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TEACHING EMOTION RECOGNITION TO CHILDREN WITH AUTISM: EFFECTS OF TWO COMPUTER DISPLAYED INTERVENTIONS

by

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Abstract

This study was conducted to determine if a computer-based intervention would be effective for increasing the emotion recognition ability of twin adolescents with autism and severe communication deficits. In the first experiment, the participants viewed *The Transporters*, with and without prompting, and they did not demonstrate increased emotion recognition ability. In the second experiment, the intervention included the Applied Behaviour Analysis teaching technique, general case analysis. Prompting and reinforcement was used to teach the twin participants multiple examples of emotional expressions demonstrated by videotaped actors. Examples of facial actions were also taught in an attempt to enhance the participants' discrimination ability. In the second experiment, the scores for one of the participants increased for recognition of *happy*, *sad*, and *surprised*, and he demonstrated generalization ability. The second participant mastered one emotional expression, *surprised*, and he was able to generalize to a novel set of stimuli.

Keywords: autism; emotion recognition; computer intervention; discrete trial; communication; language

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Introduction

Individuals with autism have demonstrated difficulty recognizing, interpreting and responding to the emotions of other people (Baron-Cohen & Harcup, 2007; Baron-Cohen, Golen, Chapman, & Granader, 2007; Celani, Battacchi & Arcidiacono, 1999) and this negatively influences relationships with families, peers, and employers (Baker, 2006; Hobson, 1986; Maurice, Green & Luce, 1996). A number of studies have described differences in emotion recognition ability between groups of children or adults with and without autism. For example, in a study by Hobson (1986), children with autism were less accurate than typically developing children or children with intellectual disabilities at recognizing and matching emotions expressed by faces on videotape to line drawings of faces on cards that showed 1 of 4 different emotional expressions. Also, Celani et al. (1999) found that relative to typically developing children and/or children with Downs Syndrome, individuals with autism scored significantly lower on tasks that required matching and sorting picture cards of the basic emotional expressions of happy and sad. Furthermore, Gross (2004) demonstrated that children with autism scored lower than control groups of typically developing, intellectually disabled, or language delayed children when performing a test requiring the participant to point to four different emotional expressions on request.

Although individuals with autism have difficulties developing typical emotion recognition skills, a strength noted by researchers has been an interest in and understanding of predictable systems, and this has been called *the systemizing theory of* *autism* (Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001; Golan et al., 2010; Wakabayashi et al., 2007). Golan et al. (2010) explained that the restricted interests of individuals with autism have been shown to be in the area of predictable systems, such as vehicles, wheels, computers and numbers. Golan et al. also argued that individuals with autism have been found to be superior than typically developing controls when tested for an ability to attend to details, and this skill has been considered important for analyzing and understanding systems. According to Golan et al., individuals with autism find systems relaxing to watch because of their desire for sameness and repetition.

Research supporting *the systemizing theory of autism* was conducted by Wakabayashi et al. (2007) by comparing individuals with autism to the general population and university control groups. These researchers found that interest in systems amongst individuals with autism, measured by the Systemizing Quotient (SQ), was significantly higher than for the typically developing control groups. Furthermore, Baron-Cohen et al. (2001) found that children with autism were able to score higher than typically developing control children during simple tests of physics knowledge. Finally, children and adults with autism have been found to have superior visual scanning skills when compared to typically developing control groups (O'Riordan, 2004). Golan et al. (2010) believed that this fascination with systems and extremely strong attention to detail could be used to teach individuals with autism difficult concepts such as emotion recognition skills.

Various methods for teaching emotion recognition to high-functioning individuals with autism have been designed and tested (e.g., Bauminger, 2002; Golan et al., 2010; Golan & Baron-Cohen, 2006; Lacava, Golan, Baron-Cohen, & Myles, 2007; Silver &

Oakes, 2001). For example, Golan and Baron Cohen (2006) designed an interactive multimedia program, *Mind Reading*, and found that using this program increased the ability of a group of adults with Asperger's syndrome and high-functioning autism to recognize complex emotions. Lacava et al. (2007) also found that *Mind Reading* was effective for teaching emotion recognition to students with Asperger's syndrome. Further, Lacava et al. (2007) found that *Mind Reading* increased the participants' ability to generalize their recognition of emotions across stimuli and settings.

Golan and Baron-Cohen (2006) based the design of the *Mind Reading* intervention program on the principle that children and adults with autism have strengths in systemizing information. Golan and Baron-Cohen explained that systemizing is the ability to create and understand rule-based events. These events involve predicting reliable outcomes, such as those when interacting with computer programs. Since individuals with autism have demonstrated an understanding and preference for predictable systems, Golan and Baron-Cohen believed that concepts difficult to understand, such as emotion recognition, could be taught with computers, where the system of interaction between computer and the person using it can be highly predictable.

Emotions may be explored and learned by using *Mind Reading* in several ways. *Mind Reading* has a "Learning Center" with emotion recognition lessons, quizzes, and rewards. This interactive software also contains an "Emotions Library" that has numerous pictures and short videos of faces displaying emotions. Finally, *Mind Reading* includes a "Game Zone" that allows for incidental learning of emotions while playing computer games.

Based on the assumption that individuals with autism have strengths in the area of systemizing information into rules and predictable events, Baron-Cohen and his colleagues also designed an animation series to teach emotion recognition skills to children with autism (Baron-Cohen & Harcup, 2007; Golan et al., 2010). This DVD, titled *The Transporters*, is a series of 15 stories, each 5 minutes in length, with characters that are eight animated trains with human faces. Each story emphasizes one emotional expression.

Golan et al. (2010) chose trains as the characters for *The Transporters* because they believed that children with autism would be highly interested in watching them because of their strength in understanding predictable and repetitive systems. These researchers based their DVD design partially on anecdotal reports from parents of children with autism that these children spend much time repeatedly watching movies that have vehicles in them. Golan et al. chose trains because these vehicles run on tracks making the route they travel on visible, and this is consistent with the interest children with autism demonstrate for predictable systems. They further argued that the difficulty individuals with autism have shown during their challenges with social interactions were eliminated by creating a system-based, animated, and enjoyable DVD for children with autism to watch.

There were basic and complex emotions included in *The Transporters* stories in Golan et al.'s (2010) study. Demonstrated by the train characters in 15 stories were six basic emotions and additional nine complex emotions that Golan et al. believed children between the ages of 2 and 7 years have been shown capable of recognizing. Basic emotions in the DVD were happy, sad, angry, disgusted, afraid and surprised. Complex emotions were excited, tired, unfriendly, kind, sorry, proud, jealous, joking and ashamed. Human faces were embedded in the trains in order to increase the possibility of generalization to the natural environment.

In their study using *The Transporters*, Golan et al. included children with autism with verbal ability matching that of typically developing children. Research to date using computer interventions to teach emotion recognition has mainly included samples consisting of children with autism who were high functioning and verbal (Gepner, Deruelle & Crynfeltt, 2001; Golan et al., 2010). The term "high functioning autism" has not been defined consistently by researchers or recognized by the DSM-IV (Klin, 2006). There has also been disagreement amongst professionals as to whether high-functioning autism and Asperger's syndrome may be considered to be the same disorder (Herba & Phillips, 2004; Klin, 2006). However, according to Golan et al. (2010), children with high-functioning autism have demonstrated language and cognitive abilities typical for their chronological age. Golan et al. also believed that children with low-functioning autism experience difficulties learning and expressing themselves using appropriate language. Golan et al. recommended that *The Transporters* intervention be explored to determine how it may be used to teach lower-functioning children with autism.

There were three groups of children aged 4-7 years old in the study by Golan et al. (2010), matched on age, sex, and verbal ability: Children with autism were assigned to intervention (n=20) and a no-treatment control (n=18), and children without autism who were typically developing (n=18) formed a second, no-treatment control group. Golan et al. predicted that the children with autism would score lower in emotion recognition and understanding than typically developing children prior to intervention.

They also predicted that emotion recognition and understanding of the children with autism in the intervention group would improve when compared to the autism no-treatment control group.

Emotion recognition and understanding tests were administered pre- and post-intervention in Golan et al.'s (2010) study, and the scores for emotional vocabulary were obtained by requesting that child participants provide definitions for 16 different emotions and examples of contexts that could generate such an emotion. The second type of task was intended to test generalization ability by matching situations to facial expressions. These generalization tasks consisted of matching character expressions to scenes from the DVD, matching character expressions to scenes that were not found in the DVD, and matching expressions of actors in the *Mindreading* program "Emotions Library" to scenarios that were not animated.

The intervention by Golan et al. (2010) was 4 weeks long, and consisted of watching a minimum of three animated stories from *The Transporters* each day. Prior to the intervention, the 2 groups of children with autism did not demonstrate differences in emotional vocabulary and matching tasks involving expressions and contextual situations. However, the typically developing children scored significantly higher than both groups of children with autism.

Following the 4 week intervention in which the children with autism in the experimental group viewed the animated stories in Golan et al.'s (2010) study, their emotion recognition performance improved to the level of the control group of children with typical development. This improvement in scores for the autism experimental group was found for all tests of generalization. Anecdotal data collected from parental interviews indicated that the children demonstrated interest in facial emotions, and discussed emotions more often. There was no improvement in scores noted in the autism group with no treatment or the typically developing control group. Taken together, the findings were interpreted by the study authors as supporting *the systemizing theory of autism* proposed by Baron-Cohen and his colleagues.

Golan et al. (2010) suggested that watching *The Transporters* increased emotion recognition ability because the children with autism were strongly interested in predictable and mechanical objects instead of human facial expressions. By teaching incidentally, using human faces embedded in the animated trains, generalization was enhanced. These researchers argued that the motivating factor that caused children with autism to engage in the stories was a strong interest in predictable systems, and that this approach also allowed for learning about emotions without the confusing aspects of change that occurs repeatedly during social interactions.

The purpose of the present study is to expand upon the ideas of Baron-Cohen and his colleagues and to explore whether an intervention based on *the systemizing theory of autism* can also improve the emotion recognition of 2 adolescents with autism who have more severe communication difficulties than present in samples in previous research. According to *the systemizing theory of autism*, children and adults of all ages and level of functioning are expected to respond to computer-based interventions when materials and training involve highly interesting and predictable systems (Golan et al., 2010). The participants with autism in Golan et al.'s (2010) study were matched in verbal ability to typically developing child participants and these children with autism benefited from *The Transporters* intervention. Golan et al. believed that the interest that the participants had in systems displayed as trains with faces increased their attention to the faces resulting in learning of emotion recognition skills.

Both high-functioning and lower-functioning children with autism have difficulty interpreting social cues from facial expressions (Kanner, 1943; Hobson, 1986; Celani et al., 1999; Gross, 2004). This may be due to a tendency for such a child to not to attend to human faces (Dawson et al., 2004; Grelotti et al., 2002). Since lower-functioning children with autism may have more difficulty learning in general when compared to high-functioning children (Golan et al., 2010), repetition and additional prompting was used to supplement the DVD in this study. By repeatedly displaying one story with one target emotion until mastery is demonstrated at 80% correct responses for 2 days, I hypothesized that the 2 adolescent participants, both of whom had autism and severe communication difficulties, would learn emotion recognition skills from viewing *The Transporters*.

The general research questions guiding the study were:

1. Will watching stories from *The Transporters* increase the emotion recognition ability of 2 adolescents with autism and severe communication difficulties?
2. Will increases in emotional recognition ability generalize to novel stimuli such as static pictures and videotapes of human faces? Will generalization to novel emotional expressions not targeted for intervention occur?

Literature Review

Background

Since Kanner (1943) first described the behaviours of children with autism, research on this clinical population has been conducted in many different areas such as genetics, etiology, brain functioning, treatments and education. Prevalence of the diagnosis of autism has been calculated across studies to have increased from 4 children in 10,000 in 1960s and 1970s to 8.7 children in 10,000 in 2005 (Fombonne, 2005). Approximately 1 in 110 children in the United States in 2006 were diagnosed with autism and/or autism related disorders (National Center on Birth Defects and Developmental Disabilities, [CDC], 2009). This increasing trend may be due to changes in the diagnostic criteria for autism (Fombonne, 2005). It is important to continue to research methods to teach individuals with autism in order to allow for the highest integration possible in public schools and the community.

Characteristics of Autism

Kanner (1943) described autism in his seminal work, and the behavioural characteristics he observed are still recognized as typical of individuals with autism (American Psychiatric Association [APA], 2000). These characteristics include abnormal sensory input reactions, resistance to changes in routine, and a lack of eye contact (Kanner, 1943; APA, 2000). Kanner especially noticed and documented the limited attempts of children with autism to communicate with others.

Although there are common characteristics amongst individuals with autism, it is difficult to describe autism in a generalized way because each case is highly individualized (APA, 2000). Furthermore, autism manifests in many different combinations of strengths and deficits (Maurice et al., 1996; Teunisse & de Gelder, 2003; Quill, 2000). Strengths of individuals with autism include rote memory and an ability to understand cause and effect when systems are repetitive and predictable, such as in moving vehicles and machines (Baron-Cohen, 2002; Baron-Cohen & Harcup, 2007; Baron-Cohen et al., 2007).

In addition to the cognitive strength associated with the interpretation of highly predictable systems among individuals with autism, such individuals have deficits in the areas of communication and social skills (APA, 2000). Social impairment is considered the primary characteristic of autism (APA, 2000). This social impairment of individuals with autism includes difficulty recognizing and interpreting the emotions of other people (Golan et al., 2010; Baron-Cohen & Harcup, 2007; Baron-Cohen et al. 2007; Celani et al., 1999).

Individuals with autism engage in more stereotypical, ritualized behaviours than typically developing peers (APA, 2000). These behaviours can interfere with learning from the natural environment (Maurice et al., 1996). Furthermore, many individuals with autism seem to prefer engaging in such repetitive behaviours to developing relationships with others (Kanner, 1943; Hobson, 1989). In addition, repetitive behaviours tend to replace participation in activities that provide learning experiences (APA, 2000; Maurice et al., 1996). For example, a child with autism may flap his hands and spin a plate on the floor for hours, while paying no attention to numerous developmentally appropriate toys nearby and not approaching or interacting with other children.

According to the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-1V-TR*) (APA, 2000), autism is one of five pervasive developmental disorders (PDD).

The term Autistic Disorder is the label attached to the disorder in the DSM-1V. The remaining four diagnostic subcategories of PDD are Asperger's Disorder, Rett's Disorder, Childhood Disintegrative Disorder, and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS). However, the term commonly used by professionals to describe Autistic Disorder, Asperger's Disorder, and PDD-NOS is Autism Spectrum Disorder (ASD) (Centers for Disease Control and Prevention [CDC], 2006).

According to the CDC (2006), individuals with autistic disorder (or "classic autism") have intellectual disability and significant communication and social difficulties, as well as stereotypical behaviours and restricted interests. In comparison, individuals with Asperger's syndrome usually do not struggle with language or intellectual disability, but still demonstrate social challenges partially resulting from unusual interests and lack of understanding of others' emotional states. Furthermore, if an individual demonstrates some of the characteristics of autistic disorder or Asperger's syndrome, the diagnosis may be labelled as PDD-NOS (CDC, 2006).

Symptoms of Autism Spectrum Disorders are evident prior to the age of 3 years of age (CDC, 2006). Some children display the behavioural symptoms a few months after birth, while other children may demonstrate these behaviours after 2 years of age. Skills gained may be lost during this time, or limited skills developed. These skills include a lack of eye contact and interest in interacting with others. Also, infants with autism may not point to objects or play with objects appropriately. Echolalia, the repeating of words or phrases, may occur, or the child may have limited sounds and demonstrate minimal non-verbal attempts to communicate. Hand flapping, spinning, rocking, and squealing sounds are common behaviours of children with autism. These children also tend to react strongly to changes in routine, resulting in lengthy tantrums and possibly aggressive behaviours (CDC, 2006).

In summary, individuals with autism have individualized profiles of behavioural symptoms, strengths and weaknesses (APA, 2000). However, the common characteristic is difficulties in the area of social interactions with others (APA, 2000). Individuals with "classic autism" often have communication difficulties, stereotypical behaviours, and limited interests (APA, 2000). These interests often include watching predictable systems such as vehicles and computers (Baron-Cohen, 2002).

Emotion Recognition Research

As stated previously, some research results suggest that individuals with autism struggle to recognize the emotions of others when compared to typically developing control participants (Baron-Cohen et al.,1993; Celani et al., 1999; Gross, 2004; Hobson, 1986; Howard et al., 2000). However, other research results contradict this finding (Castelli, 2005; Gepner, et al., 2001; Grossman, Klin, Carter & Volkmar, 2000).

For example, Castelli (2005) found no statistically detectible differences in emotion recognition ability between children with autism and typically developing children. This study investigated the ability of children with autism to recognize six basic emotional expressions (happy, sad, anger, fear, disgust and surprise) at three levels of intensity. In Castelli's first experiment, a group of children with autism were matched on verbal age to the chronological age of a group of typically developing children. Emotional expressions were presented on the flashcards and were manipulated by computer to show more or less subtle expressions at three levels. Participants sorted the emotions into six boxes and the number of correct responses was totalled following the testing session. No differences were statistically detectible between the groups for total scores or for error patterns during the study. In both groups of children, the most common error was matching fear with surprised.

In a second experiment, Castelli (2005) asked 2 groups of children to name the emotions on emotion flashcards without manipulating the intensity of the expressions. Again, no differences were found between the two groups of children for naming the correct emotion. The pattern of errors was consistent for both the children with autism and the typically developing peers and involved incorrectly labelling fear as surprised, and disgust for anger. Scores for identifying the emotional expression happy were the highest of the six emotions.

In a third experiment by Castelli (2005), the children were asked to name the six emotion types with two levels of intensity. Once again, no differences were found between the two groups of children. Both groups found happy to be the easiest expression to name, and disgust the most difficult with both groups tending to label it as angry or sad. Fear and surprised were also mistaken for each other by both groups.

Castelli (2005) argued that his results conflict with those of Baron-Cohen and his colleagues (1993) who found that surprised was more difficult for children with autism to recognize compared to typically developing peers. Furthermore, Castelli's (2005) results contradicted the results of the study by Howard et al. (2000) who also reported that recognizing fear was a specific impairment of individuals with autism.

Castelli (2005) explained that contradictory findings from studies of children with autism could be attributable to age group differences of children who participated in the studies. For example, the verbal mental age of the children with autism in Castelli's study was 9.2 years, while Baron-Cohen (1993) included children with a mean verbal mental age of 5.3 years. Castelli believed that the lack of ability to recognize surprised was common amongst 5-year-old children who were typically developing. In addition to differences between participants, differences in the stimuli used to convey emotions may help explain such contradictory results (Castelli, 2005). For instance, the Ekman (1976) flashcards, a series of standardized photographs were used for several studies (Castelli, 2005; Grossman et al., 2000). Other studies have used drawings of faces (Baron-Cohen, 1993; Silver & Oaks, 2001) or videotapes of moving and static faces (Gepner et al., 2001). Finally, Golan et al. (2010) used pictures of human faces embedded in animated trains.

Further, the lack of consistency in findings from emotion recognition studies may be associated with the nature of measures that researchers have used to assess emotion recognition. Receptive emotion recognition identification, where children are required only to point to static pictures of emotional expressions, was the procedure used in the study by Gepner et al. (2001). Grossman et al. (2000) also used a receptive measure of emotion recognition where children pressed printed emotion words on a touch pad to identify five emotions on faces on a computer screen.

In contrast to assessing receptive emotional expressions, some research studies have measured emotion recognition with expressive language data. In such studies, a participant is required to label a picture, usually with vocal language. For example, in Castelli's (2005) second experiment, the child participants were required to state verbally the emotional expressions shown to them in photographs.

This section explained the controversies found in the area of emotion recognition research. Although some studies have found that individuals with autism differ from typically developing peers in the ability to recognize emotional expressions (Baron-Cohen et al.,1993; Celani et al., 1999; Gross, 2004; Hobson, 1986; Howard et al., 2000) , other studies have found no differences between the two groups (Castelli, 2005; Gepner, et al., 2001; Grossman, Klin, Carter & Volkmar, 2000). Researchers have suggested that differences between the characteristics of the participants and varying materials used as stimuli may explain the discrepancies found in this area of research (Castelli, 2005).

Face Processing Research

Basis of Social Deficits

Social deficits of individuals with autism, including an inability to recognize emotional expressions in others, have been studied by focussing on face processing ability (Gepner, deGelder, & deSchonen, 1996; Grelotti, Gauthier, & Shultz, 2002; van der Geest, Kemner, Verbaten, & Engeland, 2002). Deficits in social skills such as lack of attending to faces and facial expressions have been documented in participants with autism when compared to typically developing control groups, (Dawson et al., 2004; Grelotti et al., 2002) and groups of children with mental retardation (Osterling, Dawson & Munson, 2002). Furthermore, gaze-direction towards facial features (Van der Geest, Kemner, Verbaten, & Engeland, 2002), social orienting (Dawson et al., 2004) and the ability to recognize familiar faces (Joseph & Tanaka, 2003) and emotional expressions (Gepner et al., 2001) have been found to be lower for children with autism than typically developing controls.

Studies investigating the neural basis for face processing ability have found differences between children with autism and typically developing peers (Dawson et al., 2002; Hall, Szechtman & Nahmias, 2003; Senju, Tojo, Yaguchi, & Hasegawa, 2005). For example, event-related potentials (ERP) of children with and without autism have been found to differ during studies of gaze processing (Senju et al., 2005). Specifically, during active gaze processing, occipito-temporal negativity (N2) was found to be equally distributed in both hemispheres in children with autism, and lateralized to the right hemisphere in typically developing peers (Senju et al., 2005). In addition, when looking at pictures of their mother and a stranger, ERP amplitude differences of children with autism did not differ between the two tasks, while differences were noted for typically developing peers (Dawson et al., 2002). Dawson et al. argued that these findings support the existence of a specific impairment in face processing in children with autism.

Results from numerous studies attempting to determine if emotion recognition is a specific deficit of individuals with autism, or the result of an inability to process facial information have been inconsistent (Gepner et al., 2001; Teunisse & de Gelder, 2003). Conflicting results in this area of research may be due to variations in the use of stimuli used during testing of facial and emotion recognition (Gepner et al., 2001: Joseph & Tanaka, 2003: Klin et al., 1999; Dennis, Lockher & Lazenby, 2000).

Development of Face Processing Skills

Facial processing skills typically develop during early infancy (Dawson, Webb & McPartland, 2005) and continue throughout childhood (Bruce et al. 2000). The development of such skills in infants and children with autism does not appear to parallel that of typically developing children (Dawson et al., 2005; Joseph & Tanaka, 2003). For example, Dawson et al. (2005) found during electrophysiology studies that infants with autism were deficient in encoding and recognition memory of faces. These researchers argued that face-processing deficits in young infants with autism were indicative of abnormal development of the nervous system. However, an alternative explanation has been that low interest in attending to faces and lack of social orienting to others does not provide the experience necessary to develop face-processing skills (Dawson et al, 2004; Grelotti et al., 2002).

Face processing development in children with autism has been studied to determine the factors that mediate weaknesses in social interaction and communication skills (Joseph & Tanaka, 2003). These studies have found that infants with autism do not attend to faces to the extent of typically developing infants (McPartland et al., 2004). Osterling and Dawson (1994) found in a study of first birthday party videotapes that 1-year-old children with autism were distinguished from typically developing children based on a lack of attention to faces. Study results have also suggested that children with autism lacked the ability to recognize differences between pictures of faces (Dawson et al., 2002; Joseph & Tanaka, 2003). An example of research in this area is the inability to recognize a picture of a face that is different amongst several pictures of identical faces (McPartland et al., 2004).

Face Processing Strategies

Langdell's (1978) seminal research in the area of face-processing ability showed that children with autism were able to identify inverted faces, while typical developing children had difficulty with this task. Langdell also found that, compared to typically developing children, children with autism were more able to recognize faces by using strategies that isolated the mouth area, but they were less able to recognize faces from looking at the eyes. Based on this research, Langdell suggested that these atypical strategies indicated that children with autism focused on features such as the mouth, rather than processing cues from the whole face (Langdell, 1978).

Joseph and Tanaka (2003) tested the hypothesis that children with autism used atypical face processing strategies. These researchers found that typically developing children were more capable of recognizing faces from the eyes than children with autism, but only in upright faces, not inverted faces. In keeping with Langdell's (1978) findings, Joseph and Tanaka concluded that the abnormal focus on the mouth area of children with autism differed from typically developing children.

Face processing amongst typically developing children has been found to begin with individual feature analysis and end with processing of the entire face (Bruce, Macrae, Cole-Davies & Dias, 2003; Schwarzer, 2002). This developmental sequence has been demonstrated by the use of various tests, such as sorting faces by categories that required focusing on a single attribute or multiple attributes (Schwarzer, 2002). For example, Schwarzer (2002) found that when young children matched faces that varied by a single attribute such as eyes or a nose, these features were the basis of the matching categories chosen. However, Schwarzer found that older children matched faces based on numerous facial features. In addition, studies using stimuli consisting of inverted photographs found that typically developing older children had more difficulty than younger children recognizing faces (Hay & Cox, 2000). One explanation of this finding is that older children process the entire face rather than attending to individual features, as younger children do (Hay & Cox, 2000).

In summary, face processing has been studied in an attempt to determine the basis for the difficulty individuals with autism have with emotion recognition. Face processing development research results have supported the existence of differences between children with autism and typically developing peers (Dawson et al., 2005; Joseph & Tanaka, 2003). The strategies used by individuals with autism during face processing have been found to differ from control groups without autism (Langdell, 1978; Joseph & Tanaka, 2003). Specifically, individuals with autism have been found to focus on features, such as the mouth, instead of the entire face (Langdell, 1978; Joseph & Tanaka, 2003).

Teaching Children with Autism Using Video-Presented Stimuli

Various video-presented stimuli have been found to be effective for teaching children with autism (Ayres & Langone, 2005; Charlop-Christy, Le, & Freeman, 2000; LeBlanc et al., 2003; Maione & Mirenda, 2006; Nikopoulos & Keenan, 2004). For example, the study by Charlop-Christy et al. (2000) compared the effectiveness of video and in vivo modeling for teaching children with autism new skills and found that video modeling decreased acquisition time and increased generalization abilities of children with autism when compared to in vivo modeling.

Charlop-Christy et al. (2000) used a multiple baseline single subject research design across 5 child participants with autism for their study. For each participant, there were baselines established for condition (video and in vivo modelling) and for task. Children's mental ages ranged from 4 years, 4 month to 6 years, 9 months. Chronological ages were 7 years, 2 months to 11 years, 3 months. All child participants in Charlop-Christy et al.'s study were in after school behaviour modification programs due to significant difficulties with behaviours that interfered with learning from traditional methods and the natural environment. The children were also highly interested in watching TV every day.

Tasks chosen for the child participants in the study by Charlop-Christy et al. (2000) depended on the skills the individual child needed to learn and were identified with input from the parents and the professionals working with the children. For example, one of the participant’s target for intervention was emotion recognition. Tasks of the same difficulty were assigned to the two intervention conditions, such as expressive labelling of the emotional expressions of happy versus sad, and tired versus afraid.

Charlop-Christy et al.’s two intervention conditions were video modelling and in vivo modelling. Video modelling consisted of videos of actors demonstrating the correct responses to one task, such as discriminating happy versus sad. In vivo modelling was actors demonstrating in front of the child the correct responses of the second task, such as discriminating tired versus afraid.

Results from Charlop-Christy et al.’s (2000) study indicated that video modelling was more effective for teaching children with autism when compared to in vivo modelling. Acquisition time was lower during video modelling than in vivo modelling. Also, generalization to novel targets occurred across all tasks during video modelling, but not during in vivo modelling.

In addition to the study by Charlop-Christy et al. (2000), LeBlanc et al. (2003) also demonstrated the effectiveness of video-presented stimuli for teaching children with autism. These researchers used a multiple baseline design across two tasks to teach perspective-taking skills. LeBlanc et al. found that combining video modelling and reinforcement was effective for teaching 3 children with autism perspective-taking, however, generalization to a novel task involving perspective taking of puppets was not demonstrated.

Furthermore, Nikopoulos and Keenan (2004) used video modeling to increase the spontaneous social behaviour and reciprocal play of 3 children with autism. Using a multiple baseline design across participants, the children in the study watched a video tape of an adult initiating play with a typically developing peer. Modifications of this condition occurred if the child participant engaged in initiating play within a 35-second time frame. The participants did not initiate play at baseline; however, all 3 children developed new social skills for initiating play during intervention, and these effects maintained for 3 months following the study.

Finally, Maione and Mirenda (2006) used video modelling and feedback to increase a child with autism's use of social language during play. A multiple baseline design was conducted across three different play activities. Video modelling was successful in increasing social language during play during the activities of playing with Play Doh and Caillou's Tree House. Additional prompting was necessary to increase social play with Chevron cars. These researchers suggested that children's high interest in the video-presented stimuli influenced the effectiveness of this intervention.

This section included research studies supporting the use of video-displayed interventions for individuals with autism. Charlop-Christy, et al. (2000) found that video modelling was a more effective teaching technique for children with autism when compared to in vivo modelling. In addition, Nikopoulos and Keenan (2004) determined that video modelling could be used to teach children with autism social and play skills. Finally, Maione and Mirenda (2006) successfully increased the social language of a child with autism during play with his peers using video modelling and feedback.

Teaching Children with Autism with Applied Behaviour Analysis

Applied Behaviour Analysis is a "scientific approach for discovering environmental variables that reliably influence socially significant behaviour and for developing a technology of behaviour change that takes practical advantage of those discoveries" (p.3, Cooper, Heron, & Heward, 2007). Although professionals use the term Applied Behaviour Analysis, or "ABA" when describing interventions used to teach children with autism (Heflin & Alberto, 2001; Simpson, 2001), this umbrella term includes all interventions that are focused on improving socially important behaviours by demonstrating a relationship between interventions and improvements (Cooper et al., 2007). Several intervention techniques associated with ABA will be described in the following sections.

Discrete Trial Teaching (DTT)

One of the ABA intervention techniques found effective for modifying the behaviour of children with autism is Discrete Trial Teaching (DTT) (Barbera & Rasmussen; Lovaas, 1987; Reed, Osborne & Corness, 2007; Smith, 2001). DTT involves teaching by breaking down tasks to components that are repeatedly presented to the child (Barbera & Rasmussen, 2007; Smith, 2001). A discrete trial consists of the cue, such as the instruction "show me the shoe?" Following the cue is the prompt in various forms such as pointing to a correct picture, or physically guiding the child's hand to the picture. The child then demonstrates a response, that may be prompted or unprompted, and if unprompted, the response may be correct or incorrect. For each trial, the instructor provides a consequence, such as reinforcement for correct responses, or an informational "no" and/or clearing the table of materials for incorrect responses. Finally, following the consequence, a pause of up to 5 seconds called the inter-trial interval occurs prior to the next discrete trial cue.

DTT is highly effective when used to teach children with autism new forms of verbal behaviour, such as producing speech sounds, and discriminating between different cues, such as "touch shoe" and "touch toothbrush" (Smith, 2001). DTT is also effective at improving imitation behaviour, receptive and expressive language, grammar, syntax and conversation skills (Smith, 2001).

Limitations for the use of DTT are associated with a lack of generalization of behaviours learned using it and the need for specialized training of instructors and professionals in the designing of intervention programs (Barbera & Rasmussen, 2007; Simpson, 2001; Smith, 2001). Generalization effects may be limited due to the fact that DDT often involves teaching in only one setting (Smith, 2001). Also, researchers report that professionals must train and monitor instructors using DTT, for if the procedure is incorrectly followed, the child may not benefit from therapy regardless of the number of hours provided (Barbera & Rasmussen, 2007; Simpson, 2001; Smith, 2001). Finally, the professionals designing programs must understand when to use DTT, as children with autism may learn skills differently in an intensive setting, depending on their strengths and level of functioning (Simpson, 2001).

Some researchers and educators have criticized DTT, and mistakenly labelled it the Lovaas type of treatment (Barbera & Rasmussen, 2007; Reed et al., 2007). However, Lovaas (1987) used other techniques than solely DTT during his intervention study. For instance, he included a high number of hours of therapy per week (minimum 40 hours), and punishment for negative behaviours (Lovaas, 1987). Furthermore, Lovaas' (1987) methodology, such as the use of different intelligence test scales pre and post intervention has been criticized by researchers (Gresham & MacMillan, 1998). Finally, the expense involved in treating a child with autism for 40 hours each week has made Lovaas type of therapy impossible for many families, although DTT may be implemented successfully with fewer hours and by members of the family (Barbera & Rasmussen, 2007).

Generalization of Behaviour Change Techniques

"Setting/situational generalization occurs when a target behaviour is emitted in the presence of stimulus conditions other than those in which it was trained directly" (p. 617, Cooper et al., 2007). For example, assume a child learns to point to a picture of a dog in one room in his home. However, if the child is unable to identify the same picture when he is at school, or is unable to point to pictures of other dogs, then generalization has not taken place. Generalization has occurred when the child is capable of the same learned behaviour in different settings and stimuli.

ABA interventions often result in a lack of generalization unless strategies that program for generalization are implemented (Cooper et al., 2007). An example of a strategy for promoting generalized behaviour change is "teaching sufficient examples" (Cooper et al., 2007). This requires teaching many examples of the same stimuli, such as using multiple fonts when teaching a child letters and numbers. Without the use of a wide variety of stimuli examples, the student may learn to identify letters and numbers that are presented as only one font.

Determining if generalization has occurred requires a generalization probe (Cooper et al., 2007). During a generalization probe, a student identifies stimuli not previously taught. If the student is not able to identify the novel stimuli, the frequency of exposure to teaching examples increases, until untaught examples result in correct responses (Cooper et al., 2007).

In order to choose teaching examples that will result in generalized responding to novel examples of stimuli, a systematic method called general case analysis may become part of the intervention design (Cooper et al., 2007). This method requires choosing teaching examples found in the natural environment (Cooper et al., 2007). Sprague and Horner (1982) used general case analysis to design an intervention for students learning to use vending machines. These researchers found that the students with moderate to severe mental retardation were successful during generalization probes with novel machines only after teaching with multiple examples in the same community (Cooper et al., 2007).

Generalization of behaviour change is enhanced when negative examples of stimuli are provided (Cooper et al., 2007). As the similarity of the negative examples to the teaching targets increases, discrimination ability will also increase (Cooper et al., 2007). For example, Horner, Eberhard, and Shehan (1986) demonstrated that teaching students with moderate to severe mental retardation to bus tables in a restaurant required teaching them when not to approach tables as well as when to approach them.

In this section, Applied Behaviour Analysis (ABA) was introduced with descriptions of Discrete Trial Teaching (DTT) and generalization techniques. ABA has been considered a scientific approach to changing socially important behaviours (Cooper et al., 2007). ABA techniques are supported by research that demonstrate a relationship between improvements in behaviour and interventions (Cooper et al., 2007). An example of such a technique is DTT, often used to teach children with autism because of the effectiveness of breaking down tasks into components and repeatedly presenting instructions and prompting to the student (Barbera & Rasmussen; Lovaas, 1987; Reed, Osborne & Corness, 2007; Smith, 2001). Finally, generalization must be considered when teaching new skills to ensure that the skill may be utilized in different environments and with novel stimuli (Cooper et al., 2007).

Intervention Research Designs

Single-Case Research Design

Also known as small-N research, single-case design involves recording each subject's performance continuously over time (Kazdin, 1982; Kennedy, 2005). Data collected is evaluated directly by visually inspecting the graph of the dependent variable as the ordinate, such as frequency or scores, over time as the abscissa (Kazdin, 1982). The resulting graph shows changes in the performance of the participant at multiple intervals. Importantly, the conditions at the times that changes occurred may be inferred as intervention effects due to the independent variable (Kazdin, 1982).

In addition to continuous assessment, the small-N research design allows for replication of experimental effects (Cooper et al., 2007). This replication is accomplished because subjects become their own controls (Kazdin, 1982). This permits including as few as one participant in a study, while obtaining as much information as possible from the repeated measures over time. Internal validity is maintained as selection bias, or the differences between groups that are not the result of experimental manipulation (Kazdin, 1982), would not be a detrimental factor within this type of design.

Multiple Baseline Research Design

The multiple-baseline research design allows for the demonstration of effects across behaviours, settings, and participants (Cooper et al., 2007; Kazdin, 1982; Kennedy, 2005). Interventions for each participant occur at different times, and in response to two or more stable baselines (Cooper et al., 2007; Kazdin, 1982; Kennedy, 2005). Use of this design controls for events other than the intervention as the cause for baseline changes (Kenney, 2005)

The multiple-baseline design is suited for use in educational research because withdrawal of the intervention does not predict a return to baseline conditions due to the participants' maintenance of new knowledge (Kennedy, 2005). This design requires collecting baseline data for each participant prior to initiating the intervention (Kazdin, 1982; Kennedy, 2005). In addition, it is important to use the same setting and data collection techniques during baseline and the intervention in order to make inferences from the data (Kennedy, 2005). Finally, visual analysis of the graph of the data collected over time determines if performance changes occur with intervention implementation; indicating that the intervention resulted in the changes observed (Kazdin, 1982; Kennedy, 2005).

In summary, single-case research designs and multiple baseline research designs may be used for intervention research (Kazdin, 1982; Kennedy, 2005). In single-case design, including a single participant or a small number of participants eliminates the need for a control group, and this decreases selection bias (Kazdin, 1982; Kennedy, 2005). Multiple baselines may be used to demonstrate experimental control by comparing participants, settings, or behaviours. Experimental effects are determined by comparing baseline conditions to conditions following initiation of the intervention (Kazdin, 1982; Kennedy, 2005).

Experiment 1: The Transporters Intervention

Rationale

Although Golan et al. (2010) used *The Transporters* to teach high functioning children with autism, there are reasons why the program may be successful for children with more severe forms of autism. The program is a passive intervention, and children are not required to make a verbal response. Further, the program does not require the use of a keyboard or joystick. Also, computers and vehicles such as trains have been found to increase the interest of all children with autism, regardless of level of functioning (Golan et al., 2010; Golan & Baron-Cohen, 2006).

Research Question

The purpose of this first experiment was to determine whether watching *The Transporters* would increase the emotion recognition ability of 2 adolescents with autism and severe communication difficulties. In addition, this study explored the possibility of generalization to novel stimuli and emotional expressions.

This intervention consisted of several components. First, the animated vehicles on tracks all had dynamic faces that conveyed emotional expressions. Prior research results have suggested that the use of dynamic stimuli during teaching recognition of emotional expressions has increased the effectiveness of the intervention (Gepner et al., 2001).

Second, the train characters interacted with others in a narrative about a specific emotion, providing additional cues for emotion recognition. Emotions were explicitly labelled throughout the narrative.

Third, there were many different interactions between the train characters, which allowed the individual with autism to see emotions generalized across diverse social contexts.

Finally, human character's faces were embedded in the front of the trains, and children and adults with autism have enjoyed watching movies with vehicles (Baron-Cohen et al., 2007).

This fascination with moving vehicles may be due to *the systemizing theory of autism* suggested by researchers in this area (Golan et al., 2010). As previously discussed, according to *the systemizing theory of autism*, individuals with autism have demonstrated a preference for systematic, repetitive movement (Golan et al., 2010). In films, trains moved in a predictable way, along train tracks. Researchers who developed *The Transporters* suggested that children with autism were attracted to the characters because the faces were displayed within the body of a vehicle that moves along tracks (Baron-Cohen & Harcup, 2007; Baron-Cohen et al., 2007; Golan et al., 2010). The participants in this study were also extremely interested in watching trains in videos.

The question addressed in the first experiment is whether *The Transporters* intervention will be effective at improving emotion recognition of 2 adolescents with autism and severe communication difficulties. These participants demonstrated high interest in moving trains in other videos. Since video-presented stimuli has been used successfully to teach children within the entire autism spectrum various skills, and *The Transporters* has been demonstrated to increase the emotion recognition of high-functioning children with autism, it is hypothesized that the 2 adolescents with autism and severe communication difficulties will increase their accuracy of recognizing emotions after viewing *The Transporters*.

Method

Participants

Simon Fraser University Department of Ethics provided written permission for the inclusion of the participants in the intervention study. For this study, the participants were a convenience sample consisting of 14-year-old twin brothers with autism. These children had received ABA intervention from the investigator for 6 years, and therefore, a professional relationship was developed with both the twins and their parents. Parents of the twin participants were informed of all the intervention procedures and they signed a consent form. Myles and Ben (pseudonyms) willingly agreed to watch *The Transporters* DVD for participation in this study.

Myles and Ben were first diagnosed with autism when they were toddlers. The severity of their disability was such that both children were able to secure funding from the British Columbia Ministry of Children and Family Development for Autism programs for children from the ages of 6-18 years. Since the children were diagnosed with autism prior to initiation of the autism funding on April 1st, 2004, the parents were required to reaffirm the diagnosis by having a paediatrician complete and sign a form when the boys were at 11 years of age. At the time of the study, Myles and Ben were adolescents attending a life-skills program in a public high school.

Table 1: Participant Characteristics

Participant	Age	Autism Severity	Abbreviated Battery IQ
Myles	14,6	70	47
Ben	14,6	54	47

Note. Age=age in years, months; Autism severity as measured by the Autism Treatment Evaluation Checklist; IQ was estimated using the abbreviated battery on the Stanford Binet Intelligence scales, 5th edition. Mean IQ=100, SD=16 according to standardization norms.

Severity of Autism-related Symptoms

I assessed the magnitude of autism symptoms observed in the behaviour of Myles and Ben with the *Autism Treatment Evaluation Checklist (*ATEC; Rimland & Edelson, 2000). Although developed primarily for evaluation of autism treatment effectiveness, and not intended for diagnosis, there may be a use for the checklist during the initial stages of diagnosis. Researchers, parents, and other professionals may fill out the checklist and score it online as it is not copywritten.

A sample of 1358 children who show characteristics consistent with a diagnosis of autism was used to validate the ATEC scale. This rating scale has the three choices of not true, somewhat true, and very true for each phrase describing an individual. A split-half reliability test was conducted on 1300 ATEC's resulted in an internal consistency of .94 for the overall score.

The ATEC measures the severity of symptoms associated with autism. Higher scores are related to greater severity of autism symptoms. There are four subtests on the

ATEC, consisting of Speech/Language/Communication (14 items); Sociability (20 items); Sensory/Cognitive Awareness (18 items), Health/Physical/Behaviour (25 items). Percentile scores are interpreted as the percentage of students in the norming sample who obtained that score or lower.

Myles and Ben scores fit into the percentiles shown in Table 2.

Table 2: Participant ATEC Percentiles

Participant	Myles	Ben
Speech	50-59	40-49
Sociability	60-69	50-59
Sensory/Cognitive Awareness	70-79	40-49
Health/Physical/Behaviour	30-39	20-29
Total	50-59	30-39

Relative to other students in the sample who show characteristics of autism behaviours, Myles and Ben scored in the mild (health and physical behaviour) to moderate (remaining scales) range. Ben scored in the mild range for the total of the subtest scores.

Intelligence

I assessed the cognitive ability of Myles and Ben with subtests from the *Stanford-Binet Intelligence Scales*, Fifth Edition (*SB5*) (Roid, 2003; Riverside Publishing, 2003). I estimated IQ using the abbreviated battery (See Table 1).

Language

The Assessment of Basic Language and Learning Skills-Revised (ABLLS-R) (Partington, 2006) is a criterion-based measure of language and learning skills for children and adults with severe communication difficulties. The assessment consists of multiple tests resulting in scores used to establish educational goals.

Ben was assessed in all tasks of the *ABLLS-R* by a trained consultant at the time of the study. The test scores for subtests for "cooperation and reinforce effectiveness" indicated he accepted tangible and social praise but he did not always seek approval from others. On the measure of "visual performance", Ben was able to match identical and non-identical pictures, complete puzzles, and sequence picture stories. In "receptive language", he could follow instructions and select many types of pictures, such as nouns, actions, feature, function and class. Ben could not select pictures of pronouns, prepositions, emotions, or of social interactions. Ben was capable of imitating motor actions and all sounds, words and phrases, but was not able to repeat a message taken to another person. Ben could label nouns and actions, but not feature, function, class, prepositions or emotions. On the "intraverbal ability" scale, Ben was able to fill in words to songs, and animal sounds. He spontaneously labelled items in the environment but did not initiate conversations.

Myles demonstrated similar abilities on the ABLLS-R as Ben except for the areas of vocal imitation and labelling. Myles had more difficulty pronouncing words and sounds, resulting in a decreased ability to imitate words and phrases, and to request items and use vocal language to label items and concepts that he could select using receptive language. Therefore, there is a greater gap in Myles ability to communicate with others what he knows when compared to Ben.

Single-Case Research Design

This single-case research experiment was conducted using a multiple baseline design across the 2 participants. The phases of the design were baseline, intervention phase: (passive viewing of *The Transporters*), intervention with prompting, and follow-up phase. All phases were completed in 30 weeks. Generalization probes were collected 5 times throughout the intervention.

Setting

The current intervention study was conducted in a bedroom in the home of the twin participants. This room was approximately 14 feet by 12 feet. A window with a view of the swimming pool was visible in the back yard. Furniture in the room was a desk, a bookshelf, and a single sized bed with a night table next to it. There was a clothes closet with a dresser and intervention supplies on a shelf above it. The lighting was adequate and in most sessions some noise could be heard from the TV in the living room, or from the parents talking in the kitchen.

Independent Variable

The independent variable was the application of the intervention consisting of the participants passively watching *The Transporters*. This DVD was created by researchers at Cambridge University in an attempt to provide a motivating and interesting way to teach children with autism between the ages of 3-8 years of age emotion recognition and understanding (Golan et al., 2010). Each of the 15 episodes presented a 5-minute movie with one emotion emphasized. These emotions were *happy, sad, angry, disgusted,* *afraid*, *surprised, excited, unfriendly, tired, sorry, kind, proud, jealous, joking and ashamed.*

The setting for the eight train characters in *The Transporters* created by Golan et al. (2010) was a boy's bedroom. Ethnic background, age, and sex were varied across the characters in an attempt to increase generalization to multiple examples in the natural context. The mouths of the characters were static, and the voices were narrated in order to encourage focussing on the entire face instead of the mouths (Golan et al., 2010).

Children may watch *The Transporters* entire DVD in order, or select preferred episodes. There were quizzes with two levels of difficulty. The DVD guide was intended for use by parents to increase the effectiveness of the intervention, such as using repetition by repeating episodes, encouraging attention to the characters and their faces, and by asking the children questions following watching the DVD.

Dependent Variables

Emotion recognition (static)

This measure required the participants to look at a card and name the emotion depicted on the face of a train. For each emotion, the twins were shown 1 of 5 cards, and each card had a picture of one of eight different train characters. The emotions tested each session were *happy, sad, excited, surprised, angry, afraid, tired, disgusted, and sorry*. Each participant was asked "How does he/she feel?" while the pictures were held up in front of them one at a time. The results were recorded as percent accuracy.

Emotion recognition (dynamic)

The second dependent variable was the ability of the participants to recognize emotion recognition probes conducted regularly by showing videos of emotional expressions to the participants from the Mind Reading Emotions Library (Golan & Baron-Cohen, 2006). This database contained short videos of different people displaying the emotional expressions targeted for intervention in this study. All testing was video-taped to produce a permanent product that could be used for inter-observer reliability calculations and further qualitative data collection.

Procedures

Establishing baseline scores for the participants consisted of testing the participants with flashcards of *The Transporters* characters prior to initiating the intervention without providing any feedback on their responses.

Baseline emotion recognition ability for Myles occurred over 14 sessions. Scores remained near zero for most of the emotions shown on flashcards except *angry* that he labelled as *mad*. The first target emotion chosen for Myles was *happy*, therefore the intervention would consist of watching the episode, “The Transporter’s Happy Day” each session.

Baseline emotion recognition for Ben occurred over 17 sessions. He was able to label the flashcards of the characters for the emotion, *happy*, 100% of the time, and sad fluctuated from 80-100%. Since Ben was able to label *happy* and *sad* consistently, the emotion chosen as the first target for intervention for Ben was *angry*, with the DVD episode chosen to teach this emotion was “Nigel’s Slow Day”.

Intervention

Following establishing baseline scores for the participants of this study, the participants watched a portion of *The Transporters*. Two episodes of approximately 5 minutes in length were reviewed each day be each participant without the twin brother present. One episode had animated characters demonstrating primarily the target emotion. The second episode showed characters demonstrating other non-target emotions. This decision to show one episode focussing on the target emotion each session was intended to increase the likelihood that the participants would learn to recognize the emotional expressions modelled by the animated characters through repetition.

Intervention + Prompting

If learning was not demonstrated during the unprompted, passive viewing of *The Transporters,* the investigator included prompts to support labelling the target emotions. These prompts were written words on flashcards that were shown to the participants when the emotion was displayed on the screen during viewing *The Transporters*. By holding the card up to the computer screen, the participants did not have to look away from the screen and were expected to maintain their attention to the DVD. The two participants were able to read the words aloud, as they had learned many sight words during previous interventions and at school. Social reinforcement was provided by the investigator for unprompted trials.

Treatment Integrity

Data sheets for this study included the date and time of the intervention. Any inattentive behaviours were noted for each intervention sitting. The efficacy of prompted sessions were documented by recording trial by trial data. The trial by trial data sheets were prepared in advance to allow the investigator to indicate by a plus or minus sign or a "p" for prompted trial in sequential order.

Inter-observer Reliability

Inter-observer reliability was calculated by having a trained observer collect data while watching the videotapes of the participants testing sittings. The trained observer was a certified teacher working as a resource teacher at Vancouver School Board. Training consisted of demonstrating the use of the data collection sheets and practicing with one sitting of a videotaped session.

Inter-observer reliability data was collected for 10% of the testing sessions, and calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Results were 99.4% reliability for Myles (range 97.7% - 100%), 97.7% for Ben (range 95.5%-100%), with an overall average of 98.6%.

Results

Myles

Myles did not demonstrate learning of the emotional expressions of *The Transporters* characters on static flashcards during this experiment (See Figure 1). This participant's baseline scores for all emotional expressions from session 1 to 14 were consistently at zero. These scores did not increase during the first intervention of passive viewing of *The Transporters* from session 15 to 21. Furthermore, the use of sight word prompts in sessions 22 to 35 did not result in increased scores when tested the following day with static flashcards of *The Transporters* characters.

Immediately after initiation of sight word prompting teaching sessions, Myles' correct and unprompted response scores for verbally identifying the emotion, *happy* on the faces of *The Transporters* trains, increased from 19% in the first session to 81% in the second session, and then was maintained for 9 sessions at a mean score of 94.8% (See Figure 2). This trend remained stable except for a drop in score to 71% on session 34. However, the following day, without prompting, Myles could not recognize static flashcards with faces depicting emotions. He continued, as in the baseline conditions, to label most flashcards as *mad*.

Following prompting the emotional expression *happy* using the sight word cards with *The Transporters*, Myles scores for recognizing the expression *happy* during generalization probes increased from zero to 100%. These probes were conducted by presenting to Myles a moving face from the videos found in the Emotions Library from the computer intervention program *Mind Reading* (See Figure 1).

Ben

Ben did not demonstrate mastery of identifying the emotional expression *angry* during the unprompted or prompted intervention (See Figure 1). His scores ranged from 0 to 60% throughout the baseline sessions 1 to17, the passive viewing of *The Transporters* from sessions 18 to 25, and during sight word prompting from sessions 25 to 35.

During teaching sessions with prompt sight word flashcards, Ben was able to label the emotional expression *angry* when looking at *The Transporters* characters on the DVD at a mean of 96.5% unprompted with a stable trend for 10 sessions (See Figure 2).

Ben was not able to consistently label the emotion *angry* when watching the faces in the Emotions Library from *Mind Reading*. The trend was unstable and generalization scores varied from zero to 100%.

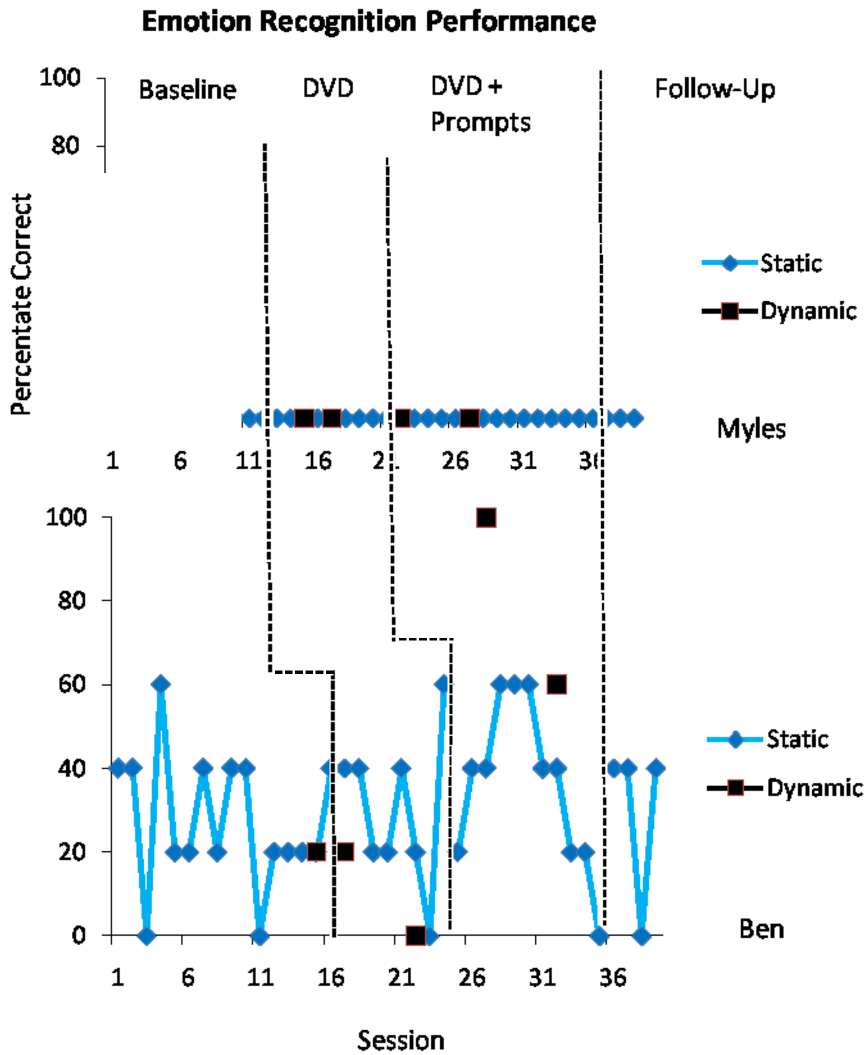

Figure 1: The percentage of correct responses using static flashcards of The Transporters characters and dynamic videotaped faces from The Emotions Library

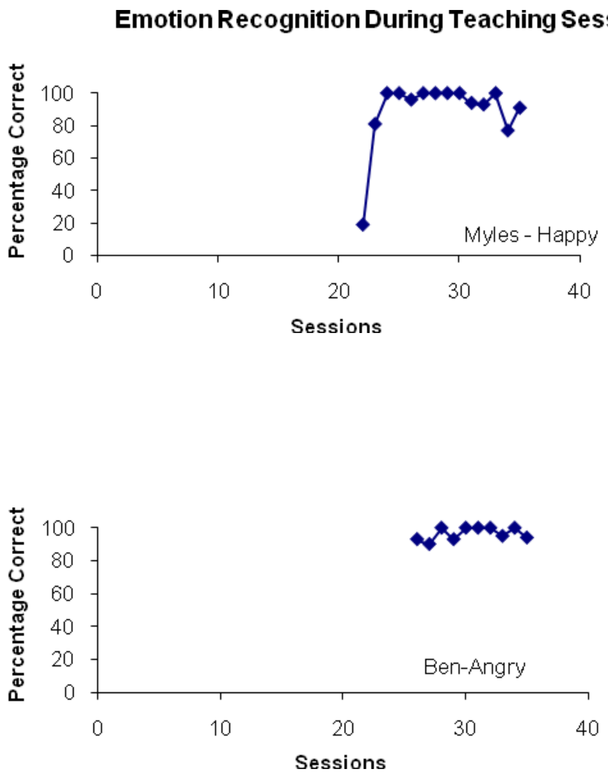

Figure 2: The percentage of correct responses as an emotion recognition measure during teaching sessions using The Transporters as testing stimuli.

During the passive viewing of the entire *The Transporters* DVD, Myles did not demonstrate learning of emotional expressions not targeted for intervention. These emotional expressions probed each session were *sad, surprised, afraid*, and *disgust*. Myles watched one episode of *The Transporters* each session following the episode repeatedly shown with the target emotion, *happy*. Myles labelled the emotional expression *sad* four times at 20% correct during the study baseline phase (See Figure 3). Since Myles had a tendency to label all emotional expressions as *mad*, high scores were collected for this. *Surprised, afraid* and *disgust* were never labelled correctly by Myles.

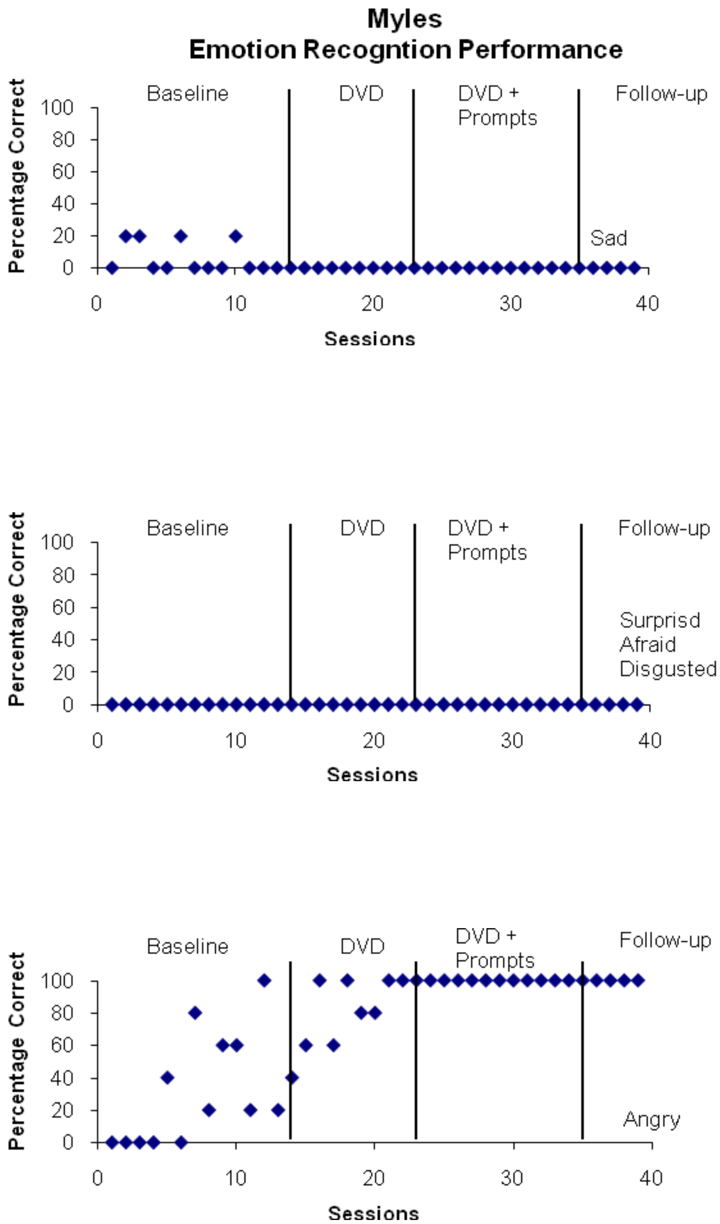

Figure 3: The percentage of correct responses as an emotion recognition measure for Myles using static flashcards of The Transporters characters for emotions not targeted for intervention

Ben also did not demonstrate learning of the non-target emotions *surprised, afraid*, or *disgusted* during passive viewing of *The Transporters* entire series of scenarios, one episode each session (See Figure 4). Ben randomly labelled *surprised* between zero and 60% correct throughout the baseline and intervention, with decreased numbers of times that he labelled this emotion when the intervention was near completion.

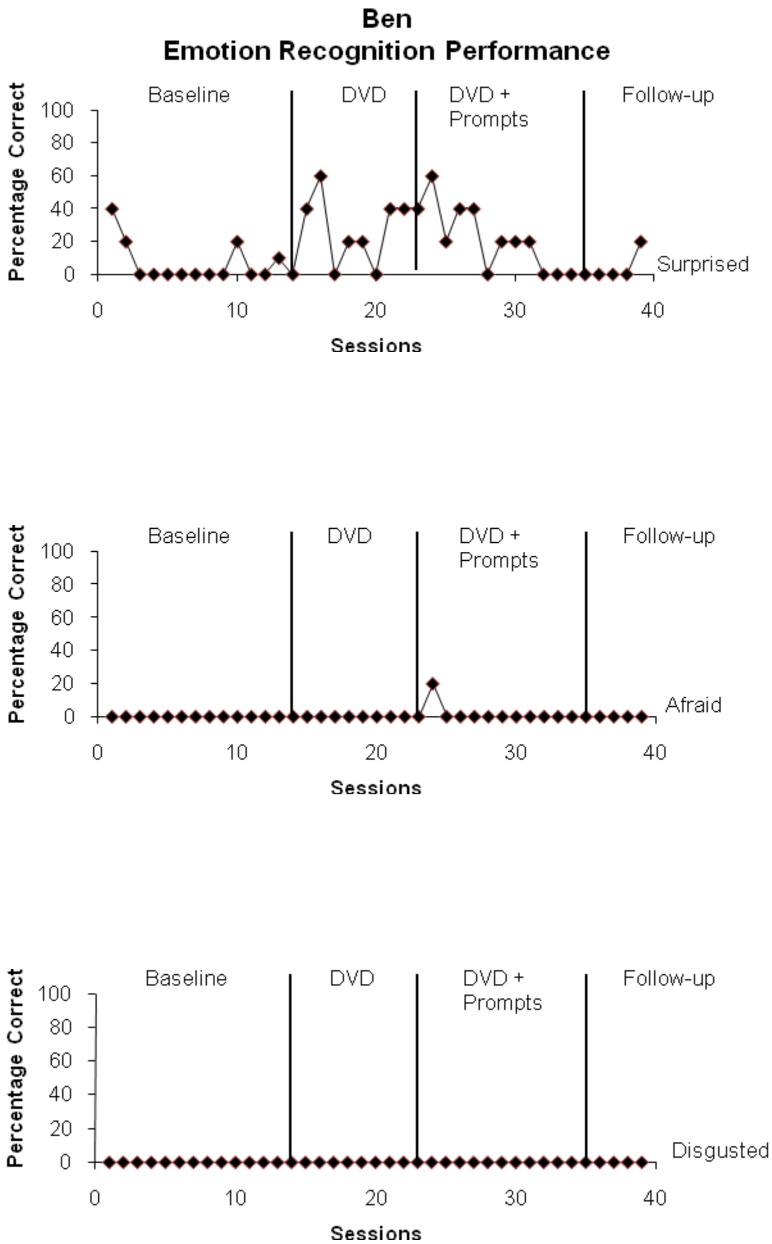

Figure 4: The percentage of correct responses as an emotion recognition measure for Ben using static flashcards of The Transporters characters for emotions not targeted for intervention

Discussion

This study was conducted to determine if twin adolescents with autism and severe communication difficulties could learn by passive viewing of *The Transporters*. The findings of this experiment were that the 2 adolescent participants did not learn emotional expressions effectively when they passively watched or when given prompts to draw attention to the stimuli in *The Transporters*. These results were consistent with studies that found that children with autism have difficulty recognizing basic emotions (Celani, et al., 1999; Davies, Bishop, Manstead, & Digby, 1994; Gepner, et al., 2001; Gross, 2004; Hobson, 1986).

Several inconsistencies were noted between the results of this study and previous research results. *The systemizing theory of autism* was not supported by the results of this study, as the participants did not learn emotion recognition skills by viewing the predictable trains on tracks in *The Transporters* as suggested by Golan et al. (2010). There was no specific difficulty noted with recognizing the emotional expression *surprised* as was found in the study by Baron-Cohen et al. (1993). Finally, since children with autism have been found to analyze facial expressions by attending to the mouth area (Joseph & Tanaka, 2003; Langdell, 1978), and the mouths do not move during *The Transporters*, it was not clear what the participants were attending to during this intervention.

Possible explanations for the lack of learning emotion recognition skills by the participants in this experiment are that they were attending to the trains in *The Transporters* instead of the faces embedded in them. It was noted during the intervention that the participants named the trains spontaneously although they did not demonstrate an ability to label the emotional expressions on static flashcards. Including an eye-gaze direction software program to this intervention would have been useful to determine what the participants were attending to when watching *The Transporters*.

The issue resulting from this experiment is whether more explicit, structured and theoretically-based ABA teaching techniques can improve emotion recognition among adolescents with autism with severe communication difficulties.

Experiment 2: General Case Analysis Intervention

Rationale

General case analysis is a research-supported method used to teach individuals with developmental disabilities new behaviours and enhance generalization to novel stimuli and settings. This is accomplished by systematically including examples of stimuli that are expected to evoke correct responding in the natural environment (Cooper et al, 2007). General case analysis requires studying the individual to determine what types of stimuli will result in successful generalization. A complimentary technique is to teach non-examples of stimuli at the same time.

An example of both general case analysis and teaching non-examples is the choice of stimuli when teaching a student with autism to greet peers appropriately at school. A reasonable number of peers for the student to greet should be included during this intervention. This will increase the possibility that the student will greet peers that were not used for teaching purposes. Furthermore, the student should be taught when it is not appropriate to greet people, such as when approaching strangers walking on the street.

In the first experiment, the child participants were not able to generalize emotion recognition ability from *The Transporters* characters on the computer screen to the static flashcards used for testing and data collection. This indicated that generalization of emotional expressions was difficult for the participants. Therefore, in an attempt to increase the possibility of generalization, the investigator included the theoretically based method, general case analysis in Experiment 2. Furthermore, since the participants often identified several emotional expressions with the same label, the investigator decided to include the teaching of non-examples. By including both general case analysis and the teaching of non-examples, it was expected that an increase in emotion recognition intervention effectiveness for the two child participants would occur when compared to the first intervention.

Research Question

Does including general case analysis and the teaching of non-examples increase the effectiveness of an intervention designed to teach emotion recognition skills to adolescents with autism and severe communication deficits? In Experiment 1, it was found that, with or without additional prompts, *The Transporters*, a DVD initially produced for high functioning children with autism, was not an effective teaching tool for the 2 adolescent participants, with or without additional prompts. The hypothesis posited is that an individualized intervention based on general case analysis will be more effective in teaching emotion recognition to the adolescent participants with autism and severe communication difficulties.

Method

Participants

The participants for Experiment 2 were the same as for Experiment 1. The twin boys were 15 years and 2 months of age at the initiation of the intervention in this study.

Procedure

Multiple Baseline Research Design

A multiple baseline research design across participants and teaching targets was used for this second experiment. The phases for this experiment were baseline, intervention with prompts (DTT), and follow-up. Baselines were extended across participants for the first target emotional expression, and then each baseline was extended as additional targets were introduced. The participants were taught emotional expressions that they were not capable of identifying or generalizing prior to the initiation of the intervention.

What to Teach

In order to determine potential teaching targets for Myles and Ben, it was important to identify all examples of emotional expressions that they would be expected to recognize in the natural environment. After discussing this with the participants' parents, it was determined that they should be recognizing emotions of all family, friends, their selves, and all strangers.

For teaching purposes, it was necessary to choose a reasonable number of examples of emotional expressions. For both Myles and Ben, emotional expressions of both of them, their father, mother, nanny, and two strangers were chosen. For Myles, the targets *happy*, *sad*, and s*urprised* were taught one at a time in this order. Ben was taught to recognize *surprised* and *afraid*.

To ensure that the child participants were able to distinguish emotional expressions from other facial movement, they were taught to identify actions at the same time as the emotional expression targets. The actions were considered negative examples that they were both expected to discriminate from emotional expressions and included *sleeping*, *sticking out tongue*, and *kissing*.

How to Teach

Short video clips of Myles and Ben, their father, mother, nanny, and two strangers were produced for the purpose of teaching the target emotions. The investigator requested that the actors display the emotional expressions *happy*, *sad, angry, surprised* and *afraid* and the videos were taped separately for each emotion. The actors were then requested to demonstrate the actions that were considered negative examples, and these actions were taped separately. This allowed the investigator to teach each emotion and action individually. The actors were shown in random order each session to avoid any pattern effects.

The teaching technique used was discrete trial teaching. This required displaying the target emotion repeatedly on the video with prompting until the participant was able to identify the emotion independently without prompts. The investigator verbally prompted the participant with the correct answer. When introducing a new emotion target, the investigator prompted for four trials prior to attempting an independent trial without prompting. Once the participant obtained 80% correct during the teaching session for the first target, the second target was introduced. Targets were considered mastered when the participants identified them correctly 80% or 100% during testing for two days. Testing occurred at the beginning of the following session to ensure that newly acquired knowledge was retained.

Testing consisted of asking the participant “How does he/she feel?” while showing the videotape of the emotional expressions of the actors in random order. To calculated the percentage of correct responses, five trials of correct or incorrect responses were totalled and converted to a percentage.

During the same session as teaching the target emotion, a non-example of an emotion, an action such as sleeping, was introduced in an effort to increase the participants’ ability to discriminate between emotions and actions. The target was introduced using the same teaching strategy as the emotional expressions.

Generalization Probes

Following the completion of the teaching sessions, the child participants were tested for generalization ability by having them label emotional expressions from the Emotions Library from *Mind Reading*, static pictures of *The Transporters* characters and static pictures of the actors in the video intervention. When testing with the Emotions Library, the volume on the computer was muted, as the emotions are identified verbally when the pictures and short videos are displayed by the program. Also, a blank flashcard was used to hide the written words on the screen of the Emotions Library, as the participants were able to read many words.

Inter-observer Reliability

Data were collected for determining inter-observer reliability using the trained observer from Experiment 1. This certified teacher from Vancouver School Board watched the video tapes of testing sessions and recorded her findings. The same data collection sheets and collection methods from Experiment 1 were used for the present study, therefore, additional training was not required.

Inter-observer reliability data were collected for 10% of the testing sessions, and was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Results were 97.5% reliability for Myles (range 90%- 100%), 97.4% for Ben (range 85.0%-100%), with an overall average of 97.4%.

Results

Myles learned to recognize the expressions *happy, sad* and *surprised* during this second experiment (See Figure 5). Following the four baseline sessions, the intervention was introduced, and Myles correct responses increased immediately to 100% when he attempted to identify the emotional expression, *happy*. After one session the correct responses for *happy* decreased to 60%, then returned to 100% for four sessions and was considered mastered. However, this ability to identify *happy* dropped to zero for two sessions (sessions thirteen and fourteen), following the introduction of the emotional expression, *surprised* at session eight. Although Myles labelled *happy* as *surprised* for two sessions, he began to discriminate between the two and eventually his scores for *happy* reached 100% and this trend was stable for over 10 sessions, including the five sessions of follow-up. An increase in scores was found for *surprised* from session eight until session 23, with a mean score of 58.7%. Although the correct responses for *surprised* reached 80% three times and 100% once, the trend was unstable. Following demonstrating mastery of *surprised*, Myles correct responses dropped for one session to 60%, then returned to 100% throughout follow-up. Myles mastered the emotional expression *sad* three sessions after introduction of this target, and the correct responses did not drop below 80% and remained at 100% to the end of follow-up.

Myles
Emotion Recognition Performance

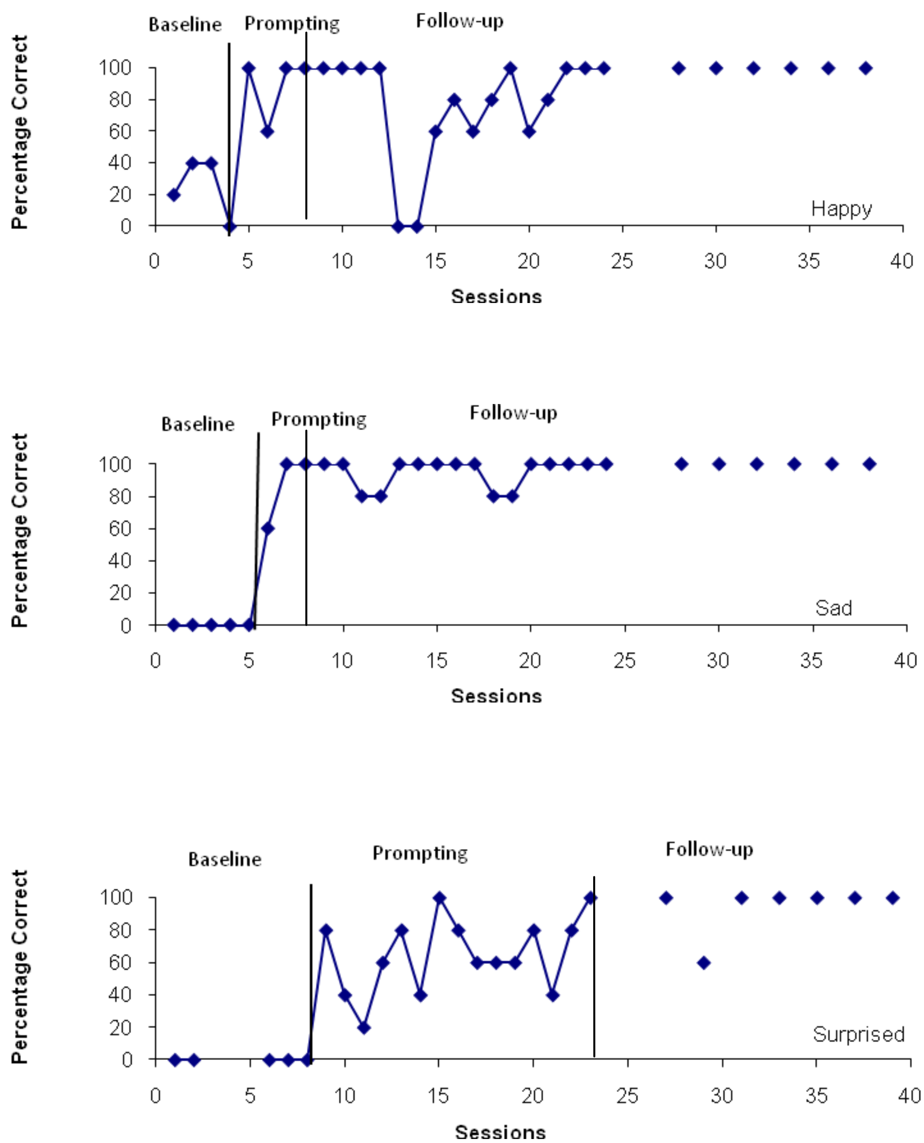

Figure 5: The percentage of correct responses as an emotion recognition measure for Myles using videotapes of emotional expressions taped by the investigator

Myles was able to generalize his recognition of the emotional expressions *happy* and *sad* using the Emotions Library pictures as stimuli (See Figure 6). He was not able to consistently generalize the emotional expression *surprised* using this stimuli.

Myles did not consistently demonstrate an ability to generalize identification of the emotional expressions *happy, sad* or *surprised* when tested with the static pictures of *The Transporters* characters used as stimuli for Experiment 1 (See Figure 7). His correct response scores for *happy* and *sad* were higher than during Experiment 1, but were not consistently at the mastery criterion of 80%.

Myles was able to demonstrate generalization of his recognition of the videotaped emotional expressions to static pictures taken from the video for *happy*, *sad* and *surprised* (See Figure 8).

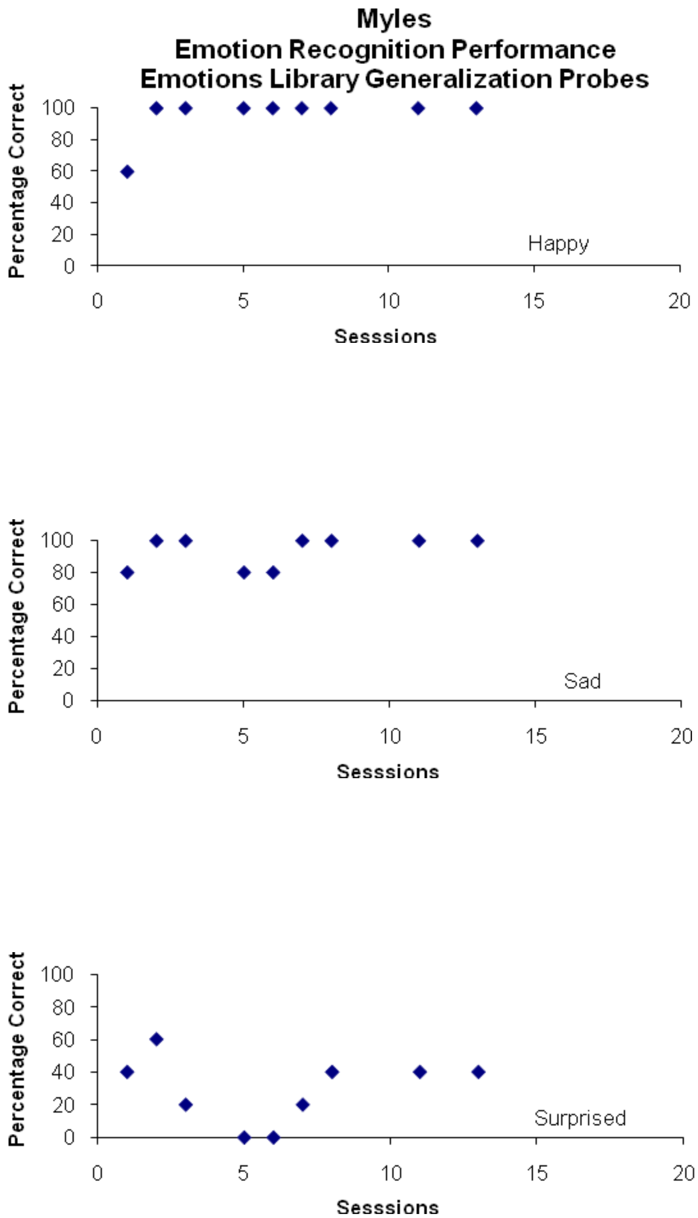

Figure 6: The percentage of correct responses as an emotion recognition measure for Myles using The Emotions Library as stimuli during generalization probes

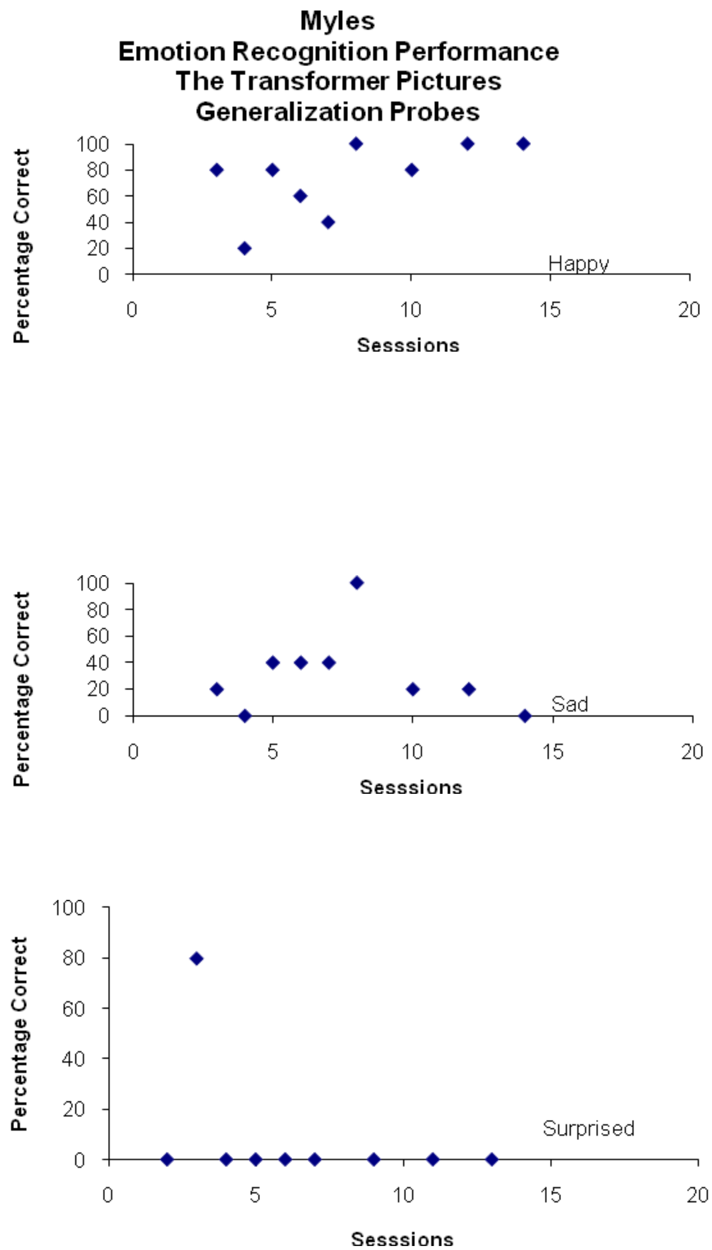

Figure 7: The percentage of correct responses as an emotion recognition measure for Myles using The Transporters character pictures as stimuli during generalization probes

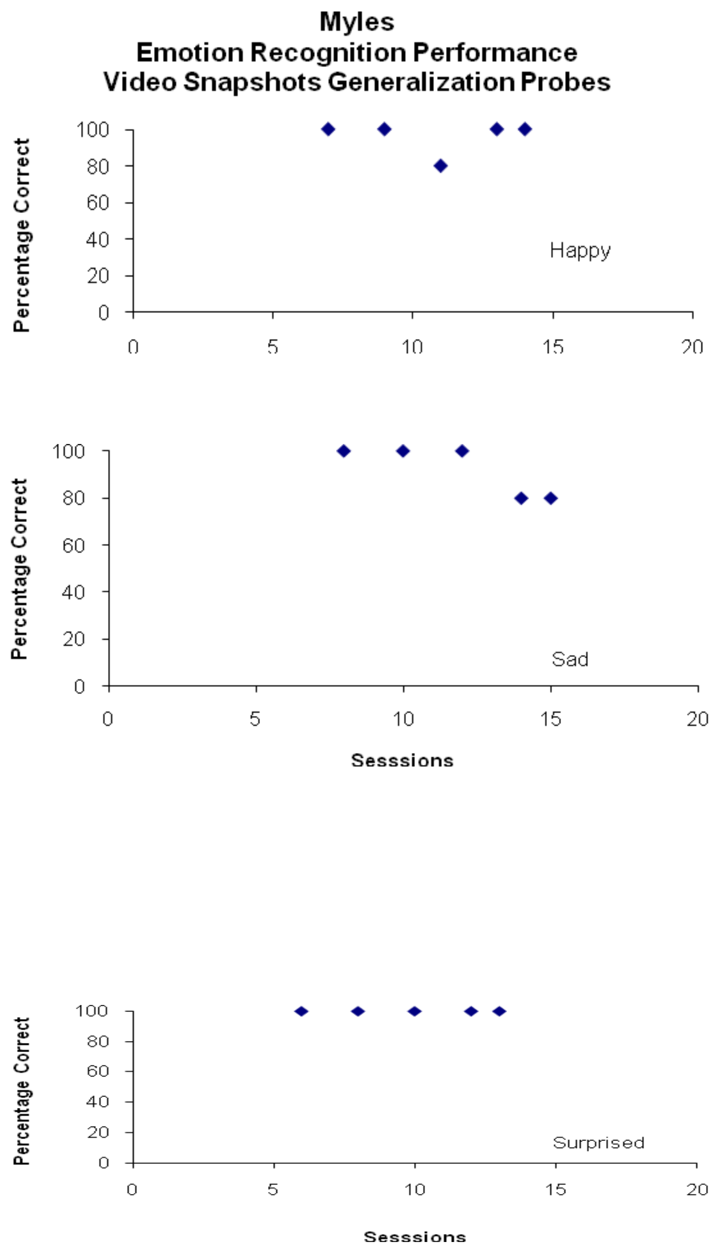

Figure 8: The percentage of correct responses as an emotion recognition measure for Myles using static pictures from the intervention videotapes as stimuli during generalization probes

Ben demonstrated mastery and maintenance for identifying the emotional expression, *surprised* during this experiment (See Figure 9). Following a decrease in correct responses during baseline from 60% to 20%, there was an unstable trend including an increase in correct responses from 20% at session eight to 80% at session 15 and 100% at session 16, indicating mastery of *surprised*. However, a second unstable trend followed mastery of *surprised* with a decrease in scores to 40% at session 20 and an increase to 100% session 23. There was a stable trend from session 23 to session 40 with scores remaining between 80% and 100%.

Ben did not demonstrate mastery of the emotional expression *afraid* during this experiment. Although Ben's scores increased for the emotional expression, *afraid* following the initiation of the intervention from 20% at session 16 to 100% at session 20, this trend was followed by a decrease in scores to 40% at session 21 and fluctuated between 60% and 80% for the remainder of the study. Therefore, Ben did not maintain consistent scores of at least 80% for two sessions in a row required to demonstrate mastery of *afraid*.

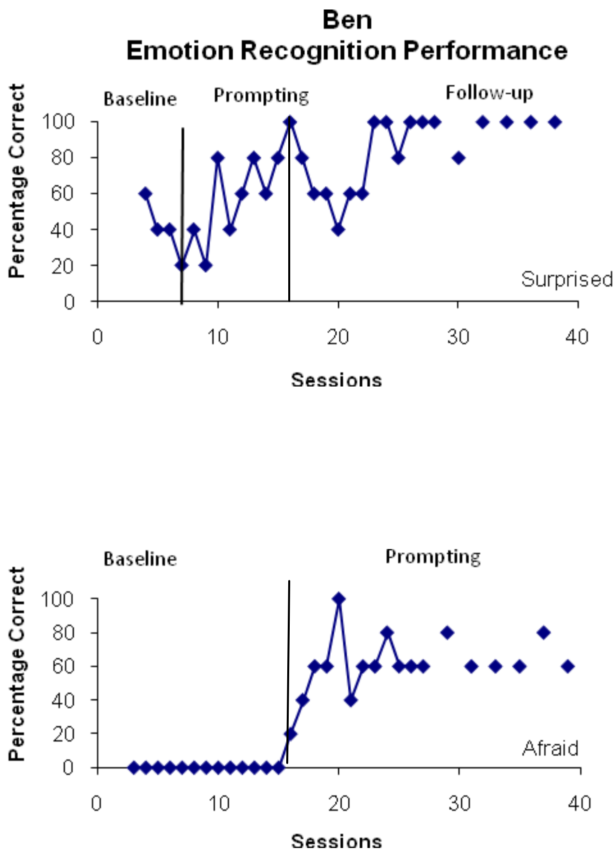

Figure 9: The percentage of correct responses as an emotion recognition measure for Ben using videotapes of emotional expressions taped by the investigator

Ben did not demonstrate a consistent ability to generalize his knowledge of the emotional expression, *surprised* when using the Emotions Library as stimuli (See Figure 10). There was more consistency noted in Ben's generalization scores when *The Transporters* characters were shown to him as static pictures from Experiment 1 (See Figure 11), and when he viewed static pictures taken from the videotapes of the actors from this intervention experiment (See Figure 12).

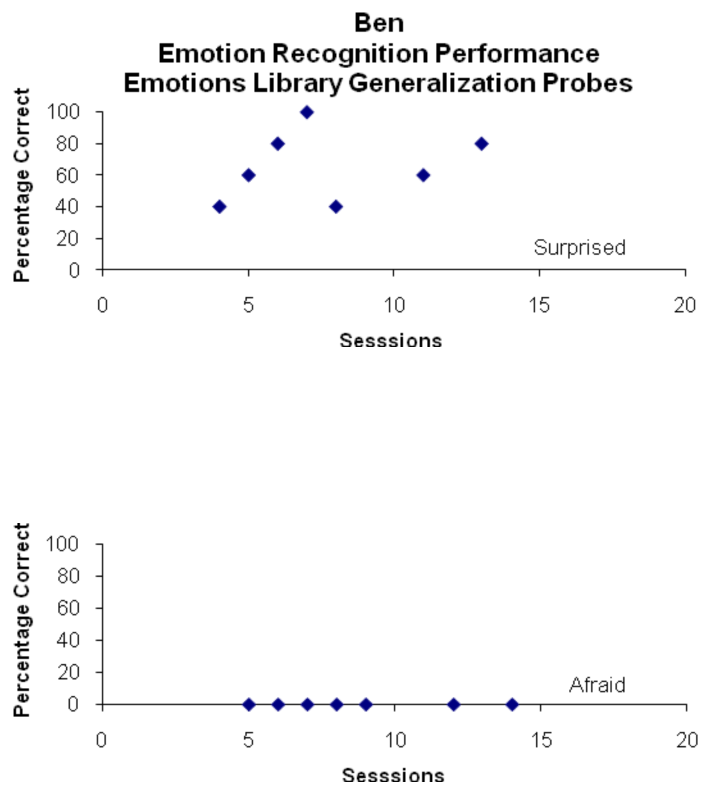

Figure 10: The percentage of correct responses as an emotion recognition measure for Ben using The Emotions Library as stimuli during generalization probes

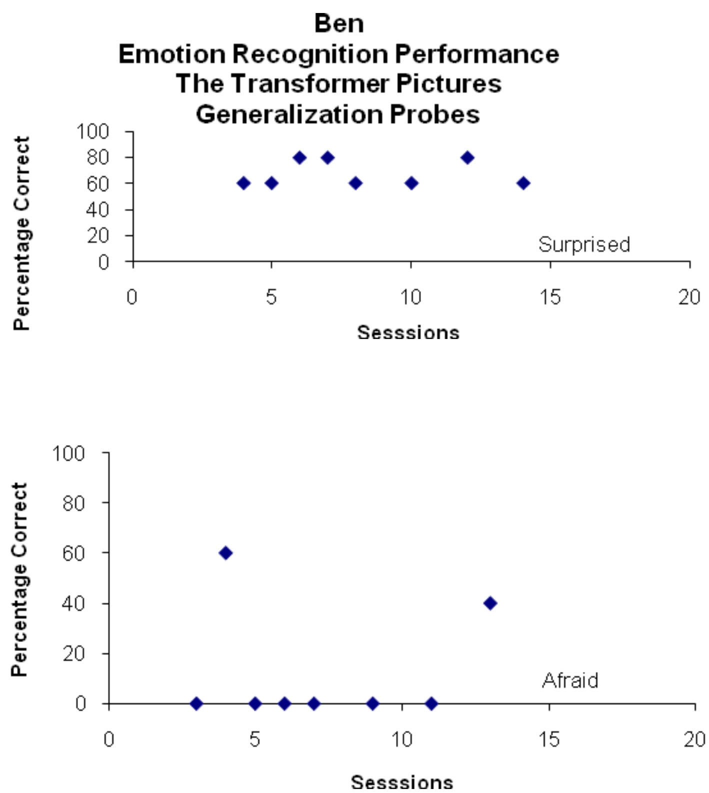

Figure 11: The percentage of correct responses as an emotion recognition measure for Ben using The Transporters character pictures as stimuli during generalization probes

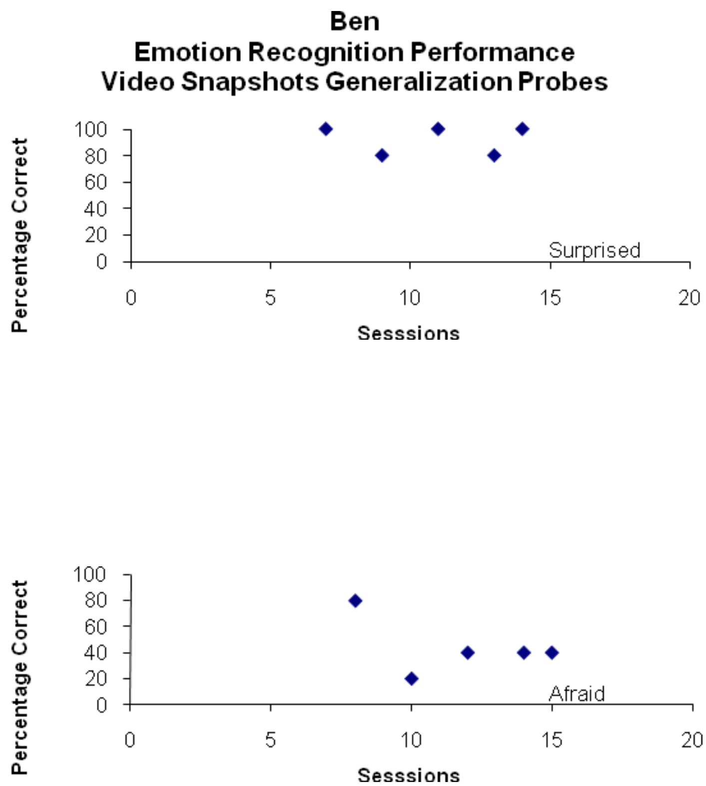

Figure 12: The percentage of correct responses as an emotion recognition measure for Ben using static pictures from the intervention videotapes as stimuli during generalization probes

Discussion

This experiment was conducted to determine if a computer presented intervention including general case analysis would be effective for teaching adolescents with autism and severe communication difficulties emotion recognition skills. When compared to the first experiment results, the twin participants learned more effectively during this computer-displayed intervention.

Following the intervention in this experiment, Myles demonstrated an ability to recognize the expressions *happy*, *sad* and *surprised*. Although there were a few sessions that Myles labelled *happy* as *surprised*, this mistake was quickly resolved, and *happy*, *sad* and *surprised* were maintained at mastery level of over 80% through the experiment follow-up.

Myles demonstrated generalization to the novel stimuli, the Emotions Library from *Mind Reading*. Although generalization to novel stimuli did not occur during the first experiment, Myles could recognize the emotional expressions *happy* and *sad* when watching the Emotions Library short videos. However, Myles was not able to demonstrate consistent generalization ability for the emotional expression, *surprised*. Previous research has supported the finding of the difficulty that children with autism have recognizing the expression *surprised*. This may have been due to Myles' stage of development, as typically developing children under the chronological age of 5 years of age have demonstrated similar challenges recognizing *surprised*, and confuse this emotional expression with *fear* (Castelli, 2005).

When generalization was tested using the static pictures, Myles demonstrated the ability to label emotional expressions from pictures of the videotaped actors, but not *The Transporters* characters from the first experiment. This supports the possibility that Myles did not attend to the expressions of the train characters in Experiment 1. Although human faces were embedded into the animated trains, Myles was unable to recognize the expressions of the characters. However, this ability was demonstrated when Myles identified the facial expressions of *happy*, *sad*, and *surprised* of the videotaped actors in static pictures.

Ben also responded to this intervention with greater demonstration of learning emotional expression recognition than in *The Transporters* intervention in Experiment 1. Ben demonstrated mastery and maintenance of recognition of the expression, *surprised*, during this experiment. However, after several weeks of intervention, Ben did not demonstrate mastery of the emotional expression *afraid*. Research has indicated that individuals with autism have difficulty discriminating between the emotional expressions surprised and afraid (Castelli, 2005). This study supports these findings.

Generalization scores for Ben were consistent when viewing static pictures of the emotional expression, *surprised*. This ability to recognize *surprised* was found with both *The Transporters* character pictures from Experiment 1, and pictures of the emotional expressions of the actors in this experiment. When compared to Myles inability to identify emotional expressions from *The Transporters* character pictures during this experiment, Ben may have used the strategy of looking at the characters mouths, while Myles did not. Developmentally, the use of the strategy of focussing on one feature of the face is found in young children, while older children use a holistic strategy

(Schwarzer, 2002; Bruce, Macrae, Cole-Davies & Dias, 2003). Determining the strategy that Myles and Ben used could have been explored by including identification of inverted faces (Langdell, 1978), or sorting by single or multiple attributes of the face (Schwarzer, 2002).

Although capable of generalizing to the two sets of static picture stimuli in this experiment, Ben was not able to recognize *surprised* with the short videos from the Emotions Library from *Mind Reading*. This contrasts with previous research findings that children with autism find facial motion to enhance the ability to recognize emotional expressions (Gepner et al., 2001). Further exploration of Ben's strategies used during emotion recognition, such as determining the areas of the face that he focused on, would be necessary to explain these results.

The results of this study support the use of computer-displayed interventions when teaching emotion recognition skills to individuals with autism. This has been found in previous studies in this area of research (Ayres & Langone, 2005; Charlop-Christy, Le, & Freeman, 2000; LeBlanc et al., 2003; Maione & Mirenda, 2006; Nikopoulos & Keenan, 2004).

These findings do not support the tenants of *the systemizing theory of autism* suggested by Golan et al. (2010). Golan et al. argued that the interest that children with autism have in systems such as trains on tracks could enhance the development of emotion recognition skills because emotional expressions were embedded in the train characters in *The Transporters*. This fascination with predictable systems was expected to increase the childrens' attention to the emotional expressions. Watching these train characters with emotional expressions labelled during the narrative was expected to increase the ability of children with autism to recognize these expressions. However, although highly interested in trains, the participants in this study learned much more effectively when watching human actors displayed on a computer screen than when watching faces on animated trains. It is possible that the train faces were not the part of the computer display that these participants attended to during the first experiment.

Limitations

This study was conducted with 2 participants, therefore, it is not possible to generalize to other adolescents with autism and severe communication difficulties. Cases of autism differ widely in characteristics (APA, 2000), and in patterns of strengths and deficits (Maurice, Green & Luce, 1996; Teunisse & de Gelder, 2003; Quill, 2000).

The adolescents with autism in this study were cooperative and demonstrated minimal interfering behaviours during the 2 experiments. Individuals with autism engaging in more severe behavioural symptoms may have demonstrated different responses to the intervention.

Generalization to new environments, such as school and day camp, is necessary to determine if the newly acquired knowledge of emotional expressions will be used in the participant's natural environment. Anecdotal evidence indicated that the twin participants recognized emotional expressions of their teachers and parents more often after the intervention was completed. It is important that this ability to recognize emotional expressions be used during social interactions with peers. This may require additional intervention with the use of prompting and feedback to encourage the use of emotion recognition to direct conversation skills.

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