacting with peers on two separate days. Two research assistants blind to the status of the participants in the study observed the social interactions and coded the interactions on a rating system that has been developed and used in previous studies (Hauck, Fein, Waterhouse, & Feinstein, 1995). Prior to collecting data, the two research assistants spent a 2-hour practice session scoring children's social interactions until 90 percent agreement had been reached consistently between the assistants and the investigator. Intrarater reliability was established for 100% of the coding data.

The items on the rating scale assess specific social skills (greeting, joint attention, and affection). Each of the behaviors was coded as present, not present, or not applicable to the situation. (See Appendix A). Example items from the observation scale include, "the child looks into the eyes of another child," "the child approaches another child with a social intention" (Positive interaction); "the child avoids social overtures made towards him/her by peers," "the child behaves in malicious intrusive ways toward peers" (Negative interaction); and "the child approaches and responds to another child with an intention to fulfill his/her own needs, and with no social intention," "the child stands in close proximity to another child (3 feet or less) but does not approach the peer" (Low-level interaction). Composite scores for each of the three areas (Positive, Negative, and Low-Level) were calculated.

The observers maintained close proximity to the children during recess, whether in the gymnasium or outdoors; however, they did not interact with the children and politely rejected any overtures made towards them. Children were told that the observer was interested in learning about their play habits. Cohen's kappa (Cohen, 1960) was calculated across the two raters. The kappas were .95 for Positive social interaction, .74 for Low-level social interaction, and .86 for Negative social interaction. According to Fleiss (1981), kappa levels of .40 to .60 are fair, .60 to .75 are good, and .75 and above are excellent. Thus, these kappa levels are considered good to excellent.

Recruitment

Participants were recruited through several sources. Twenty-three (23) of the participants were recruited through Glenwood, Inc. where the program director sent flyers to children in the Allan Cott program. (See Appendix B). Children attending the after school program at Mitchell's Place were another source of participants. Twenty-four (24) participants were recruited through this mechanism. Two (2) subjects were also recruited via two elementary schools in Shelby County. Ethical approval was obtained from the local research ethics committee. (See Appendix C). Parents of children enrolled at participating schools or centers were sent a recruitment flyer describing the study and soliciting their child's participation. Parents responded via mail or phone call if they were interested. Before beginning the project the consent form for the project was explained, parents completed the form, and were then given a copy. Formal child assent was obtained from children whose mental age was above seven years. Prior to beginning of the study, a group meeting with the parents and the children was held to give an overview of the study's procedures, explain the importance of regular attendance, and to answer any questions the parents or children may have.

Procedures

All procedures occurred at the child's school or after-school facility. At the baseline assessment session, parents of the children completed a demographic information form and the Social Skills Rating System. The children completed the Emotion Recognition test, the Benton Facial Recognition test, and the Kaufman Brief Intelligence Scale. The participants were then observed interacting with other children during recess. The research assistants completed the CARS and the Social Skills Observation.

The children were randomly assigned to the training group or the control group:

Autism/Asperger Control Group Fourteen participants with autism and 11 children with Asperger Syndrome were asked to use an art software (provided free of charge) at the school with the assistance of one or two investigator(s) twice per week over a period of 6 weeks, a total of 12 sessions. The curriculum of the art software (i.e. teaching painting, drawing, and coloring) was not associated with the aims of the intervention software (i.e. joint attention, facial processing, and eye gaze).

Autism/Asperger Training Group Eleven participants with autism and 13 participants with Asperger Syndrome were asked to use the FaceSay (Symbionica, LLC, San Jose, CA) software (provided free of charge) at the school with the assistance of one or two investigators twice per week over a period of 6 weeks, a total of 12 sessions.

Compatible PCs loaded with the computer software programs used specifically for the study were used in all sessions. The software programs ran on a 600-MHz PC with a 80-GB RAM hard drive operating on Microsoft XP. FaceSay and the art software were presented on an AccuSync 500 15-inch CRT monitor. The auditory speech was delivered at a comfortable listening intensity via a two piece speaker system. All computers had touch screens installed.

Before beginning the computer sessions, training sessions were conducted to introduce the children to the computer. The students learned to sit at the computer, to listen and respond to the software, and use the mouse or to touch the screen. Each student had the option to respond with either an external mouse (Logitech, M-CAA42, Fremont, CA) or a touch screen (KEYTEC Magic Touch, Richardson, TX). The students were reinforced for correct behaviors.

The computer-based intervention and control sessions began following the two training sessions and continued for six weeks. All children were asked to attend to 2 sessions per week (10-25 minutes each) for a total of 12 sessions. Children who attended greater than 83% of the sessions were included in the analyses. Two children were excluded from the study due to low attendance rates (one student moved and one student was hospitalized for an extended period).

Each student was taken separately to a room in the school that was equipped with a PC computer. All sessions occurred at the specific location at the child's school or after school setting. Children were seated facing a computer monitor at a viewing distance of approximately 20 inches and with eye level at the computer screen. The student sat at the computer with the investigator and/or research assistant sitting by him or her to assist if needed.

Intervention Procedures

The interactive software program (FaceSay) was created especially for this study by a computer programmer with the assistance of the investigator. FaceSay is a colorful program that contains three different activities designed to teach children specific social skills. The interactive features of the software provide opportunities for children to respond to social situations. Targeted social skills included teaching specific social skills for responding to joint attention and eye contact, and recognizing facial expressions. Specific social scripts were used and the children were asked to attend to and interact with the computer animated talking head. For example, a script for joint attention was taught by teaching children to turn and look at the avatar's eyes to determine what face or object the avatar was attending to. The tasks differed in difficulty to assure that participants of various levels could be successful as well as challenged by the tasks.

Because children with ASD respond well to structure, each session followed a predictable schedule that remained unaltered across all sessions. As each session started, the program would open with the first screen depicting several animals and a baby. A recorded voice stated: "Hi, welcome to FaceSay! I have made up some games so you can practice your social thinking. Click on the cat to start." Next, a short animation of the program appeared followed by a statement by the "coach" animal that described the activity. The children were cued by a recorded or computerized voice to solve the task (e.g. "Welcome to the Amazing Gazing game. You get to guess where my friend Rebecca is gazing. Just touch where you think she is gazing.").

Upon selecting the correct answer, a computer voice praised the child (e.g. "Great job, Johnny", "Way to go") and the object or face was animated on the screen. Incorrect answers were followed by a verbal cue (i.e. "She is looking at number three") or a visual cue (i.e. the correct answer flashed on the screen). If the child gave three consecutive incorrect responses, the assistant physically moved the participant's hand to the correct answer. If a child appeared reluctant to respond, he or she was told, "It is okay to make your best guess." Children's attention to the test stimuli was carefully monitored by the experimenter. If a child looked away from the screen when the stimuli appeared, or if a child appeared to have chosen a response without scanning the other options, the experimenter said "Make sure you look at all the faces/objects/numbers before you make your choice." Instructions such as these were necessary on occasion during the beginning sessions, but became rare toward the latter sessions, and were given regardless of the accuracy of the response.

Exposure to the program lasted from 10 minutes at the beginning of the first session to 25 minutes at the end of the last session (i.e. the exposure time to the software expanded as the children became more familiar with the task and were able to pay attention for longer duration). Each computer session was terminated by the examiner or if the participant indicated a desire to quit and return to class.

While some scripts were used by investigator to prompt the students, no verbal interaction with the investigator was required during the computer session. Behavioral charts were used to keep the children on task and to minimize inappropriate behaviors. The behavioral charts did not address the skills taught in the curriculum, but instead addressed behavior that may interfere with learning (e.g. "Stay in your seat."). Also, a token schedule was used with the children who required additional assistance. They received one token for each attempted task on the computer, and after 10 or 20 attempts (depending on the child's attention span), the child received a predetermined reward (e.g. puzzle pieces, turning pages in a book, or Cheerios).

For the purpose of the current study, three games from FaceSay were used to teach specific social skills. First, given that children with ASD have impairments in joint attention and eye gaze (e.g. Mundy, 1995; Mundy, Sigman, & Kasari, 1994) and that children with ASD can be trained to orient to an experimenter's eyes and head direction in an experimental situation (Leekam, Lopez, & Moore, 2000), the "Amazing Gazing" game was designed to teach children to attend to eye gaze and respond to joint attention. (See Figure 1). Also, as research studies have indicated orienting difficulties to both social and nonsocial stimuli, with even greater problems in response to social stimuli (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998), "Amazing Gazing" included both social and nonsocial stimuli. In the game, the avatar is surrounded by an array of objects, numbers, or faces. The child was asked to look at the avatars eyes and touch the object, number, or face that the avatar was attending to. If the child was correct, the object lit up and a verbal reinforcement was given (e.g. "Good job, Johnny!"). If the child was incorrect, a verbal and/or a visual prompt was given to indicate the correct answer. The aim of the "Amazing Gazing" game was to teach children to attend to the eye gaze of another person or to respond to their efforts at joint attention.

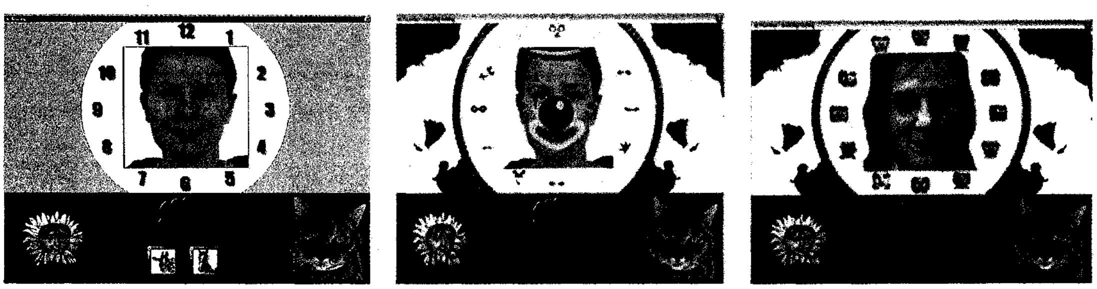

Figure 1. Screenshots from the "Amazing Gazing" Game.

Second, given that studies (e.g. Joseph and Tanaka, 2003) have found that children with ASD do not adopt a configural strategy when recognizing faces, but rely on a more object-based featural approach, the "Band Aid Clinic" was developed to build on the local processing cognitive operations that children with ASD use when viewing faces. In the "Band Aid Clinic", a game designed to teach facial recognition, the children were asked to match an appropriate facial area to a targeted face. The child was asked to select the appropriate face "band aid" that would fit over the avatar's face. The possible matches increased in number and similarity as the games progressed. The face was reconstructed by touching the correct band aid. Once reconstructed, the face "came alive" and expressed gratitude for the band aid. The goal of the "Band Aid Clinic" was to encourage processing of facial expressions in terms of their features and configuration. (See Figure 2).

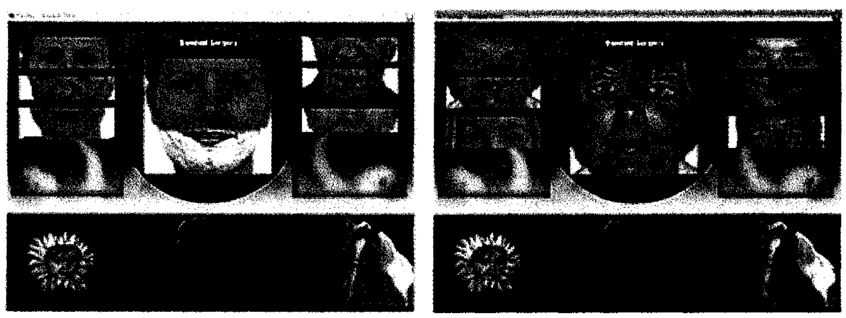

Figure 2. Screenshots from the "Band Aid Clinic" Game.

Third, given children with ASD's difficulties recognizing facial expressions and especially identifying facial expressions from information of the eyes (Hopkins & Biasini, 2005) the "Follow the Leader" game emphasized the ability to distinguish and create facial expressions of emotions in the avatars. Pertinent to expression recognition deficits in children with ASD, (e.g. Hobson, 1986), the game specifically emphasized how subtle changes in eye information can alter the perception of the facial expression. Since investigations of eye movements have revealed that children with ASD perform more visual saccades and spend longer fixation times looking at the mouth of the face as opposed to the eyes (Klin, Jones, Schultz, Volkmar, & Cohen, 2002), "Follow the Leader" was designed to teach children to look to the eyes for information and to improve their ability to read facial expressions from the eyes.

In the first level, the child was asked to identify identical facial expression of emotions by selecting "Yes" for same and "No" for different expressions. The similarity of the two faces increased as the game progressed. In an advanced level, the child was asked to make the avatar's twin match the avatar's expression by selecting appropriate eyes from a selection of eyes. As the game progressed, the facial expression changes became more subtle. The purpose of the "Follow the Leader" was to teach emotional cognition and facial recognition. The game allowed the child to receive practice comparing and modulating the avatar's facial expressions. (See Figure 3).

Figure 3. Screenshot from the "Follow the Leader" Game.

DATA ANALYSIS

Analysis

Statistical analysis of the data consisted of descriptive statistics and an Analysis of Covariance (ANCOVA) for each measure. The Statistical Package for Social Science (version 14.0: Chicago, Ill) was used to calculate the statistics. Descriptive statistics were first analyzed to examine the distribution of scores. The scatter plots were examined for kurtosis and skewness. In addition, Levine's method was used to test the homogeneity of variances. No significant differences in the variance of groups were found. In other words, the basic assumption of homogeneity of variance was not violated. The assumption of equal regression slopes was also tested and found to be non-significant (Autism: $F(2,22) = 3.08$, $p > 0.05$; Asperger: $F(2,21) = 3.10$, $p > 0.05$). Therefore, the assumption of homogeneity of regression was found tenable. These analyses were valuable in interpreting if the assumptions of ANCOVA were met, as well as interpreting how the variability of scores would impact the results (Bonate, 2000; Maris, 1998; Rogosa, 1988).

Analysis of Covariance (Maxwell, 1990; Rogosa, & Willett, 1983) was used to study the separate and interactive contributions of intervention group and time of assessment. ANCOVA combines the advantages and reconciles the differences of two widely applicable procedures, known as regression and Analysis of Variance (ANOVA) (Myers, & Hansen, 2002). Covariates are used in ANCOVA in order to control for their relationship to the dependent variable as their presence may increase error variance.

Specifically, the pre-test scores and KBIT score were used as the covariates and the post-test scores as the dependent variable.

Reliability

For the Social Skills Observation coding system, two undergraduate assistants were trained to independently code the interactions. Interrater reliability was computed for 100% of the data. To compute this statistic, one of the undergraduates' coding of each Social Skills Observation code was compared to the second undergraduate's coding of the same child. Intrarater Kappas ranged from .78 to 1.0, with a mean of .87.

Once the data was collected, the data was scored and entered into an Excell database program to allow computer scoring and to facilitate analysis of the measures. The data entry was completed by two undergraduate research assistants and the principal investigator. Finally, a random selection of 20% of the data was checked for accuracy.

RESULTS

Participant Descriptive Statistics

Forty-nine children with autism or Asperger Syndrome participated in the project. Although all the children had previously received a diagnosis of autism (n=25) or Asperger Syndrome (n=24) according to the criteria specified by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; American Psychiatric Association, 1994) the ASD diagnosis was confirmed by the CARS (M= 35.49). The children were

Table 2
Frequency (Percentage) for Participants' Demographic Characteristics

Variable	*Autism Training (N=11)*	*Autism Control (N=14)*	*Asperger Training (N=13)*	*Asperger Control (N=11)*	*Total (N=49)*
Gender					
Male	10 (90.9)	13 (92.9)	12 (92.3)	9 (81.8)	44 (89.8)
Female	1 (9.1)	1 (7.1)	1 (7.7)	2 (18.2)	5 (10.2)
Ethnicity					
African American	3 (27.3)	4 (28.6)	3 (23.1)	3 (27.3)	13 (26.5)
Caucasian	8 (72.7)	10 (71.4)	10 (76.9)	7 (63.3)	35 (71.4)
Other	0 (0)	0 (0)	0 (0)	1 (9.1)	1 (2.0)
Mother's Marital Status					
Married	6 (54.5)	7(50.0)	7 (53.8)	7(63.6)	27 (55.1)
Divorced	3 (27.3)	3 (21.4)	4 (30.8)	2 (18.2)	12 (24.5)
Single	1 (9.1)	3 (21.4)	2 (15.4)	0 (0)	6 (12.2)
Remarried	1 (9.1)	1 (7.1)	0 (0)	2 (18.2)	4 (8.2)
Maternal Education					
< High school	3 (27.3)	3 (21.4)	1 (7.7)	0 (0)	7 (14.3)
Some College	6 (54.5)	5 (35.7)	5 (38.5)	3 (27.3)	19 (38.8)
4 Year College	1 (9.1)	3 (21.4	5 (38.5)	6 (54.5)	15 (30.6)
Advanced Degree	1 (9.1)	3 (21.4)	2 (15.4)	2 (18.2)	8 (16.3)

recruited from several sources, including Glenwood Inc, Mitchell's Place, and local elementary schools. Demographic characteristics are presented in Tables 2 and 3.

Table 3

Means (standard deviations) of Age, CARS, and IQ Scores for All Groups

Variable	*Autism Training (N=11)*	*Autism Control (N=14)*	*Asperger Training (N=13)*	*Asperger Control (N=11)*	*Total (N=49)*
Age	10.31 (3.31)	10.57 (3.2)	10.05 (2.30)	9.85 (2.87)	10.17 (3.02)
CARS	34.64 (3.93)	36.92 (5.79)	34.00 (5.26)	35.00 (5.22)	35.49 (5.24)
IQ					
Verbal	52.09 (16.68)	50.00 (15.46)	92. 05 (18.63)	93.09 (21.91)	74.51 (25.59)
Nonverbal	59.00 (23.54)	58.38 (19.03)	91.76 (20.98)	93.81 (26.05)	78.86 (28.94)
Composite	55.09 (20.91)	54.79 (16.41)	91.88 (19.54)	93.00 (25.47)	75.71 (27.34)

Among the children in the sample, 5 were girls and 44 were boys, ranging in age from 6 years, 3 month to 15 years, 1 month (M= 10.17). Approximately 71% of the children were Caucasian, 27% were African American, and 2% were from other ethnic backgrounds. Fifty-five percent of the mothers were married with the child's biological father, 25% were divorced, 12% were single, and 8% were remarried. In terms of education level, 14% of the mothers graduated from high school, 39% attended trade school or some college, 30% attended four years of college, and 16% attended Master's programs or advanced degrees. Forty percent of the children had one sibling, 33% were only-children, and 27% had two siblings.

All continuous variables were analyzed using an Analysis of Variance (ANOVA) and are listed in Table 4. The children with autism and Asperger Syndrome differed on number of siblings, maternal education, and previous social skills: the children with Asperger Syndrome had fewer siblings, $F(1, 47) = 4.10$, $p = .049$, had more often received previous social skills training, $F(1, 47) = 4.65$, $p = .037$, and their mothers had

Table 4
ANOVA Comparing the Groups on Demographic Variables

	Autism Training vs. Autism Control			*Asperger Training vs. Asperger Control*			*Autism vs. Asperger*		
Measure	*df*	*f*	*p*	*df*	*f*	*p*	*df*	*f*	*p*
Age	1,23	1.2	0.28	1,22	2.6	0.12	1,47	0.3	0.59
Maternal Education	1,23	0.5	0.49	1,22	0.2	0.62	1,47	5.5	0.02*
Siblings	1,23	0.2	0.64	1,22	0.6	0.44	1,47	4.1	0.05*
Marital Status	1,23	1.1	0.31	1,22	1.7	0.21	1,47	3.4	0.07
Age diagnosed	1,23	0.6	0.43	1,22	0.0	0.93	1,47	2.6	0.12
Social Skills	1,23	0.2	0.29	1,22	0.2	0.61	1,47	4.6	0.04*
IQ	1,23	0.5	0.48	1,22	0.7	0.62	1,47	16.75	0.0001*

$*p < .05$

completed higher education, F(1, 47) = 5.52, $p = .024$. Due to the categorical nature of some of the demographic variables, significant differences between the groups were explored using chi-square. As shown in Table 5, the Chi square revealed that the groups did not differ on gender, race, or repeated grades.

Possible demographic differences between the intervention and control groups of children with autism and Asperger Syndrome were tested using ANOVA or Chi square. No significant differences were found between the groups. In addition, two children were not included in the analysis due to low attendance rates. The two excluded children did not pose a significant threat to the results.

Table 5

Pearson Chi-Square (X^2) Comparisons of Dichotomous Group Demographics

Measure	*N*	*df*	X^2	*p*
Gender				
Autism Training	14	1	0.04	0.84
Autism Control	11			
Asperger Training	11	1	1.24	0.27
Asperger Control	13			
Autism	25	1	0.18	0.67
Asperger	24			
Ethnicity				
Autism Training	14	1	0.02	0.94
Autism Control	11			
Asperger Training	11	1	1.37	0.50
Asperger Control	13			
Autism	25	1	1.59	0.45
Asperger	24			
Repeated grade				
Autism Training	14	1	0.10	0.99
Autism Control	11			
Asperger Training	11	1	1.26	0.30
Asperger Control	13			
Autism	25	1	0.20	0.72
Asperger	24			

Table 6

Means (standard deviations) of Measures of Emotional and Facial Recognition Pre and Post Intervention for All Groups

	Autism Control (N=14)		*Autism Training (N=11)*		*Asperger Control (N=11)*		*Asperger Training (N=13)*	
Measure	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Emotion test								
Pictures	2.91 (1.38)	2.91 (1.51)	2.71 (1.49)	3.50 (1.22)	3.61 (1.19)	3.31 (1.18)	4.54 (1.63)	5.00 (1.00)
Drawings	2.36 (0.67)	2.27 (1.10)	2.71 (1.38)	3.07 (1.21)	2.69 (0.95)	2.77 (1.24)	3.64 (1.91)	4.54 (1.37)
Total	5.27 (1.95)	5.18 (2.44)	5.43 (2.59)	6.57 (2.28)	6.31 (1.97)	6.08 (2.33)	8.00 (3.13)	9.54 (2.34)
Benton								
Short Form	11.18 (4.87)	12.64 (4.20)	12.79 (4.19)	14.64 (4.96)	13.23 (3.37)	14.54 (3.26)	16.27 (5.91)	19.45 (4.27)
Long Form	28.18 (4.21)	29.36 (4.24)	29.86 (4.72)	32.64 (6.81)	29.31 (5.59)	31.23 (5.79)	36.00 (7.03)	40.64 (6.67)

Table 7

Means and Adjusted Post-Means for All Groups

	Autism Control (N=14)		*Autism Training (N=11)*		*Asperger Control (N=11)*		*Asperger Training (N=13)*	
Measure	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Benton-Short Form	11.18	12.84	12.79	14.48	13.23	15.42	16.27	18.41
Emotion Composite	5.27	5.23	5.43	6.53	6.31	6.79	8.00	8.70
SSRS Composite	60.91	59.68	61.71	68.46	68.38	63.9	61.55	67.25
SSO Composite	10.14	11.05	9.86	9.60	8.85	10.46	8.68	7.54

Table 8

Means (standard deviations) of Measures of Social Skills Pre and Post Intervention for All Groups

	Autism Control (N=11)		*Autism Training (N=14)*		*Asperger Control (N=13)*		*Asperger Training (N=11)*	
Measure	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
SSRS								
Cooperation	6.09 (2.91)	6.00 (3.41)	6.43 (2.24)	8.14 (2.07)	8.38 (1.75)	7.08 (2.87)	6.36 (3.07)	6.73 (2.24)
Assertion	7.27 (2.33)	6.09 (1.97)	6.93 (2.97)	7.93 (2.62)	8.85 (1.86)	7.77 (2.68)	7.00 (2.45)	7.82 (2.63)
Responsibility	4.09 (3.01)	4.09 (2.84)	4.07 (3.19)	5.36 (2.76)	6.69 (2.75)	6.15 (3.05)	4.82 (3.49)	4.82 (3.37)
Self-Control	5.91 (2.51)	4.09 (2.34)	5.71 (2.73)	7.57 (2.56)	7.00 (1.96)	6.31 (3.17)	4.64 (2.29)	6.54 (1.50)
Composite	60.91 (8.39)	59.45 (9.49)	61.71 (8.62)	68.64 (9.93)	68.38 (7.13)	66.78 (10.68)	61.55 (9.43)	63.90 (8.84)
SSO								
Positive	7.36 (1.63)	7.82 (1.25)	7.71 (1.58)	7.46 (1.31)	6.81 (2.17)	7.54 (1.19)	6.86 (1.80)	6.18 (2.12)
Negative	0.95 (0.91)	1.68 (1.23)	0.89 (1.21)	0.68 (0.79)	0.69 (0.72)	1.35 (0.99)	0.45 (0.65)	0.59 (0.92)
Low-Level	1.82 (1.08)	1.45 (0.93)	1.39 (0.92)	1.68 (0.75)	1.35 (0.80)	1.42 (0.81)	1.36 (0.84)	1.05 (0.82)
Total	10.14 (2.17)	10.95 (1.42)	9.86 (2.48)	9.68 (1.71)	8.85 (2.58)	10.31 (0.97)	8.68 (2.11)	7.72 (2.56)

Primary Analyses

Hypothesis 1

It was hypothesized that children with autism or Asperger Syndrome who received training would demonstrate increased emotion recognition skills following the intervention. To analyze the impact FaceSay had on emotional skills, separate ANCOVAs were run for the autism group and the Asperger group. For these analyses the independent variable was the group (training or control). The dependent variable was the emotion recognition post-test score, and the covariates were the emotion pre-test score and KBIT score. Using the pre-test score and IQ score as covariates allowed an adjustment for a difference between the groups prior to treatment. In addition, the resulting analysis was capable of reflecting a change in emotional skills that takes into account the cognitive functioning of each group prior to treatment.

The first analysis compared the change in emotional skills for the children with autism who received training with that of the children with autism who did not receive the training. There was a significant difference in total emotional skills, $F(1, 21) = 6.40$, $p < 0.05$ (adjusted *M*s 6.53 and 5.23, respectively). Also, there was a significant difference in emotional skills using pictures as stimuli, $F(1, 21) = 7.35$, $p < 0.01$ (adjusted *M*s: 3.59 and 2.79, respectively). However, there was no significant difference in emotional skills using drawings as stimuli, $F(1, 21) = 2.39$, $p > 0.05$; (adjusted *M*s: 2.95, and 2.42, respectively).

The second analysis compared the children with Asperger Syndrome who received training with that of the children with Asperger Syndrome who did not receive the training. There was a significant difference in total emotional skills, $F(1, 20) = 23.04$,

$p < 0.001$ (adjusted *M*s 8.70 and 6.79, respectively). Also, there were significant differences in emotional skills using pictures as stimuli, $F(1, 20) = 16.31$, $p < 0.001$ (adjusted *M*s 4.58 and 3.66, respectively), and in emotional skills using drawings as stimuli, $F(1, 20) = 11.96, p < 0.01$; (adjusted *M*s: 4.11, and 3.14, respectively). The results of these two analyses indicate that there was an overall change in emotional skills and emotional skills using pictures as stimuli after training for the children who received the intervention. However, only the children with Asperger Syndrome who received the training improved

Table 9

Analysis of Covariance for Autism Training vs. Control

Measure	*df*	*F*	*p*
Benton			
Pre-test (covariate)	1	1.31	0.27
IQ (covariate)	1	0.07	0.79
Group	1	0.69	0.41
Within-Group Error	21		
Emotion			
Pre-test (covariate)	1	50.66	0.001*
IQ (covariate)	1	0.33	0.57
Group	1	6.40	0.02*
Within-Group Error	21		
SSRS			
Pre-test (covariate)	1	62.90	0.001*
IQ (covariate)	1	1.78	0.19
Group	1	17.90	0.004*
Within-Group Error	21		
Social Observation			
Pre-test (covariate)	1	0.09	0.76
IQ (covariate)	1	2.68	0.12
Group	1	5.04	0.001*
Within-Group Error	21		

*$p < .05$

in their ability to interpret drawings of emotions following the intervention. Means, standard deviations and adjusted means for these significant results are given in Tables 6 and 7.

Table 10
Analysis of Covariance for Asperger Training vs. Control

Measure	*df*	*F*	*p*
Benton			
Pre-test (covariate)	1	37.78	0.001*
IQ (covariate)	1	0.03	0.85
Group	1	8.24	0.009*
Within-Group Error	20		
Emotion			
Pre-test (covariate)	1	103.47	0.001*
IQ (covariate)	1	0.97	0.34
Group	1	23.04	0.001*
Within-Group Error	20		
SSRS			
Pre-test (covariate)	1	25.37	0.001*
IQ (covariate)	1	0.15	0.70
Group	1	4.36	0.05
Within-Group Error	20		
Social Observation			
Pre-test (covariate)	1	4.76	0.04*
IQ (covariate)	1	1.29	0.27
Group	1	13.61	0.001*
Within-Group Error	20		

*$p < .05$

Although not hypothesized, a post hoc analysis of whether autism symptomology and cognitive ability impacted training success as defined in this study by the children's scores on the Emotion task after the training. To analyze whether autism symptomology and cognitive ability impacted the children's scores on the measure for the children who received the training, a series of simultaneous multiple regressions were run. For these analyses, there were two levels of independent variables. Level 1 was the pretest score of the Emotion Composite. Level 2 was made up of the CARS score, the KBIT Composite, and the Emotion pre-test score, put into the equation simultaneously. Variables are listed in Table 11. For model one, which held the pre-test Emotion Composite score constant, a significant model emerged ($R^2 = 0.790$, $F(1, 23) = 91.53$, $p < 0.001$). For model two, which held the CARS score, the KBIT Composite, and the pre-test Emotion Composite score constant, a significant model also emerged ($R^2 = 0.873$, $F(3, 21) = 55.96$, $p < 0.001$). Cognitive ability and pre-test emotion recognition ability significantly impacted emotion recognition ability after the training. Higher KBIT scores and pre-test Emotion Composite scores were related to higher post-test Emotion Composite scores.

Hypothesis 2

The second hypothesis was that children with autism or Asperger Syndrome who participated in the avatar assistant social skills intervention would acquire facial recognition skills after the training program. To analyze the impact FaceSay had on facial recognition skills, separate ANCOVAs were run for the autism group and the Asperger group. The Benton pre-test scores and the KBIT score were used as the covariates and the Benton post-test scores as the dependent variable. The independent variable was the group (training or control). The results for children with autism indicated that there was no significant difference in their performance on the Benton-Short form $F(1, 21) = 0.69, p > 0.05$ (adjusted *M*s: 14.48 and 12.84, respectively), or on the Benton-Long form $F(1, 21) = 1.07, p > 0.05$ (adjusted *M*s: 32.29 and 29.81, respectively).

For children with Asperger Syndrome, ANCOVA results showed that the training group and the control group differed significantly on the Benton-Short form $F(1, 20) = 8.29, p < 0.01$ (adjusted *M*s: 18.41 and 15.42, respectively), and on the Benton-Long form $F(1, 20) = 5.09, p < 0.05$ (adjusted *M*s: 38.11 and 33.37, respectively) with the training group having significantly higher post-test scores. The results of these two analyses indicate that there was an overall change in facial recognition skills for the children with Asperger Syndrome who received the intervention. Means, standard deviations and adjusted means for these significant results are given in Table 6 and 7.

An additional post hoc analysis examined whether autism symptomology and cognitive ability impacted training success as defined in this study by the children's scores on the Benton after the training. To analyze whether autism symptomology and cognitive ability impacted the children's scores on the measure for the children who received the training, a series of simultaneous multiple regressions were run. For these analyses, there were two levels of independent variables. Level 1 was the pretest score of the Benton. Level 2 was made up of the CARS score, the KBIT Composite, and the Benton pre-test score, put into the equation simultaneously. Variables are listed in Table 11. For model one, which held the pre-test Benton-short score constant, a significant model emerged ($R^2 = 0.465$, $F(1, 23) = 21.84$, $p < 0.001$). For model two, which held the CARS score, the KBIT Composite, and the pre-test Benton-short score constant, a significant model also emerged ($R^2 = 0.463$, $F(3, 21) = 7.89$, $p < 0.003$). Pre-test facial recognition ability significantly impacted facial recognition ability after the training.

<u>Hypothesis 3</u>

It was hypothesized that children with autism or Asperger Syndrome who attended the avatar assistant social skills intervention would acquire social interaction skills after the training program. To analyze the impact FaceSay had on social interaction skills, separate ANCOVAs were run for the autism group and the Asperger group for their scores on the SSRS and the Social Skills Observation. The SSRS or the Social Skills Observation pre-test scores and the KBIT score were used as the covariates and the SSRS or the Social Skills Observation post-test scores as the dependent variable. The independent variable was the group (training or control).

Table 11
Predictor Varaible Results from Multiple Regression on Children with Autism and Asperger Disorder who Received Training (n=24)

Model	*Predictor Variable*	*Beta*	*p*
1	Pre-test Benton-short	0.698	0.001*
2	Pre-test Benton-short	0.582	0.003*
	CARS	-0.101	0.546
	KBIT Composite	0.178	0.337
1	Pre-test Emotion Total	0.894	0.001*
2	Pre-test Emotion Total	0.688	0.001*
	KBIT Composite	0.289	0.005*
	CARS	-0.133	0.110
1	Pre-test SSRS	0.776	0.001*
2	Pre-test SSRS	0.789	0.001*
	CARS	-0.05	0.740
	KBIT Composite	-0.111	0.469
1	Pre-test Social Skills Observation	0.301	0.143
2	Pre-test Social Skills Observation	0.257	0.214
	CARS	0.486	0.023*
	KBIT Composite	0.051	0.817

*$p < .05$

The first analyses compared the children who received training with that of the children who did not receive the training on their parents' reported social skills on the SSRS. For children with autism, there was a significant difference in their scores on the SSRS, $F(1, 21) = 10.36$, $p < 0.05$ (adjusted *M*s 64.99 and 58.51, respectively). Also, there were significant differences in Assertion, $F(1, 21) = 7.32$ $p < 0.01$ (adjusted *M*s 8.06 and 5.92, respectively), Responsibility, $F(1, 21) = 4.99$ $p < 0.05$ (adjusted *M*s 5.36 and 4.09, respectively), and Self-control, $F(1, 21) = 7.35$ $p < 0.05$ (adjusted *M*s 7.57 and 4.91, respectively),. However, there was no significant difference in Cooperation, $F(1, 21) = 0.35, p > 0.05$.

For children with Asperger Syndrome who received training compared with that of the children with Asperger Syndrome who did not receive the training, a trend emerged in their parents' reported social skills on the SSRS, $F(1, 20) = 4.36$, $p = 0.05$ (adjusted *M*s 67.77 and 62.27, respectively). However, there were no significant differences in Cooperation, $F(1, 20) = 4.04, p > 0.05$, Assertion, $F(1, 20) = 0.26$ $p > 0.05$ Responsibility, $F(1, 20) = 0.31$ $p > 0.05$, or Self-control, $F(1, 20) = 0.84$ $p > 0.05$.

The second set of analyses compared the children who received the training to that of the controls on their observed social interactions. For children with autism, there was a significant difference in their total scores on the Social Skills Observation, $F(1, 21) = 5.05$, $p < 0.05$ (adjusted *M*s 9.60 and 11.05, respectively), with the training group having significantly lower post-test scores (i.e. less inappropriate social interactions). Also, there were significant a difference in their Negative Interactions, $F(1, 21) = 5.52$ $p < 0.05$ (adjusted *M*s 0.67 and 1.69, respectively), with the training group having significantly lower post-test scores (i.e. less negative interactions). However, there were no significant differences in their Positive Interactions, $F(1, 21) = 0.76$, $p > 0.05$ or in their Low-level interactions, $F(1, 21) = 0.13, p > 0.05$.

For children with Asperger Syndrome who received training compared with that of the children with Asperger Syndrome who did not receive the training, there was a significant difference in their total scores on the Social Skills Observation, $F(1, 20) = 13.61$, $p < 0.001$ (adjusted *M*s 7.54 and 10.46, respectively), with the training group having significantly lower post-test scores (i.e. less inappropriate social interactions). Also, there were significant a difference in their Positive Interactions, $F(1, 20) = 11.49$, $p < 0.01$ (adjusted *M*s 5.93 and 7.75, respectively), with the training group having significantly lower post-test scores (i.e. more positive interactions). However, there were no significant differences in their Negative Interactions, $F(1, 20) = 2.72, p > 0.05$ or in their Low-level interactions, $F(1, 20) = 0.42, p > 0.05$.

Additional post hoc analysis examined whether autism symptomology and cognitive ability impacted training success as defined in this study by the children's scores on the SSRS and the Social Skills Observation after the training. To analyze whether autism symptomology and cognitive ability impacted the children's scores on the measures for the children who received the training, a series of simultaneous multiple regressions were run. For these analyses, there were two levels of independent variables. Level 1 was the pretest score of the SSRS or the Social Skills Observation. Level 2 was made up of the CARS score, the KBIT Composite, and the SSRS or the Social Skills Observation pre-test score, put into the equation simultaneously. Variables are listed in Table 11.

The first analysis, which included the two groups who received the intervention (autism and Asperger Syndrome), examined the impact on the children's reported social skills. For model one, which held the pre-test SSRS Composite score constant, a significant model emerged ($R^2 = 0.585$, $F(1, 23) = 34.83$, $p < 0.001$). For model two, which held the CARS score, the KBIT Composite, and the pre-test SSRS Composite score constant, a significant model also emerged ($R^2 = 0.557$, $F(3, 21) = 11.06$, $p < 0.001$). Pre-test parent reported social skills significantly impacted the children's reported social skills after the training.

The second analysis, which included the two groups who received the intervention (autism and Asperger Syndrome), examined the impact on the children's observed social skills. For model one, which held the pre-test Social Skills Observation Composite score constant, a significant model did not appear ($R^2 = 0.051$, $F(1, 23) = 0.143$, $p > 0.05$). For model two, which held the CARS score, the KBIT Composite, and the pre-test Social Skills Observation Composite score constant, a significant model emerged ($R^2 = 0.209$, $F(3, 21) = 3.12$, $p < 0.05$). Autism symptomology significantly impacted the children's observed social skills after the training. Higher CARS scores (e.g. more autism symptoms) and higher pre-test Social Skills Observation scores were related to higher post-test Social Skills Observation scores (e.g. more inappropriate social interactions).

DISCUSSION

Several prior studies have used computers to enhance educational and problem-solving activities of children who have ASD. However, the use of an interactive computer program to investigate the facial recognition abilities and social skills by children with ASD has not previously been addressed. The purpose of this study was to examine the effects of a computer interactive-intervention program for children with autism and Asperger Syndrome for specific social skills. The results of this study provide support for the effectiveness of using computer-based interactive games for enhancing social skills. This study suggests that providing children with autism and Asperger Syndrome opportunities to practice eye gaze and face recognition in a controlled, structured, and interactive environment through computer simulation improved their social skill. The children with autism demonstrated improvement in two areas of the intervention: emotion recognition and social interactions. The children with Asperger Syndrome demonstrated improvements in all three areas of the intervention: facial recognition, emotion recognition, and social interaction.

First, the ability to recognize unfamiliar faces improved for children with Asperger Syndrome following the intervention, but not for children with autism. This difference could be an indication of individual differences such as intellectual functions. The children with autism had significantly lower cognitive functioning than the sample of children with Asperger Syndrome. Thus, it is possible that the children with autism did not completely understand the concepts or directions in the games, and therefore, did not fully benefit from the intervention.

Second, the children with autism and Asperger Syndrome improved their emotional knowledge. After the intervention, the children demonstrated improvement in their ability to recognize emotions. More specifically, children with autism improved in their ability to recognize emotions when provided with pictures, whereas children with Asperger Syndrome improved in emotion recognition when provided with pictures or drawings. As the computer games only included pictures of adults and children, it is interesting to note that children with Asperger Syndrome generalized their increased emotion abilities to schematics of faces.

These findings support the notion that emotions can be taught and that facial recognition abilities can be improved as an outcome of training and corroborate recent studies that focused on facilitation of social cognitive abilities in children with ASD. Several studies have demonstrated that children with ASD are able to acquire specific skills using computer-based training (e.g. problem-solving, communication). However, a major question raised by the current study, in line with the main difficulty encountered in other intervention programs for this population, is whether children's improvements were transferred into the child's more global social competence with peers and family.

Participants were able to transfer the skills learned from the structured, simulated computer-based environment to the natural setting on the playground. Transition from one environment to another is a task involving an ability to generalize. Generalization, the ability to transfer a learned behavior from a trained situation to another, is considered a difficult task for children with ASD (Koegel, Koegel, & McNerney, 2001). Researchers have promoted teaching social skills in a naturalized setting to ease transition and generalization. Results of this study demonstrate that when students with autism and Asperger Syndrome were provided with an opportunity to learn and practice specific social skills in a controlled environment that simulated a natural setting, they were able to generalize their knowledge to the playground and in the home.

Children did show qualitative and quantitative improvements in their social interactions based on peer interactions, and their parents' report. In terms of social interactions, children did show an increase in their overall interactions with peers. More specifically, the children with Asperger Syndrome demonstrated growth in their positive social interaction behaviors (e.g. more likely to use eye contact skills, more likely to share experiences or an object with a peer). For children with autism, significant decreases in their negative behaviors were demonstrated following the intervention (e.g. the children were less likely to avoid social overtures made towards them by a peer, less likely to look away when social contact was initiated). Also, their parents reported an improvement in children's overall skills. Specifically, for children with autism, the parents reported an improvement in their ability to be more assertive (e.g. initiates more social activities with peers), to be more responsible (e.g. acknowledges compliments), and to have more self-control (e.g. cooperates with family members without being told to do so).

Previous research has highlighted the role for exposure to faces in the development of face processing and its underlying mechanisms (Gauthier, Skudlarski, Gore, & Anderson, 2000). It is possible that children with ASD avoid looking at faces during a period through which typically developing children acquire face processing skills, thus, they do not acquire such skills at a typically developing pace. The lower levels of exposure to faces that children with ASD experience relative to other children may inhibit the acquisition and development of basic face processing mechanisms. The current study indicates that with increased exposure to faces, it is possible to enhance children with Asperger Syndrome's face processing skills. This may also be the case for children with autism who have higher cognitive skills than those who participated in the present study.

It is possible that cueing participants to the features (e.g. eyes, mouth) of the avatar's faces not only improved overall emotion recognition ability in children with autism and facial and emotion recognition ability in children with Asperger Syndrome, but also enhanced holistic processing. Holistic face representations are computed in an automatic or effortless fashion, and attentional cuing may increase the efficiency of input into these computations. Thus, an assessment of whether FaceSay possibly fosters holistic processing of faces in children with ASD certainly seems worthy of investigation. It is also worth investigating if children improve in their ability to represent and encode the eye region of faces as a result of FaceSay. If this were found to be true, it would suggest that holistic face processing can be acquired using computer-based experiences attending to and encoding face information, which in the case of ASD is often lacking in real-life experiences.

Implications

The purpose of the current study was to examine the effects of a computer interactive intervention program on specific social skills of children who have ASD. This study indicates that practicing simulated activities on the computer enhances facial and emotion recognition abilities. The results provide support for the effectiveness of using a computer-based interactive simulation program as a vehicle for enhancing observed and reported social skills. These results are consistent with previous results on the effectiveness of computer-based interventions for children with ASD (e.g. Bernard-Optiz et. al., 1990; Chen & Bernard-Optiz, 1993; Panyan, 1984; Yamamoto & Miya, 1999).

One of the most important factors in the success of this study was that all participants who received the intervention easily adapted to the computer interactive program. They always wanted to go to work on the computer (although a few wanted to finish an activity first), and they typically participated in the games until the activities were terminated. Although not measured, anecdotal observations of the children who received the intervention indicated that the children with ASD enjoyed the programs. They frequently asked to play the games, and became upset if there was an interruption of the sessions due to field trips or holidays. The students also provided themselves with verbal praise such as "Good job" or prompted the experimenter to say "Good job." Also, observations of the participants indicate that some of the students increased their computer skills following the study. For example, one participant who previously had no experience with computers learned to navigate a mouse, turn the program on and off, and log off the computer. An objective enthusiasm assessment and valid computer skills measures would serve as useful collateral data in future studies.

The simulated computer program appears to be a promising strategy for teaching specific social skills for children with ASD. Multidisciplinary approaches, involving educational specialists, psychologists, programmers, as well as parents and their child with ASD, could be useful. Although real-life practice remains the most important part of social skills training, computer-based simulations might be a non-threatening starting point for individuals with ASD, contributing to the facilitation of better social and communicative competence.

Limitations

The use of computer-based tasks in the evaluation of learning and generalization in this study has its limitations. Although such tasks allow for controlled and structured learning of emotion and facial recognition skills, they are quite different than real life experiences. Hence, the relevance of improvement among the software users in this study to real life functioning should be considered with care.

A few limitations to this study design are important to note. It is not clear how length of treatment is related to the effectiveness of FaceSay. While the present study implemented training for 6 weeks, fewer sessions may have been just as beneficial. Conversely, longer term treatment might impart more improvement than found in this investigation. This issue is important to clarify when resources are limited. Another question unaddressed by the present study is the duration of improvement. This study focused on short-term follow-up. It is not yet known whether these improvements continue as children mature. Are there continued gains 6 months and a year after cessation of the training program? Although the intention of this training model is to provide children with lifelong tools to assist the child, is this goal successfully attained? Do children continue to make gains after formal involvement ends?

In addition, this study did not attempt to directly compare the computer-based program with other treatment models. What is needed in future studies are head-to-head comparisons of different programs for treating ASD, in which variables such as number of hours of intervention and parent involvement are tightly controlled, while teaching models are varied (e.g. interactive computer-based teaching vs. two-dimensional computer-based training).

The measure of social skills interactions is also subject to a few methodological limitations. First, although the current study involved a social interaction observation to evaluate if the specific skills taught during the intervention generalized into practice, the children were evaluated during recess at school with familiar peers. Thus, it is difficult to say whether the social skills learned in the intervention generalize across different settings and to unfamiliar age peers. Second, the items on the social skills observation rating scale did not address the frequency or duration of the social skills, but rather focused on the presence or absence of each skill during the 5-minute period.

Finally, the groups of children with autism and Asperger Syndrome were from a sample of children with developmental disabilities coming to a specialized school or after-school center, often because parents wanted the children to receive therapy, or because their problems were particularly challenging. In this sense, it seems likely that the sample may have included children who are more severely impaired than the general population of children with ASD. The outcomes of this study might therefore be limited in terms of generalizability to the population of individuals with ASD as a whole. Thus, there is a need to replicate the findings from this study with a different sample, and ideally, from a population-based sample, where heterogeneity is likely to be found.

Future Research

The neurobiological basis for ASD is a topic of intense recent research (Piven, 1997). It remains unclear to what extent the abnormal processing of social and emotional information in individuals with ASD could be due to a dysfunction a specific limbic structures, such as the amygdala. The theory that amygdala pathology could contribute to some of the neuropsychological impairments in social and emotional processing seen in ASD (Baron-Cohen, Ring, Bullmore, Wheelwright, Ashwin, & Williams, 2000) is supported by the finding that individuals with damage to the amygdala also show abnormal emotional and social processing. In particular, several studies have found that the amygdala is important for recognition of certain emotions and that it is important for making complex social judgments from faces (Adolph, Tranel, Damasio, & Damasio, 1994).

The results of the current study call for neuroimaging studies to examine possible changes in the functioning of brain areas (e.g. in the amygdala, fusiform gyrus, or prefrontal cortex), and gaze tracking studies to examine subtle behavioral changes following the use of FaceSay. Such studies would throw light on whether the observed facial processing changes reported here are arising from changes in those neural regions that are typically recruited by the brain in typically developing individuals, or if they are due to compensatory strategies by other neural regions.

This investigation focused on facial and emotion recognition skill, as well as social skill improvements in children using FaceSay. A number of outcome variables could be explored in future studies, including objective measures of eye gaze and child satisfaction to the games. Also, future research should clarify which variables predict most successful utilization of computer-based training. The current study found that children with autism or Asperger Syndrome who had higher initial IQ and lower autism symptomology benefited most from the intervention. The effects of other child variables, such as visual spatial ability, and behavior problems, should also be explored. In addition, parent and family variables, such as stress and depression levels, and socioeconomic status may predict treatment outcomes. Since services are, at least in most areas of the country, a limited resource available to only a subset of children, determination of who benefit most from the training model is critical.

Future research should also investigate the generalization from computer-based programs that explore situations in the classroom, at home, and in the community. The use of such programs and the development of additional strategies could enhance our knowledge of instructional strategies for enhancing the social skills of children with ASD. Additional computer-based programs that enhance the social skills of children who have other developmental disabilities, such as Attention-Deficit/Hyperactivity Disorder, could also further our understanding and could provide additional opportunities to expand on understanding of theory of mind and impairments in social skills.

Summary

In summary, the current study investigated the outcomes of a computer-based social skills intervention for children with autism or Asperger Syndrome. The study provides a starting point for further investigations on the effectiveness of computer-based treatment. This study demonstrates the promise of computer technologies as a supplement to traditional behavioral techniques in teaching specific skills to children with ASD. Computers are a cost-effective method to educate children who require one-on-one assistance in learning environments. The software developed here is a first step in examining how computers can be used to integrate children who have ASD into the social environment that characterizes human interaction.

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APPENDIX A

DEFINITION OF OBSERVED SOCIAL INTERACTION

OBSERVED SOCIAL INTERACTION

1. Social initiation: The child begins a new social sequence, distinguished from a continuation of a previous sequence by a change in activity.

2. Social response: The child responds verbally and/or nonverbally to social stimuli directed toward him/her by peers.

3. Positive social interaction/response: The child exhibits verbal and nonverbal social behaviors that lead to an effective social process with peers. Behaviors that serve to start or maintain social interaction.

   a. Eye contact: The child looks into the eyes of another child.
   b. Eye contact combined with smile: The child looks and smiles toward another child.
   c. Smile with no eye contact: The child smiles at another child but does not look into the peer's eyes.
   d. Affection: The child expresses affection toward another child, either verbally or nonverbally.
   e. Sharing objects: The child offers his/her objects to another child or shares an object with another child.
   f. Sharing experiences: The child tells about an experience to peers or asks them about their experiences.
   g. Social communication: The child approaches another child with a social intention.
   h. Greeting: The child says hello to another child or replies appropriately to such a greeting.
   i. Giving help: The child offers help to another child.

4. Negative social interaction/response: The child exhibits unpleasant social behaviors that operate to stop or decrease the likelihood of the development of an adequate social interaction.

   a. Physical or verbal aggressiveness: The child behaves in malicious intrusive ways toward peers.
   b. Teasing: The child tries to drag another child into conflict.
   c. Controlling: the child dominates other children without respecting their needs.
   d. Avoidance: The child avoids social overtures made towards him/her by peers.
   e. Looking away: The child actively avoids social contact by looking away from the initiator.

5. Low-level interaction/response: The child exhibits behaviors that indicate social intention, but with minimal social enactment, such as close proximity to children without initiating a positive social interaction.

    a. Looking: The child looks at the other child's face or body, or child's action without establishing eye contact.
    b. Close proximity: The child stands in close proximity to another child (3 feet or less) but does not approach the peer.
    c. Functional communication: The child approaches and responds to another child with an intention to fulfill his/her own needs, and with no social intention.

APPENDIX B

RECRUITMENT MATERIAL

Research study of the effectiveness of computer-based social skills training for children with Autism Spectrum Disorders.

We are recruiting children to participate in a study investigating the efficacy of a computer-based social skills intervention for children with autism or Asperger Syndrome. This study is sponsored by the Civitan International Research Center and the UAB Department of Psychology.

Purpose: To investigate the extent to which a computer-based intervention can improve children's social skills.

Study details: Tasks will involve parental and teacher questionnaires. The children will be asked to participate in either the social skills training group or a control training group. The children will be asked to participate in 12 sessions at their school, each lasting for about 20 minutes. The children and families will be compensated for their participation.

Eligibility:

Children with Autism	*Children with Asperger Syndrome*
Diagnosis of Autism Ages 6-15 Both genders Native English speaker	Diagnosis of Asperger Syndrome Ages 6-15 Both genders Native English speaker

Contact information: Maria Hopkins [redacted]

APPENDIX C

ETHICAL APPROVAL

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Institutional Review Board for Human Use

Form 4: IRB Approval Form
Identification and Certification of Research
Projects Involving Human Subjects

UAB's Institutional Review Boards for Human Use (IRBs) have an approved Federalwide Assurance with the Office for Human Research Protections (OHRP). The UAB IRBs are also in compliance with 21 CFR Parts 50 and 56 and ICH GCP Guidelines. The Assurance became effective on November 24, 2003 and expires on February 14, 2009. The Assurance number is FWA00005960.

Principal Investigator: HOPKINS, MARIA J

Co-Investigator(s):

Protocol Number: F060213001

Protocol Title: *Demonstration and Evaluation of Avatar Assistant for Elementary Aged Children With and Without an Autism Spectrum Disorder or Mental Retardation*

The IRB reviewed and approved the above named project on 4/26/2006. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received FULL COMMITTEE review.

IRB Approval Date: 4/26/2006

Date IRB Approval Issued: 4/26/06

Identification Number: IRB00000196

Ferdinand Urthaler, MD
Ferdinand Urthaler, M.D.
Chairman of the Institutional Review Board for Human Use (IRB)

Investigators please note:

The IRB approved consent form used in the study must contain the IRB approval date and expiration date.

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.

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