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A Comparison of Two Computer-Based Programs Designed to Improve Facial Expression Understanding in Children with Autism:

by

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Abstract

This randomized clinical trial compared models used to explain facial expression understanding difficulties experienced by individuals with autism. The intervention effects of two computer-based training programs, *The Transporters* and *Let's Face It!* were investigated in young children with autism (N = 21), aged 4-8 years old. *The Transporters* is an animated series designed to enhance emotion comprehension informed by Theory of Mind and Extreme Male Brain theories. *Let's Face It!* has seven interactive games designed to improve children's visual face perception strategies and is informed by Weak Central Coherence theory. Children were assessed on measures before and after 20 hours of intervention. Compared to children randomized to a no treatment control group (n = 7), children receiving *The Transporters* training (n = 8) or *Let's Face It!* program (n = 6) experienced no significant improvement. Verbal ability and age of participants was linked to performance on the facial understanding measures.

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Introduction

Autism Spectrum Disorder (ASD) is a pervasive developmental disorder marked by qualitative impairment in social interaction (American Psychiatric Association, 1994). Studies suggest that individuals with ASD struggle to gather emotional meaning from the faces of others (Celanie, Battachi, & Arcidiacono, 1999; Golan, Baron-Cohen, & Golan, 2008; Gross, 2004; Hobson, 1986) and it is speculated that these face-based impairments underlie the wide-ranging social-emotional-communicative deficits that traditionally mark the condition (Schultz, 2005). Drawing upon cognitive theories of autism, efforts have been made to develop effective computer-based training interventions. The present study compared two such programs that aim to improve facial expression understanding in children with ASD.

Facial Expression Understanding and Typical Development

Study of facial expression understanding is not an exclusively modern phenomenon. Darwin (1872) was the first to argue that certain emotional expressions are innate and the same for all people. His arguments were, however, largely ignored by the scientific community until a seminal paper published in the late 1960s (Ekman, Sorenson, & Friesen, 1969). In this research, drawing from a small set of basic emotions (anger, disgust, fear, happy, sad, and surprised), college-educated adults in Brazil, the United States, Argentina, Chile, and Japan, and non-college educated adults from preliterate indigenous cultures in Borneo and New Guinea were all shown to agree on how to correctly label both posed and spontaneous facial expressions. Regardless of cultural and educational background, the adults demonstrated a striking resemblance in their interpretation and understanding of facial expressions.

Perhaps unsurprisingly, the study was met with initial skepticism. The results were contested on the bases that members of the compared cultures all had previous exposure to mass media portrayals of facial expressions. To counter these criticisms, Ekman and Friesen returned to the remote South East Highlands region of New Guinea where previously isolated indigenous inhabitants were recruited and studied (Eckman & Friesen, 1971). Lacking any prior exposure to mass media, a story was told to consenting male and female adults (n = 189). From a set of three Western-based facial expressions, they had to choose the face that correctly matched each emotion appropriate to the story. Their responses were compared to members from the same indigenous culture (n = 23 male adults), but who were literate and Westernized. The results for the most Westernized male adults were almost exactly identical as those reported for the least Westernized male and female adults. There were, however, instances of failure to select the correct picture when fear was to be distinguished from surprise (Eckman & Friesen, 1971). Twice, fear was not discriminated from surprise, and once, surprise was chosen more often than fear from a story that intended to describe fear. However, when the number of correct responses was totaled for each subject, T-test comparisons showed no significant differences between the most and least Westernized adults.

This early work by Ekman and Friesen (1971) was important because it established a set of *six basic emotions* that is universally perceived by humans regardless of culture. This finding was foundational to later research that sought to understand the developmental progression of facial expression understanding. While newborn infants exhibit innate preferential orientation towards human faces, the ability to view the face and accurately interpret facial expressions develops gradually, with abilities typically emerging throughout childhood and well into adolescence. (Camras & Allison, 1985; Felleman, Barden, Carlson, Roesenberg, & Masters, 1983; Herba & Phillips, 2004; Kolb, Wilson, & Taylor, (1992). Based on extensive research in this area, two key variables have been linked with facial understanding performance: chronological age and verbal abilities.

Influence of chronological age. Age has been identified as a significant moderating variable in facial expression understanding with older children outperforming younger children (Felleman et al., 2004; Herba, Landau, Russell, Ecker, & Phillips, 2006; Tracy, Robins, & Lagattuta, 2005). Infants as old as a few months discriminated happy and sad faces from surprised faces (Herba & Phillips, 2004). Children typically have a very accurate understanding of happiness by age two (Smiley & Huttenlocher, 1989), followed by an accurate understanding of sadness by age three (Tracy et al., 2005). By ages four to five, children can typically identify all of the basic six emotions with some developmental discrepancies (Camras & Allison, 1985; Felleman et al., 1983; Herba, & Phillips, 2004). While children aged four to five very accurately identify happiness and sadness, they identify surprised, fearful, and angry less accurately, and identify disgust the poorest (Camras & Allison, 1985). In the same age frame, young children also begin to expand in their comprehension of facial expressions beyond the basic six emotions (Tracy, Robins, & Lagattuta, 2005). They increasingly demonstrate an understanding of more complex emotions such as pride and shame (Tracy et al., 2005). By age seven, children are typically identifying these more complex emotions as accurately as they are recognizing happiness (Tracy et al., 2005).

Kolb, Wilson, and Taylor (1992) revealed that facial expression understanding continues to develop into adolescence. Using a photograph-matching test (matching faces by shared emotion), and a cartoon face-matching test (matching emotional faces according to a depicted social scenario) adolescents outperformed younger children in accuracy to identify the basic six facial expressions. They speculated that improved accuracy in identifying the basic six facial expressions may be linked to neural growth and maturation in the frontal lobe region of the adolescent brain. In another study, Tonks, Williams, Frampton, Yates, and Slater (2007) demonstrated that a marked improvement in facial expression understanding occurs at roughly 11 years of age. Across three assessment measures, the *Florida Affect Battery: Face Expression tests* (Bowers, Bolder, & Heilman, 1999), *Florida Affect Battery: Vocal Prosody tests* (Bowers, Bolder, & Heilman, 1999), *and The Mind in the Eyes Test* (Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001), children aged under 11 made significantly more errors than children aged over 11 years. These measures went beyond the difficult of simply naming the basic six emotions. While younger children had developed some aspects, older children were better in naming, discriminating, matching, and selecting facial affect; and in reading emotions from the eyes. Tonks et al. (2007) suggested that future studies examine possible cognitive correlates of emotion recognition in children. The works of Kolb et al. (1992) and Tonks et al. (2007) highlight our growing knowledge that facial expression understanding, is incumbent on progressive neural brain development, and continues to improve well into adolescence.

Influence of verbal ability. Facial expression understanding is also influenced by verbal ability with more verbal children outperforming less verbal children (Camras & Allison, 1985; Herba & Phillips, 2004). Language comprehension and the ability to use verbal labels are required to identify one's level of emotional understanding (Camras & Allison, 1985; Herba & Phillips, 2004). Children begin to use emotional words at roughly two to three years of age (Herba & Phillips, 2004; Izard & Harris, 1995). As children expand their emotional lexicon, they are more able to accurately identify a broader range of emotions (Herba & Phillips, 2004). Greater verbal abilities also impact their ability to think abstractly. As children grow older and acquire improved verbal abilities, their ability to conceptualize emotions and feelings improve (Herba & Phillips, 2004).

Facial Expression Understanding In Individuals with ASD

Facial expression understanding is a prerequisite to successful social interactions, communication, and emotional relationships (Schultz, 2005). According to Jemel, Mottron, and Dawson (2006), there are experimental conditions under which individuals with ASD have demonstrated facial perception understanding quite comparable to those without ASD. In one study, children with ASD were matched with other children according to chronological age. Four separate measures were administered to all children. On the first measure, children sorted photographs of faces by their emotions. On the second measure, children chose an emotion while listening to a vocalization. On the third measure, children matched facial expressions with a target face. Finally, mothers completed a 50-item expressive vocabulary questionnaire in which they reported words that their child used. Children with ASD on these measures performed no differently in their understanding of facial emotions (Ozonoff, Pennington & Rogers, 1990).

The majority of researchers, however, have reported facial expression understanding deficits in individuals with ASD (for a review, refer to Dawson, Webb, & McPartland, 2005). For example, one study examined the abilities of children with autism, children with mental retardation, and typically developing children to correctly recognize happy, unhappy, angry, and fear (Hobson, 1986). The children viewed video clips of a person in a social situation eliciting one of the four emotions. They were then required to choose the correct facial expression (drawn by hand, or photographed by a camera) to ‘go with’ the video. Children with ASD performed worse in comparison to both the mentally retarded and typically developing children. They demonstrated marked difficulty when choosing faces to match videotaped expressions and contexts. In another study, children and teenagers with ASD were required to view black and white photos of faces and then match them by emotion (Celani, Battacchi, & Arcidiaconono, 1999). Compared to children with Down Syndrome and typically developing children, children with ASD demonstrated significantly worse performance. In a similar photograph task, children with ASD, mental retardation, language disorders, or non-affected children were shown images of human female, orangutan, and canine faces expressing the emotions of happy, sad, angry, surprised, and neutral (Gross, 2004). While individuals with ASD identified facial emotions at above chance levels, they identified facial expressions less accurately than other children. Though not universally accepted, a large number of studies do indeed suggest the presence of facial expression understanding difficulties in individuals with ASD.

Others point out that fundamentally different face viewing behavior may be the root of facial expression understanding difficulties (Langdell, 1978). In his landmark study, Langdell demonstrated that while children with autism accurately identified photographed faces of their peers, they did so by focusing on the lower halves of faces (mouth and chin), whereas typically developing individuals tended to concentrate attention to the upper halves of faces (eyes, nose, and forehead) (Langdell, 1978). Langdell was the first to suggest that ASD may be characterized by a unique facial viewing style that does not place relevance on eyes; thus, leading to difficulties in gathering social salience and affective meaning from the face (Langdell, 1978). In addition, Langdell made a second considerable discovery. He observed that after inverting photographs and having the faces of peers appear upside-down, the performance of typically developing children was compromised. They had problems when pictures were inverted. On the other hand, children with ASD were not compromised by inversion. Their performance was not negatively influenced by the *inversion effect* (Langdell, 1978). Langdell hypothesized that children with ASD may possess a less well defined or more flexible visual scanning strategy. (Langdell, 1978).

Langdell's pioneering work sparked further exploratory studies. Interested in the newly observed inversion effect, Hobson, Ouston, and Lee (1988) conducted a replication study and confirmed Langdell's inversion effect. Yet, they also enhanced Langdell's work by demonstrating that compared to typical adults, individuals with ASD were superior in identifying facial expressions of inverted faces. While Hobson et al. (1988) were unable to provide an explanatory model for their findings, they shared Langdell's conclusions that individuals with ASD employ qualitatively different face viewing behaviors and strategies. In a further photograph study, Tantam, Monaghan, Nicholson, and Stirling (1989) showed that while children with ASD had difficulty picking the odd person out, discriminating between emotions, and labeling facial expressions when faces were right-side-up, children with ASD performed no worse than typical children when the faces were inverted. Confirming and extending the results of the Langdell (1978) and Hobson et al. (1988) studies, Tantam et al. (1989) speculated evidence of a unique cognitive style specific to individuals with ASD. While advocating for further studies of pattern perception exhibited by individuals with ASD using non-personal stimuli, they also brought attention to work being done by Frith (1982) exploring perceptual strategies employed by individuals with ASD. Still, it was too early to attach theoretical models to the unique face viewing phenomena (attending to the lower halves of faces and having immunity to the inversion effect) being observed by researchers at the time. It is critical to note that samples used in the above studies included children with autism and not children with ASD. Since 1994, however, autism has been recognized as a spectrum disorder, and the umbrella term of ASD has been used to encompass autism, Pervasive Developmental Disorder – Not Otherwise Specified, and Asperger syndrome (American Psychiatric Association, 1994). That said, studies published since 1994 have demonstrated that similar to individuals with Autism, individuals with ASD also experience facial expression understanding difficulties.

Many such studies have utilized eye tracking technology, opening up a whole new paradigm for exploring Langdell’s early findings. Using photographs of faces displaying the basic six emotions (anger, disgust, fear, happy, sad, and surprised), an eye tracking study confirmed that adult males with Aseperger Syndrome (with ages ranging from 19.1 - 30.2 years) attended far more to exterior, and non-affective areas of the face (i.e., to the ears, chin, and hair-line) rather than core social salient areas such as the eyes and nose (Pelphrey et al., 2002). Klin et al. (2002) made similar conclusions after analyzing eye-tracking data from video clips of complex faces in natural environments. Klin et al. (2002) compared the face viewing behaviors of 15 cognitively-able adolescent males with and without ASD. They were matched by age, and verbal ability. Visual scanpaths revealed that the young people with ASD spent significantly less time fixating on eyes, and rather, gravitated their attention towards the lower region of the mouth. Eye tracking evidence has confirmed Langdell's observation that individuals with ASD employ a unique cognitive viewing style that likely contribute to difficulties in facial expression understanding.

Explanatory Models

That individuals with ASD appear to view the face differently has led to reflection on cognitive theories of ASD. Following are three theoretical models that attempt to explain facial expression understanding difficulties experienced by individuals with ASD.

Weak Central Coherence (WCC) model. Poor facial expression understanding in individuals with ASD has been strongly linked to WCC. WCC is a cognitive theory of autism first proposed by Frith (1989). For a review of WCC and other cognitive theories of autism, see Rajendran and Mitchell (2007). Central coherence is the ability to process information by extracting overall meaning or gist (Rajendran & Mitchell, 2007), at the expense of attention to or memory for lesser details (Happé & Frith, 2006). Researchers have suggested that individuals with ASD demonstrate a processing bias for featural and local information at the expense of seeing the 'big picture' (Happé, 1996; Happé & Frith, 2006). Frith (1989) and Happé (1996) have hypothesized that individuals with ASD process in a piecemeal manner thus demonstrating WCC. Frith and Happé argue that due to WCC, individuals with ASD struggle to generalize their learning from one environment to another (Happé & Frith, 2006). Thus, individuals with ASD who demonstrate WCC might experience particular difficulty in understanding facial expressions. First, they may struggle to transfer understanding of one face to the next. Second, because facial expressions vary tremendously across individuals, those with ASD may struggle to categorize emotional facial expressions across different faces. And finally, while attempts at face-based intervention may be made, WCC may prevent generalization of learning to provide meaningful long term benefit.

While studies highlight that typically developing individuals view the face holistically as a single unit (Baenninger, 1994; Tanaka & Farah, 1993; Tanaka, Kay, Grinnell, Stansfield, & Szechter, 1998), as previously discussed, individuals with ASD have been found to focus primarily on the lower region of the face, particularly on the mouth and chin, It has also been found that their performance in facial recognition tasks is not compromised by the ‘inversion effect’ (Langdell, 1978; Hobson et al., 1988; Tantam et al., 1989). These findings can explained taking WCC into account. Researchers explain that individuals with ASD do not view the face holistically, but rather in a piecemeal cognitive style, and are consequently compromised in deducing emotional meanings from the face as a socially salient unit (Gross, 2004; Tanaka et al., in press). Studies investigating WCC in individuals with ASD (Caron, Mottron, Rainville, & Chouinard, 2004; Happé, 1996; O'Riordan, Plaisted, Driver, & Baron-Cohen, 2001) seem to suggest that superiority found in visual-spatial processing comes at a significant cost to central coherence mechanisms necessary for effective social interaction. The influence of WCC cannot be overlooked in our search to better grasp the nature of communication and social interaction deficits found in individuals with ASD.

Theory of mind (ToM) hypothesis model. Another leading hypothesis is that face-based difficulties experienced by individuals with ASD are best explained by Theory of Mind (ToM) deficits. In essence, ToM is the ability to attribute mental states to oneself or another person (Premack & Woodruff, 1978). This is the primary way that we make sense of or predict another person's behavior (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). In regards to individuals with ASD who have difficulties in ToM, they struggle to take into account their own mental states and that of others (Baron-Cohen, 1989; Prior, Dahlstrom, & Squires, 1990). For an excellent review, see Rajendran and Mitchell (2007).

The most commonly used test for ToM is the *unexpected transfer test of false belief task* (i.e., 'I think she thinks'), devised by Wimmer and Perner (1983). In this task, the observer is introduced to a story of events enacted by two dolls, one named Sally and one named Anne. The story consists of four separate scenes. In scene one, Sally and Anne appear together. Sally has a basket and Anne has a box. Sally places a marble in her basket. In scene two, Sally leaves, though Anne remains behind. In scene three, Anne takes the marble out of Sally's basket and puts it into her own box. In scene four, Sally returns, and the experimenter poses the critical belief question: "Where will Sally look for her marble?" If the child points to Sally's basket, they pass the belief question by honoring Sally's false belief. If the child points to Anne's box, they fail the question by not taking into account Sally's false belief.

Assessed in children with ASD, Baron-Cohen, Leslie, and Frith (1986) found that 16/20 youngsters failed to answer the critical belief question correctly. Based on this data, it was reported that children with ASD as a whole do not employ ToM, have an inability to represent mental states, and are at great disadvantage when having to predict the behavior of other people.

However, use of the ToM hypothesis to explain difficulties experienced by individuals with ASD has generated criticism too. One study in particular challenged that individuals with ASD do indeed struggle with ToM deficits (Bowler, 1992). Bowler (1992) used a *second-order ToM belief task* (i.e., ‘I think she thinks he thinks’) based on that developed by Perner and Wimmer (1985). In Bowler (1992), the following story was read aloud to young adults with Asperger Syndrome:

> This is John, this is Mary. They live in this village. Here they are in the park. Along comes the ice-cream man. John would like to buy an ice-cream but he has left his money at home. He is very sad. “Don’t worry” says the ice-cream man, “you can go home and get your money and buy some ice-cream later. I’ll be here in the park all afternoon…” “Oh good,” says John, “I’ll be back in the afternoon to buy an ice-cream.”
>
> So John goes home. He lives in this house. Now the ice-cream man says, “I’m going to drive my van to the church to see if I can sell my ice-creams outside there.” The ice-cream man drives over to the church. On his way he passes John’s house. John sees him and says, “Where are you

> going?" The ice-cream man says, "I'm going to sell some ice-cream outside the church." So off he drives to the church.
>
> Now Mary goes home. She lives in this house. Then she goes to John's house. She knocks on the door and says, "Is John in?" "No", says his mother, "he's gone out to buy an ice-cream."

After listening to this story, the young adults with Asperger Syndrome were asked the critical question: "Where does Mary think John has gone to buy ice-cream?" In Bowler (1992), 73 percent of individuals with Asperger Syndrome answered the second-order ToM belief question (i.e., 'I think she thinks he thinks') correctly. The study raised doubts that ToM hypothesis could explain the spectrum of communication and social interaction deficits experienced by individuals with ASD.

However, others have highlighted that ToM difficulties are readily found in children with ASD, displayed in the form of problematic joint attention appearing very early in life (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997). Joint attention deficits attributed to poor ToM, such as poor demonstration of eye contact and an inability to use eye gaze cues to infer the emotions, goals, desires, and points of interest of others, have been identified as hallmark early childhood indicators of ASD (Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995; Dawson et al., 2005). In a study exploring the feasibility of providing early ASD diagnosis, analysis of videotapes from one-year old birthday parties concluded that joint attention and ToM inabilities - failure to look at others, and failure to recognize social facial cues - were the two best discriminators of ASD recognizable in infants (Osterling, Dawson, & Munson, 1994). Some emphasize that difficulty in ToM contribute to multiple cascading social and communicative deficits that are diagnostic of ASD (Baron-Cohen et al., 1997).

ToM as an explanatory theory of ASD has been of considerable interest to those studying facial expression understanding. From the ToM perspective, individuals with ASD have been described as being *mindblind*; lacking the ability to look into the eyes of others and accurately infer their mental states (Baron-Cohen, 1995). As evidence, Baron-Cohen et al. (1997) designed a task in which adults with high functioning ASD, Tourette Syndrome, and those deemed to be neurotypical were required to examine 25 photographs of faces in which only the region of the eyes (midway along the nose to just above the eyebrow) was visible. Coined the *Reading the Mind in Eyes* test, participants were required to view each photograph for 3 seconds before choosing one of two contrasting mental states printed below. In one photograph, for example, participants had to decide whether the eyes of the person were concerned or unconcerned. Adults with ASD, despite possessing normal to above-average IQ, were found to correctly identify the emotions in the eyes the worst (Baron-Cohen et al., 1997).

More recently, Golan, Baron-Cohen, and Golan (2008) developed a new *Reading the Mind in Films* task. In an attempt to create an ecologically valid and naturalistic measure, the task employed 27 scenes from feature films. In each film segment (6-30 seconds long), a protagonist character was identified taking part in a social-emotional situation. At the end of each scene, the observer had to choose how the protagonist felt from a list of four possible emotions. Compared to typically developing children, children with ASD performed significantly poorer (Golan et al., 2008). Such studies suggest that the ToM hypothesis is relevant in the exploration of communication and social deficits experienced by individuals with ASD.

Extreme Male Brain (EMB) model. The continuous search for better alternatives has separated our species from the rest. Baron Cohen (2002; 2003) has provided an additional explanatory model for comprehending communication and social difficulties reported in individuals with ASD. Extreme Male Brain (EMB) theory offers important insight into the present discussion of facial expression understanding difficulties reported in individuals with ASD. Heavily influenced by previous work in ToM, in essence, EMB suggests that people with ASD possess an extreme, male oriented, systemizing cognitive style that is devoid of empathy (Baron-Cohen, 2002; Baron-Cohen, 2003). Baron-Cohen suggests that every person's unique cognition can be located along a spectrum between two opposing cognitive styles: *empathizing* and *systemizing*. Empathizing here is seen as the drive to identify with another person's thoughts and emotions (Baron-Cohen, 2002). According to Baron-Cohen (2002), empathizing enables the emotional observer to are about how other people feel, respond back in emotionally appropriate ways, and predict the behavior of others by anticipating their thoughts and feelings. On the other hand, systemizing describes the drive to master systems: to better understand variables, derive underlying rules that govern systematic behavior, and predict, control, and develop new and improved systems (Baron-Cohen, 2002). Baron-Cohen (2002) has listed six types of systems that the human brain can analyze, control, and construct: technical (i.e., computers), natural (i.e., weather patterns), abstract (i.e., mathematics), social (i.e., electoral boundaries), organizational (i.e., library services) and motoric (i.e., techniques for playing music instrument). As an inductive process, systemizing works for phenomena that are lawful, infinite, and deterministic. Baron Cohen (2003) argues, however, that systemizing is of little use when predicting spontaneous changes in another person's behavior. Baron Cohen (2002) suggests that to predict human behavior – empathizing – a different type of processing, is required. Admittedly drawing from folk psychology, Baron-Cohen has attributed women as being typically stronger empathizers and men as being typically stronger systematizers (Baron-Cohen, 2002; Baron-Cohen, 2003).

According to EMB theory, while most individuals experience a healthy balance of both empathizing and systemizing strengths, individuals with ASD are systemizing statistical outliers. Along a normal curved distribution, individuals with ASD appear at the far edge of the systemizing scale (Baron-Cohen, 2002; Baron-Cohen, 2003). While Baron-Cohen suggests that EMB may result in mathematical and/or scientific brilliance (Baron-Cohen, 2003), it may come at significant cost. In a zero-sum game, the extreme systemizer, while able to master complicated and intricately detailed systems, is completely inept to successfully partake in everyday social situations that are dynamic and encompass human relationships (Baron-Cohen, 2002).

Applied to facial expression understanding, an extreme male brain struggles to infer emotional meanings from the faces of others. This is because human faces are not systematic, but dynamic in nature (Golan et al., 2010). Faces attached to human bodies change in orientation, sway, and shift around in unpredictable movements. Muscles in the face elongate and shorten reflexively as a result of external causes. Facial expressions, feelings, and emotions are not predictable and systematic in the same manner as an on/off light switch. As a more recently developed cognitive theory, EMB speculates new considerations for grasping communication and social impairments exhibited by individuals with ASD.

Computer-Based Interventions Designed to Improve Facial Expression Understanding

Some children with learning disabilities prefer multi-media, computer-based learning platforms (Huntinger, 1996; Lahm, 1996). Technology seems to inherently have several advantages in providing social/cognitive intervention to individuals with ASD (see Moore, 1998):

- While children with ASD often find the world to be chaotic and unpredictable, computer programs deliver intensive one-to-one instruction that is consistent, stable, and systematic.
- Computer instruction is free from the types of social demands and expectations such as attending to a person and appropriate eye gaze that negatively impact the learning of children with ASD

- Computer interventions provide explicit rules, expectations for success, and direct immediate feedback. They enable the user to self-monitor his/her learning, thereby increasing self-efficacy and motivation.
- Computer programs provide infinite opportunities for practice until mastery is achieved.
- Computers can provide individualized instruction when learning is appropriately matched to the ability of the user. Progressive levels that provide increasing difficulty in small increments enable the user to learn and progress at their own pace.

However, computer-based face interventions also have identified limitations:

- The user is often passively engaged in structured game play that is void of spontaneous and natural social interaction,
- Rather than relevant human characters, computer programs typically employ static avatars whom the user has no human connection with.
- Game experience is often not immersive, but narrow and shallow.
- Learning is not always customized to the specific learning needs of the child. Computer interventions are programmed with their end products being fixed. They cannot always be adapted and adjusted

Benefits of computer-based intervention have led to the development of software programs that aim to improve facial expression understanding in ASD. In light of limitations, however, questions remain over the extent to which game learning is transferred to the real world. In a five-week intervention study, ten adolescents and adults with ASD who received face-based training through computer modules improved on limited facial expression understanding tasks, but did not demonstrate any meaningful social/cognitive improvement beyond them (Bolte et al., 2002). It was concluded that computer-based social skills training did not generalize and transfer to actual benefit in everyday life. In another study, participants demonstrated better, yet still limited generalization of computer learned social skills (Silver & Oakes, 2001). One group of 11 children with ASD received two weeks of face-based software intervention (for a total of 10 hours) while a second group of 11 children with ASD received no intervention. The *Facial Expression Photographs* task from Spence (1980), *Strange Stories* task from Happé (1994), and *Emotion Recognition Cartoons* task from Howlin et al. (1999) were utilized to assess generalization of computer game learning across multiple constructs of facial expression understanding. While those who received computer training improved on the Emotion Recognition Cartoons task and Strange Stories task, they showed no improvement on the Facial Expression Photographs task. While generalization may not have fully taken place, the findings provided some support for the social efficacy of using computer-based interventions to improve facial expression understanding in children with ASD.

***Let's Face It!* (*LFI!*).** *LFI!* is a recent face-based computer intervention. The program is heavily derived from linking poor facial expression understanding found in individuals with ASD with WCC. The intervention consists of seven interactive, arcade-style games, *Two of a Kind, Eye Spy, Zap It, Face Maker, Find* *a Face, Search Party,* and *Splash It.* It addresses specific face processing deficits, including inattention to the eyes, impaired recognition of facial expression, and failure to perceive the face as a holistic unit (Tanaka et al., 2010). *Two of a Kind* is a memory matching card game in which the user is required to match cards with the same faces and facial expressions. In *Eye Spy*, the user must follow shifting eye gaze and identify points of eye contact. In *Zap It*, the user must make lines or groups of bubbles according to matching faces and facial expressions. In *Face Maker*, the user views a target face and must replicate it by dragging appropriate matching face parts and facial expressions to a second face. In *Find a Face*, the objective is to search for faces within real environments. The user is required to find faces in common landscape scenes (i.e., farmer's field, grassland, and city scene). In *Search Party*, a face flashes before the user's eyes before disappearing. Then, using the detective's magnifying glass, the user must find the same face or same matching facial expression from a selection of three possible suspects. Finally, *Splash It* is a game in which the user is presented with a target face and, using water balloons, must splash matching faces or faces sharing the same expression.

Each of the *LFI!* games includes engaging real face graphics, an original music track, and at least 24 levels of game play that steadily increase in difficulty and complexity (Tanaka et al., 2010). For correct answers, users are rewarded with score points, which are deducted for errors. Each game records player scores and upon exiting, high scores and names of top players are listed. The nature of the *LFI!* games is highly visual, drawing little from use of narrative. Rather, *LFI!*

is organized along a hierarchy of facial processing domains that train the user to attend to faces, recognize and discriminate facial expressions, and interpret facial cues in social context (Tanaka et al., 2010).

***The Transporters (TRANS*).** *TRANS* is a second face-based software intervention. It is an animated DVD series heavily derived from linking poor facial expression understanding with ToM deficits. To improve situational facial expression understanding, children are exposed to 15 episodes involving eight vehicular characters, all of whom have grafted human faces from real-life actors (Golan et al., 2010). As the vehicular characters go about their day-to-day business, they encounter a wide range of social situations with their friends that elicit varied emotional responses. Rich in language, social narrative, and dialogue, each of the 15 *TRANS* episodes introduces children to a unique key emotion, including the six basic emotions (anger, disgust, fear, happy, sad, and surprised) and additional more complex ones such as pride and jealousy (Golan et al., 2010). To improve facial expression understanding for users with ASD, the DVD series draws from EMB. The developers of *TRANS* (Golan et al., 2010) have referred to the program as one that teaches empathy through systemizing. The DVD aims to teach empathy by introducing ASD users to a friendly community of mechanical systems. Drawing upon vehicular characters to teach human social skills follows the EMB assumption that children with ASD who are highly drawn to systems may, therefore, bond more favorably to vehicular characters rather than human ones. Unlike everyday life, where the movement of faces is unpredictable, faces in *TRANS* are fixed to mechanical bodies that move about predictably, always as part of a toy set in a boy's bedroom. From this system where movement follows rules, *TRANS* aims to draw from systemizing preferences that ASD children may have to better teach empathy (Golan et al., 2010). Through hours of repetitive systems viewing, children may pay increased attention to dynamic faces and the facial expressions made by their favorite vehicular characters (Golan et al., 2010).

Built in quizzes and a parent user guide enable assessment of child comprehension. The *TRANS* DVD includes a selection of quizzes relating to each episode. Each quiz has two levels of difficulty, easy and hard. While the questions in both quizzes are identical, the easy quiz provides the user with two possible answers while in the hard quiz, the user is challenged by three. The quizzes consist of three types of questions; matching faces to faces, matching faces to emotions, and matching situations to faces (Golan et al., 2010). In addition, a parent user guide consists of accompanying ToM-based questions which parents can use to supplement their child's learning.

Purpose of the Study

While both *LFI!* and *TRANS* aim to improve facial expression understanding in individuals with ASD, they do so from differing explanatory models. As previously discussed, *LFI!* was developed under the premise that facial expression understanding difficulties in individuals with ASD can be largely explained by WCC and can be ameliorated through perceptual training. On the other hand, *TRANS* is rooted in the perspective that facial expression understanding difficulties found amongst individuals with ASD are best explained using the ToM hypothesis, and can be improved by teaching empathy through systemizing as described in the EMB literature. The objective of this study is to test these differing explanatory models by directly comparing the effects of *LFI!* and *TRANS* intervention. The research question was:

1.) In contrast to no treatment, which program, *TRANS* and *LFI!*, results in better performance on measures of facial expression understanding for children with ASD?

Contrasting these two programs demonstrates the potential value of intervention research as a tool for better understanding the explanatory models behind the nature of facial expression understanding difficulties found in individuals with ASD. Additionally, intervention experiments such as the present study are important in that they provide insight into the malleability of traits such as facial expression understanding found in individuals with ASD and the potential presence of subgroups (types of individuals with ASD) that might be more responsive to one type of intervention above another (Warren, 2004).

Study Hypotheses

1.) Children with ASD receiving *TRANS* or *LFI!* intervention will improve more on measures of facial expression understanding than children receiving no treatment (control group).

2.) Regardless of receiving intervention or no intervention (control condition), older children with ASD should outperform younger children with ASD by experiencing greater improvement on measures of facial expression understanding.

3.) Regardless of receiving intervention or no intervention (control condition), children with greater verbal ability with ASD should outperform children with less verbal ability with ASD by experiencing greater improvement on measures of facial expression understanding.

Method

Participants

Inclusion. Children aged 4 - 8 years old (48 - 107 months) were purposely recruited from service providers, school districts, and advocacy groups on the basis of a previous ASD diagnosis made at specialist centres using established criteria (American Psychiatric Association, 1994) and verbal ability at or above a *Peabody Picture Vocabulary Test*, *4th edition* (PPVT-4) standard score of 65 (Dunn & Dunn, 2007). Screening for participants took place from January, 2011 to June, 2011. After parental consent to participate was granted (see Appendix A; Appendix B), twenty-seven children were screened and one child was excluded due to a verbal ability score below the designated cutoff.

Assignment to groups. Twenty-six children (22 males, 4 females) were assigned to one of three intervention groups: *TRANS*, *LFI!,* and no treatment control (see Figure 1). Final intervention groups were affected by participant attrition. One child who was screened and assigned to the *TRANS* intervention group did not participate because the child could not orient to the computer, a necessary behavior for the facial expression understanding measures. During pretesting but prior to the start of intervention, parents of another child assigned to the *TRANS* intervention group withdrew their child, citing a lack of time. An additional child completed pretesting and started receiving *LFI!* intervention when parents reported the child had lost interest in the program. The child was withdrawn the study. Furthermore, two children assigned to the *LFI!* intervention group took part in, but did not fully complete the intervention before the time of final data collection. Hence, the final number of participants in this study was 21 children (18 males, 3 females). Eight children fully completed *TRANS* intervention, six children fully completed *LFI!* intervention, and seven children fulfilled their participation in no treatment control.

Children were randomized to intervention groups using the random numbers method. Software was used to develop a table of 200 random numbers, ranging in value from one to three. Arbitrarily, a value of one represented child assignment to *TRANS* intervention. A value of two represented child assignment to *LFI!* intervention. A value of three represented assignment to the no treatment control group. Starting from the first number in the random number table, children were assigned to intervention groups in blocks of three, as described by Graziano and Raulin (2010). Assigning participants in this method ensured that each intervention group received one child before additional participants were assigned to the next block. Within each block, the first participant was assigned to the intervention group indicated by the value (i.e., two) of the appropriate random number in the table. The second child was assigned to the intervention group indicated by the value (i.e., three) of the next random number, while the third child was assigned to the intervention group indicated by the value (i.e., one) of the following random number - as long as there were no repeat values. When repeat values were encountered within the same block (i.e., two was followed by the next random number also being a value of two), the child with the repeating value was assigned to the intervention group indicated by the value (i.e., three) of the next non-repeating number. However, due to a limited number of active participants, the size of the no intervention control group was capped at seven children. After the seventh block, participants were randomly assigned only to *TRANS* or *LFI!* intervention. Though participant screening and inclusion took place over a 6-month period, by randomly assigning participants to intervention groups using the random number method and in blocks of three, the final intervention groups were comparable and similar in size.

Characteristics. Active participants included a total of 21 children with a diagnosis of ASD residing in the greater Edmonton and Calgary regions of Alberta, Canada. These are two urban centers of similar population, both consisting of roughly 1 million inhabitants. Seventeen children were identified as Caucasian, three children as Asian and one child was South Asian. Children ranged in age from 4 years and three months (51 months) to 8 years and eight months (104 months) old. Mean age of the children was 6 years and ten months (or 82 months) old (SD = 1 year and 2 months, or 14 months). Children also ranged across verbal ability. Children's verbal ability as PPVT-4 standard scores ranged from 65-126. Children's mean PPVT-4 standard score was 95.7 (SD = 20.8.) While all families reported English as the primary language spoken in the home, seven families reported additional languages also being spoken. Three families reported speaking French, one family spoke Korean, one family spoke

Filipino (Tagalog), one family spoke Spanish, and one family spoke Urdu in the home.

With one exception, selected participants came from two parent (mother and father) families. Mothers (n = 21) had achieved overall high levels of education ranging from partial high school (n = 1), high school diploma (n = 2), partial post-secondary (n = 1), post-secondary certificate, diploma or undergraduate degree (n = 13), to graduate degree (n = 4). Fathers (n = 20) had similar high level of education, ranging from partial high school (n = 1), high school diploma (n = 2), partial post-secondary (n = 4), post-secondary certificate, diploma or undergraduate degree (n = 9), to graduate degree (n = 4). Yearly family income of selected children ranged from below $25,000 (both parents had graduate degrees) to over $100,000 per annum, with two families choosing not to report. Median and mode family income was self-reported in the $75,000 - $100,000 range.

Intervention Procedure

Group 1: *TRANS* intervention group. Eight children (7 males, 1 female) and their families were provided a copy of the *TRANS* DVD. Mean age of children was 6 years and eleven months, (or 83 months) old (see Table 1). Mean verbal ability (as PPVT-4 standard score) was 94.6 (SD = 22.3). Prior to the start of the intervention, a meeting was held with at least one parent to describe the intervention protocol. During the meeting, the DVD and its user guide was introduced to parents. Parents were encouraged to use the instructional material provided in the guide to supplement their child’s learning. Outside of using the user guide, parents were instructed not to engage in child coaching. This was done to limit the final results being confounded by parent teaching skills, knowledge, and background. Parents were instructed to ensure that their child would view the *TRANS* intervention, attempt the quizzes, and answer questions from the DVD's user guide for a total of 20 hours. While a 6-week intervention period was suggested, some families required additional time before completing the 20 hours of *TRANS* intervention. As in the Golan et al. (2010) study, children were given the freedom to engage in the DVD intervention independently; there was no correct or incorrect method of viewing the DVD, exploring the quizzes, or answering user guide questions, so long as children and families met the 20-hour intervention requirement. To keep track of intervention exposure, parents were instructed to keep a daily log book tracking the total number of minutes and episodes their child had watched.

Group 2: *LFI!* intervention group. For six children (4 males, 2 females) and their families assigned to the *LFI!* group, the *LFI!* program was installed on their home computer. Mean age of children was 6 years and eight months, (or 80 months) old (see Table 1). Mean verbal ability (as PPVT-4 standard score) was 94.8 (SD = 25.6). Similar to the *TRANS* group, prior to the start of the intervention, a meeting was held with at least one parent to describe the intervention protocol. During the meeting, the *LFI!* program and games were introduced to parents. Parents were instructed not to engage in child coaching and to ensure that their child would view and play the *LFI!* games for a total of 20 hours. While a 6-week intervention period was suggested, some families required additional time before completing the 20 hours of *LFI!* intervention. As in the Tanaka et al. (2010) study, children were given the freedom to engage in the computer intervention independently; there was no correct or incorrect method of playing the games to meet the 20-hour intervention requirement. Rather, children were encouraged to explore and play the games on their own as suited within the family's daily lives and schedule. In addition, parents were coached on how to send game data files to the author. This allowed for monitoring of child's *LFI!* play. To keep track of intervention exposure, parents were instructed to keep a daily log book tracking the total number of minutes their child had played with the *LFI!* games.

Group 3: No treatment control group. Seven boys and their families were asked to continue on with their daily lives as normal over a 6-week period. Mean age of children was 7 years, (or 84 months) old (see Table 1). Mean verbal ability (as PPVT-4 standard score) was 97.9 (SD = 19.7). No facial expression understanding intervention was provided. At the end of the 6-week period, children and families received their own copy of one of the two intervention programs to keep.

Assessment Procedure

Child measures were individually administered before and after 20-hours of *TRANS*, and *LFI!* intervention taking place over a minimum of 6-weeks; or 6-weeks of no intervention for children assigned to the control group. Measures were administered by a trained graduate student who was blind to children's intervention type. At both time 1 and time 2, children generally required approximately 2 hours to complete all facial expression understanding measures. Because children participating in this study were young, the 2 hours of assessments were for the most part broken up and took place over two back-to-back days. Due to travel time and additional family commitments, three children at time 1 and time 2 completed all measures in one day. One child at time 1 required additional time and assessment took place over three consecutive days.

Measures

Demographic questionnaire. Families completed a form describing child demographic characteristics including: birth date, diagnosis, date of diagnosis, and ethnicity. Parent demographic characteristics such as: marital status, household income, level of education, and languages spoken in the home were also collected.

Test of Emotion Comprehension (TEC). Children's ability to comprehend facial expression by way of non-verbal intelligence was assessed using TEC, developed by Pons and Harris (2000). TEC consists of picture books with separate boy and girl versions. It is a thorough nine subtest measure and has good test-retest reliability, r (18) = .84, after being re-administered to children aged 3-10 years old after 3 months; and good stability in the administration to 40 respondents after 13 months, r (40) = .68 (Pons, Harris & Doudin, 2002; Tenenbaum, Visscher, Pons, & Harris, 2004). In a recent validation study, using the Kudar-Richardson Formula for Internal Consistency Reliability (KR-20), the instrument has good internal consistency (KR-20 = 0.79) (Molina & DiChiacchio, 2008). In the current study, the Emotion Recognition subtest (Cronbach alpha = .72) and External Cause of Emotion subtest (Cronbach alpha = .66) were used.

- ***Emotion Recognition subtest.*** Children's ability to comprehend facial expression by visual recognition was assessed. During administration of this subtest, a protagonist cartoon character (of the same gender as the child) was displayed to children depicting four distinct facial expressions. Children were required to discriminate facial expressions by visual emotion recognition. For example, on one particular item, the examiner pointed to each of the protagonist character's four distinct facial expressions before asking the child to, "Point to who is surprised" (see Appendix C). For each item in this subtest, children received a score of 1 for the ability to point to the protagonist's correct facial expression. Children received a score of 0 if they erred in pointing to the correct facial emotion.

- ***External Cause of Emotion subtest.*** Children's ability to comprehend facial expression by understanding external cause was assessed. During administration of this subtest, a series of cartoon scenarios were presented to children. At the bottom of each page a protagonist cartoon character (of the same gender as the child) was displayed to children depicting four distinct facial expressions. With the examiner telling a short accompanying story for each cartoon, children were required to discriminate facial expressions by interpreting external cause of emotion. For example, on one particular item, the examiner explained to the child "This boy (girl) is looking at his (her) little turtle, which has just died." The examiner then asked the child, "How is this boy (girl) feeling? Is he (she) happy, sad, angry, or alright" (see Appendix C)? For each item in this subtest, children received a score of 1 for the ability to point to the protagonist's correct facial expression. Children received a score of 0 if they erred in pointing to the correct facial emotion.

Situation Facial Expression Matching Test. Children's ability to interpret facial expressions by mediating through social context was assessed using a method similar to that devised by Golan et al. (2010). Three pointing subtests were developed to represent three levels of generalization, as described in Golan et al. (2010):

1. ***Familiar Close Generalization subtest***. Children matched familiar situations from the *TRANS* DVD with familiar facial expressions of the *TRANS* vehicular characters which appeared in the series (see Appendix D). Internal consistency for this measure in the current study was good (Cronbach alpha = .84).

2. ***Unfamiliar Close Generalization subtest.*** Children matched novel situations from the TRANS DVD with novel facial expressions displayed by the TRANS vehicular characters (see Appendix E). These were expressions from *TRANS* characters not displayed in the intervention series, but appearing in a separate *TRANS* resource DVD (Baron-Cohen, Harcup, & Drori, 2010). Internal consistency for this measure in the current study was good (Cronbach alpha = .86).

3. ***Distant Generalization subtest***. To test generalization to facial expressions that are not attached to vehicular characters, children matched novel

situations with novel facial expressions using a selection of human faces (see Appendix E) taken from the *Mind Reading* software (Baron-Cohen, Golan, Wheelwright & Hill, 2004). Internal consistency for this measure in the current study was good (Cronbach alpha = .88).

Each Situation Facial Expression Matching Test subtest consisted of 16 items, including one practice question and one item to assess each of the 15 key emotions explored in the *TRANS* series. Each item included a short story of a protagonist character engaged in an emotional scenario. At the bottom of the page were three still-shot images of facial expressions demonstrated by the protagonist: one depicting the correct facial expression and two depicting incorrect expressions. The examiner directed children to point to the face that best illustrated how the protagonist was feeling. For each item across the three generalization tasks, children received a score of 1 for the ability to point to the protagonist's correct facial expression. Children received a score of 0 if they erred in pointing to the correct facial emotion.

***LFI!* Skills Battery: Emotion Module.** To assess children's ability to apply emotional labels, demonstrate understanding of emotion constancy, and recognize emotions, the *LFI!* Skills Emotion Battery: Emotion Module, as developed by Tanaka et al. (in press) was utilized. The module is part of the *LFI!* Skills Battery, a comprehensive computer-based battery that assesses a broad range of facial processing skills (Tanaka et al., 2010). The emotion module consists of three subtests, as described by Tanaka et al. (in press):

- ***Name Game subtest.*** Children's ability to match a word label to its facial expression was assessed (see Appendix G). An emotional face was presented on a computer screen with a list of six emotions (happy, angry, sad, disgusted, surprised, and fearful) shown on the right side of the display. Children were required to click on the emotion that depicted the face. To eliminate reading requirements, the computer software spoke out each emotion when children scrolled over it with their mouse. The face remained on the screen until a selection was made. The faces were color imaged from the NimStim face set of facial expressions (Tottenham et al., 2009). There were a total of 66 items consisting of 11 items for each of the six above described emotions. Internal consistency for this measure in the current study was good (Cronbach alpha = .97).

- ***Match Maker-Expression subtest.*** Children's ability to match emotional expressions across changes in facial identity was assessed (see Appendix H). A study face depicting happy, angry, sad, disgusted, or frightened was shown in a frontal view for one second followed by three probe faces of different identities. Children were required to select the probe face that matched the emotion depicted in the study face. The study and probe faces remained on the screen until the children had made their selection. There were a total of 20 such items, with four items per emotion. Internal consistency for this measure in the current study was good (Cronback alpha = .83).

- ***Parts/Whole-Expression subtest.*** Children's use of featural and holistic strategies to recognize facial expressions was assessed (see Appendix I). A study face depicting either a consistent or inconsistent expression was presented for 2 seconds. The consistent expressions depicted the same top and bottom expressions of the same person. The inconsistent expressions were constructed by combining the top of one expression (i.e., angry) with the bottom of the other (i.e., happy) from the same individual. Children's memory for a face part (eyes or mouth) was evaluated by presenting the face part and its foil either in isolation or embedded within a whole face. The measure of holistic processing is the difference between performance in the whole face test condition versus the part test condition. The measure of emotional processing is the difference in performance between the consistent expression condition and inconsistent expression condition. The four faces used in the assessment were normed for expression, taken from the *Sackler Face Set* (Tottenham, et al., 2009). There were a total of 40 items. Internal consistency for this measure was good

Intervention Implementation Fidelity

Intervention implementation was tracked via a parent daily log book. At the time of child pretesting, the author held a meeting with at least one of child's parents to consistently and explicitly describe the intervention protocol. As a key component of this meeting, parents of children placed in either *TRANS* or *LFI!* intervention were instructed to track their child's participation on a daily basis. Intervention time, then, was continually tracked by parents who recorded when (the date) and for how long (in minutes) their child had participated. In addition, during the intervention period, the author stayed in weekly contact with parents via email and telephone to continually monitor implementation fidelity.

Results

Data Analytic Plan

Statistical analysis was conducted using Predictive Analytics SoftWare (PASW) software, Version 18. Preliminary analysis using ANOVA and MANOVA models was carried out to examine if the three intervention groups were comparable at the start of the study. Statistical assumptions necessary for repeated-measures ANOVA were also tested. Implementation fidelity data was explored through descriptive statistics. Following, the effect of intervention using a series of repeated-measures ANOVAs was investigated. Finally, predictors of post test scores using chronological age and verbal ability were explored using regression analyses.

Preliminary Analyses

Group allocation. A series of ANOVAs were performed to examine mean background variables between the *TRANS*, *LFI!* and control group (see Table 1). No significant between-groups differences were found: age, F (2, 18) = .26, p = .77; verbal ability (as PPVT-4 raw score), F (2, 18) = .07, p = .93; verbal ability (as PPVT-4 standard score), F (2, 18) = .05, p = .95; and days between assessments at time 1 and time 2, F (2, 18) = 2.52, p = .11.

To examine whether there were significant differences between groups at pretest, a MANOVA was conducted with each of the pretest scores as the dependent variable and intervention group (i.e., *TRANS*, *LFI!*, and control) as the independent variable (see Table 2 for means at Time 1). The results of this analysis yielded a non-significant multivariate effect, Wilks´ Lamda = .73, F (8,

12) = .56, p = .79. This further indicated that groups were equivalent at the start of the study.

Testing repeated-measures statistical assumptions. Analysis for each TEC, Situation Facial Expression Matching Test, and *LFI!* Skills Battery: Emotion Module subtest was conducted to test whether statistical assumptions of normality of sampling distributions, sphericity, and homogeneity of variance were met.

Normality of sampling distributions. An overall trend of negative skewness (range = -1.5 - .54) was present on the TEC, and Situation Facial Expression Understanding Matching Test subtests suggesting that the majority of the children scored high on these subtests which is indicated by the pre and post test means (Table 2). The Kolmogorov-Smirnov value was significant for all but the Familiar Close Generalization subtest, indicating deviations from normality for this group of subtests. On the *LFI!* Skills Battery Emotions Module subtests, an overall trend of positive skewness (range = -.94 to -.84) indicated that the majority of the children scored low on these subtests. The Kolmogorov-Smirnov value was significant for the Name Game subtest indicating a deviation from normality for this subtest. Overall, the skewness and kurtosis statistics suggest that most of the subtests violated the assumption of normality. Nevertheless, transformation of the data was not performed as violation of the normality of sampling distributions has a marginal effect on analyses, such as F-tests which were conducted in the present study (Glass, Peckham, & Sanders, 1972).

Sphericity. Sphericity was automatically met for all of the TEC, Situation Facial Expression Matching Test, and *LFI!* Skills Battery: Emotion Module subtests because the repeated-measure variable requires at least three levels for sphericity to be an issue (Field, 2009). In the current study, the repeated-measures variable had only two levels (time 1 and time 2) and thus, the assumption of sphericity was met on all subtests.

Homogeneity of variance. Homogeneity of variance was met for all TEC, Situation Facial Expression Matching Test, and *LFI!* Skills Battery: Emotion Module subtests with one exception. Homogeneity of variance was not met for the Situation Facial Expression Matching Test, distant generalization subtest. Data transformation in this subtest, however, was avoided due to this study's small number of degrees of freedom.

Correlations Among Subtests. The measures in this study were selected based on previous efficacy research on *TRANS* (i.e., Situation Facial Expression Matching Tasks; Golan et al., 2010), *LFI!* (i.e., *LFI!* Skills Battery: Emotion Module subtests; Tanaka et al., in press) and in an attempt to assess children's understanding of facial expressions beyond measures developed by the computer program authors (i.e., TEC; Pons & Harris, 2000). Some of the measures in the current study were highly correlated (i.e., Situation Facial Expression Matching Test, Unfamiliar Close Generalization and Situation Facial Expression Matching Test, Distant Close Generalization, $r = .90$; TEC, External Causes and Situation Facial Expression Matching Test, Familiar Close Generalization, $r = .85$; TEC, External Causes and *LFI!* Skills Battery: Emotion Module, Name Game, $r = .84$;

Situation Facial Expression Matching Test, Familiar Close Generalization and *LFI!* Skills Battery: Emotion Module Name Game, r = .83; Situation Facial Expression Matching Test, Unfamiliar Close Generalization and *LFI!* Skills Battery: Emotion Module, Parts Whole Expression, r = .80). This indicates that, on average these subtests shared 60 – 80% variance. However, a decision was made to keep all of the subtests in the analysis to align the present study more closely with previous efficacy studies on these interventions and, in the case of the TEC (Pons & Harris, 2000), as stated previously, to include a measure beyond those developed by the computer program authors.

Implementation Fidelity

Based on parent report data, the *TRANS* and *LFI!* interventions were carried out as intended (see Table 4). All children participated in at least 20 hours of intervention. Participation hours were very close with children allocated to *TRANS* intervention averaging 23.15 total hours (SD = 3.55) and children allocated to *LFI!* intervention averaging 21.13 total hours (SD = 1.40) (see Table 3). In addition, *TRANS* and *LFI!* intervention took place over almost the same total number of days. Children in the *TRANS* group spent on average 33.63 days (SD = 8.68) watching the DVD, while children in the *LFI!* group spent on average 38.67 days (SD = 12.66) playing the games. In terms of minutes played per day, children who participated in *TRANS* intervention averaged 44 minutes while children who participated in *LFI!* intervention averaged a slightly fewer 36 minutes. Using a MANOVA there were no significant differences between *TRANS* or *LFI!* group intervention days, total hours, or minutes per day (Wilks´

Lamda = .70 *F* (4, 9) = .99, *p* = .46. The data and MANOVA finding indicates high implementation fidelity on the part of parents.

Analyzing the Effect of Intervention

To assess for the effect of intervention, series of repeated-measures ANOVAs were conducted for each subtest with intervention group (*TRANS*, *LFI!*, no treatment control) as the independent variable (see Table 4). The dependent variable was total accuracy on each subtest (as percentage scores for the *LFI!* Skills Battery: Emotion Module subtests; and sum scores for the TEC, and Situation Facial Expression Matching Test subtests). The comparison of interest was the interaction between group and time, in order to determine whether the *TRANS* and *LFI!* intervention groups demonstrated greater significant improvement than the no treatment control group (see Table 4).

TEC, Emotion Recognition subtest. There was a significant main effect for time, F (1, 18) = 5.50, p = .03, η_p^2 = .23. No interaction effect was found between group and time, F (1, 18) = 2.16, p = .14, η_p^2 = .19. This suggests that children's scores improved over time on their TEC, Emotion Recognition subtest scores, but this effect was not associated with either the *TRANS*, or *LFI!* intervention. Scores of children in the control group were very stable over time.

TEC, External Cause of Emotion subtest. Analysis found no significant main effect for time, F (1, 18) = 1.16, p = .30, η_p^2 = .06 and no interaction effect between group and time, F (1, 18) = .04, p = .96, $\eta_p^2 < .01$. This suggests that children did not improve on their TEC, External Cause of Emotion subtest scores.

Neither time, nor *TRANS*, nor *LFI!* intervention led to significant improvement. Scores of children in the control group decreased over time.

Situation Facial Expression Matching Test, Familiar Close Generalization subtest. Analysis found a significant main effect for time, *F* (1, 18) = 11.11, $p < .01$, $\eta_p^2 = .38$ and no interaction effect between group and time, *F* (1, 18) = .88, $p = .43$, $\eta_p^2 = .09$. This suggests that children improved over time on their Situation Facial Expression Matching Test, Familiar Close Generalization subtest scores, but this effect was not associated with either the *TRANS*, or *LFI!* intervention. Scores of children in the control group also improved.

Situation Facial Expression Matching Test, Unfamiliar Close Generalization subtest. Analysis found a significant main effect for time, *F* (1, 18) = 6.46, $p = .02$, $\eta_p^2 = .26$ and no interaction effect between group and time, *F* (1, 18) = .49, $p = .62$, $\eta_p^2 = .05$. This suggests that children improved over time on their Situation Facial Expression Matching Test, Unfamiliar Close Generalization subtest scores, but this effect was not associated with either the *TRANS*, or *LFI!* intervention. Scores of children in the control group also improved.

Situation Facial Expression Matching Test, Distant Generalization subtest. Analysis found no significant main effect for time, *F* (1, 18) = .59, $p = .45$, $\eta_p^2 = .03$ and no interaction effect between group and time, *F* (1, 18) = .12, $p = .89$, $\eta_p^2 = .01$. This suggests that children did not improve on their

Situation Facial Expression Matching Test, Distant Generalization subtest scores. Neither time, nor *TRANS*, nor *LFI!* intervention led to improvement.

***LFI!* Skills Battery: Emotion Module, Name Game subtest.** Analysis found no significant main effect for time, *F* (1, 18) = 2.90, *p* = .11, η_p^2 = .14 and no interaction effect between group and time, *F* (1, 18) = .05, *p* = .95, η_p^2 < .01. This suggests that children did not improve on their *LFI!* Skills Battery: Emotion Module, Name Game subtest scores. Neither time, nor *TRANS*, nor *LFI!* intervention led to significant improvement. Scores of children in the control group also improved.

***LFI!* Skills Battery: Emotion Module, Match Maker-Expression subtest.** Analysis found a significant main effect for time, *F* (1, 18) = 5.00, *p* = .04, η_p^2 = .22 and no interaction effect between group and time, *F* (1, 18) = .03, *p* = .98, η_p^2 < .01. This suggests that children improved over time on their *LFI!* Skills Battery: Emotion Module, Match Maker-Expression subtest scores, but this effect was not associated with either the *TRANS*, or *LFI!* Intervention. Scores of children in the control group also improved.

***LFI!* Skills Battery: Emotion Module, Parts/Whole-Expression subtest.** Analysis found no significant main effect for time, *F* (1, 18) = .24, *p* = .63, η_p^2 = .01 and no interaction effect between group and time, *F* (1, 18) = 1.07, *p* = .37, η_p^2 = .11. This suggests that children did not improve on their *LFI!* Skills Battery: Emotion Module, Parts/Whole-Expression subtest scores. Neither time, nor *TRANS*, nor *LFI!* intervention led to significant improvement. The scores of chidren in the LFI group decreased over time and scores of children in the control group remained very stable.

Analyzing Predictors of Post Performance

After a significant main effect for time was found on four subtests (TEC, Emotion Recognition subtest; Situation Facial Expression Matching Test, Familiar Close Generalization subtest; Situation Facial Expression Matching Test, Unfamiliar Close Generalization subtest; and *LFI!* Skills Battery: Emotion Module, Match Maker-Expression subtest) regression analyses were performed to examine if children's pretest score, chronological age, or verbal ability (as PPVT-4 standard score) influenced their post performance on the given subtests.

Predictors of post performance on the TEC, Emotion Recognition subtest. Regression analysis showed that only children's pretest score significantly predicted their post performance, $\beta = .78$, t (17) = 4.72, $p <.01$. Higher pretest score predicted higher post performance. Children's chronological age and verbal ability were not found to be a significant predictor of their post performance,

Predictors of post performance on the Situation Facial Expression Matching Test, Familiar Close Generalization subtest. Regression analysis showed that children's pretest score significantly predicted their post performance, $\beta = .78$, t (17) = 7.40, $p < .01$. Higher pretest score predicted higher post performance. Children's chronological age was also found to be significant, $\beta = .19$, t (17) = 2.19, $p = .04$. Older age predicted higher post performance.

Children's verbal ability approached, but did not reach significance, $\beta = .21$, t $(17) = 1.91$, $p = .07$.

Predictors of post performance on the Situation Facial Expression Matching Test, Unfamiliar Close Generalization subtest. Regression analysis showed that children's pretest score significantly predicted their post performance, $\beta = .72$, t $(17) = 5.37$, $p < .01$. Higher pretest score predicted higher post performance. Children's verbal ability also significantly predicted their post performance, $\beta = .29$, t $(17) = 2.05$, $p = .05$. Children's greater verbal ability predicted higher post performance. Children's chronological age was not found to be a significant predictor of their post performance,

Predictors of post performance on the *LFI!* Skills Battery: Emotion Module, Match Maker-Expression subtest. Regression analysis showed that children's pretest score significantly predicted their post performance, $\beta = .65$, t $(17) = 4.10$, $p < .01$. Higher pretest score predicted higher post performance. Children's verbal ability approached, but did not reach significance, $\beta < .29$, t $(17) = 1.77$, $p = .10$. Children's chronological age, however, was not found to be a significant predictor of their post performance.

Discussion

This study compared the effects of *TRANS* and *LFI!* Intervention with each other and a no treatment control condition. The development of *TRANS* was informed by the theory that facial expression understanding difficulties found in individuals with ASD are best explained by ToM and EMB deficits. *LFI!* was developed under the premise that facial expression understanding difficulties found in individuals with ASD are largely explained by WCC deficits. This study attempted to test the soundness of the WCC, ToM, and EMB explanatory models to rationalize facial expression understanding difficulties reported in children with ASD by directly comparing the effects of the *TRANS* and *LFI!* interventions.

Interpretation of the Findings

The author hypothesized that children with ASD receiving *TRANS* and *LFI!* intervention would experience greater post performance on measures of facial expression understanding than children receiving no treatment control intervention. However, 20 hours of face training with *TRANS* and *LFI!* intervention did not have an effect on children's performance on any of the facial expression understanding measures used in this study. Children's improvement on the TEC, Situation Facial Expression Matching Test, and *LFI!* Skills Battery: Emotion Module subtests could only be attributed to time, not intervention effect.

The present findings differ from Golan et al. (2010) where *TRANS* intervention significantly improved children's emotion comprehension and recognition skills and also from Tanaka et al. (2010) where *LFI!* intervention significantly improved children's analytic and holistic face processing skills. Nevertheless, the present findings partially mirror Silver and Oakes (2001) where computer intervention to teach individuals with ASD to recognize and predict emotions had insignificant effects on improving children's performance on two of three subtests (*Happe's Strange Stories* subtest and *Emotion Recognition Cartoons* subtest). These measures were not used in this study. Like the current study, Silver and Oakes reported that in one subtest, *Facial Expression Photographs* subtest (a measure similar to the TEC, Emotion Recognition subtest used in the present study), children improved significantly over time, but the improvement was not associated with significant intervention effect from the computer-based face training provided.

In contrast to previous examinations of intervention effects of *TRANS* and *LFI!* (i.e., Golan et al. and Tanaka, 2010; respectively), a methodological strength of the present study was the assessment of effect of intervention across multiple constructs. This was done in response to Bolte et al. (2002) who found that specific face skills acquired through computer-based training did not successfully transfer to other measures. In the current study, the TEC (Pons & Harris, 2000), Recognition subtest and External Cause of Emotion subtest were used to assess children's recognition of emotion. The situation facial expression matching tasks described by Golan et al. (2010) were used to assess children's contextual understanding of emotions. The *LFI!* Skills Battery: Emotion Module developed by Tanaka et al. (2010) assessed children's visual perception strategies. By incorporating the procedures of all these measures, this study provided more comprehensive testing of facial expression understanding than either Golan et al. (2010) and Tanaka et al. (2010).

Bolte et al. (2002) concluded that face-based computer interventions may not generalize and, therefore, will fail to provide children with meaningful social benefits. The insignificant intervention effects found in the present study suggest the limited social efficacy of *TRANS* and *LFI!* intervention. In Golan et al. (2010), children received 10 hours of *TRANS* intervention. In the present study children received a minimum 20 hours of intervention and did not produce significant improvement on any of the TEC, Situation Facial Expression Matching, or *LFI!* Skills Battery: Emotion Module subtests. In fact, analysis of individual data of each child assigned to the *TRANS* group revealed that despite being exposed to *TRANS* concepts and vehicular characters, these children did not consistently show progress on the measures that were directly associated with their intervention, the Situation Facial Expression Matching tasks. Here, only one of 8 children progressed on all three subtests. The mean gain on all Situation Facial Expression Matching subtests for *TRANS* intervention children was equivalent to the gains made by children in the *LFI!* intervention and no treatment control.

Whereas the present study represents a lack of replication of the treatment effect of the *TRANS* program found in Golan et al., (2010), the same cannot be said of *LFI!* In Tanaka et al. (2010), 20 hours of *LFI!* intervention improved analytic and holistic face processing skills. Unlike the present study, Tanaka et al. (2010) demonstrated that children who experienced *LFI!* intervention, compared to no treatment control, exhibited improvements in facial identity understanding measures, not facial expression understanding measures which were used in the present study. Of the facial identity measures assessed in Tanaka et al. (2010), the effect of *LFI!* intervention was significant on only one of five subtests, Parts/Whole-Identity. This measure was not used in the current study.

By utilizing the TEC (Pons & Harris, 2000) measure, the current study also attempted to assess children's understanding of facial expressions beyond the measures developed by the computer program authors. In addition, the TEC has good internal consistency (Molina & DiChiacchio, 2008) and strong test-retest-reliability (Pons, Harris & Doudin, 2002; Tenenbaum, Visscher, Pons, & Harris, 2004)s.

While the repeated-measures ANOVA finding of no significance for time by intervention group, visual inspection of the mean data (see Table 2) indicates that in the TEC, Emotion Recognition subtest, scores of children in *TRANS* group improved .58 from time 1 to time 2. Scores of children in the no treatment control group performed close to ceiling at time 1, mean = 4.72, and did not change from time 1 to time 2. Scores of children in the LFI group improved by .33.

These factors may have contributed to an intervention effect that was not detected with a small sample (n = 8) and within-subjects variability amongst children allocated to *TRANS* intervention. This effect might be expected considering the work of Camras and Allison (1985) and Herba and Phillips (2004) who established that children require sufficient verbal ability, verbal labels, and an emotional lexicon to describe their level of emotional understanding. Because children receiving *TRANS* intervention experienced intensive emotional vocabulary training in which facial expressions were constantly matched to emotional labels, they likely performed better at post test. While this intervention effect of *TRANS* is speculative, it should be further investigated.

Regardless of using *TRANS*, using *LFI!*, or receiving no treatment, older and more verbal children with ASD were expected to outperform younger and less verbal children with ASD by experiencing greater improvement in performance on measures of facial expression understanding. However, regression analyses found that these variables were weak predictors of post intervention performance. Pretest scores more reliably predicted post test scores, indicating that more complex cognitive processes not examined in this study are likely attributable to facial expression understanding difficulties experienced by children with ASD. As previously noted, there has been an emphasis on explanatory models based in cognitive theories used to describe facial expression understanding difficulties experienced by individuals with ASD. The present study attempted to test the explanatory power of the WCC, ToM, and EMB models by directly comparing the effects of *LFI!*, and *TRANS* intervention. However, because no effects of either intervention were found, there is insufficient empirical evidence to make judgements on the soundness of WCC, ToM, and EMB models for explaining the facial expression understanding difficulties reported in ASD.

Parents' high satisfaction with the intervention was reflected in the strong quality of this study's implementation fidelity data: intervention group mean data were very similar, all children allocated to the *TRANS* and *LFI*! groups received a minimum 20 hours of intervention, only one child withdrew from the study after beginning intervention, and parents in the control group reportedly avoided any additional specialized facial expression understanding training. The efforts of parents and families of children participating in this study must be commended. Anecdotally, parents of children receiving *TRAN*S and *LFI!* intervention were overall very pleased with the experience. Almost all parents reported their children to have improved face viewing behaviour. Many parents were pleased that their children asked new questions about faces and feelings. One child reportedly broke up a brewing argument when he asked his parents why they were angry and sad. While intervention group effects do not reflect the positive comments made by parents, further exploration of the merits of these interventions is clearly warranted.

Limitations

The results of this study must be interpreted with caution considering the following limitations. Foremost, at the outset of this study it was anticipated that 60 participants would be recruited. Recruiting children with ASD (a low-incidence and highly heterogeneous disorder) with sufficient verbal ability, and between the ages of 4-8 years old was challenging. The sample size of 21 was small, resulting in only 6 to 8 children per group. As a result, the results on the measures of facial expression understanding used in this study were constrained by low statistical power. Thus, with high Type II error, it remains possible that this study did not detect the significance of *TRANS* and *LFI!* intervention. Inspection of the effect sizes for Emotion Recognition, Familiar Close Generalization, Unfamiliar Close Generalization and Parts/Whole Expression (Partial Eta Square range .05 - .19) indicate that a time x intervention effect may have been missed. Based on Cohen's (1988) criteria, the effects found in these subtests can be classified as small (.01 - .05), moderate (.06 - .14) to large (> .14).

While parent report data suggests that the interventions (*TRANS*, *LFI!*, no treatment control) were carried out as intended, there were variations in the amount of parental involvement during the intervention period. For children allocated to the *LFI!* Intervention, parents reported that children participated independently, but that for the most part, parents were required to sit together with the child. One parent, however, had to extend her involvement by providing constant (almost continuous) food motivators in order for her child to engage in and progress with the intervention. Parents of children allocated to the *TRANS* intervention group were perhaps most likely to use parent coaching because the DVD came with an accompanying parent user guide. The parent user guide to engage with the child was a key component of the *TRANS* intervention as described by Golan et al. (2010). Thus, inclusion of the user guide in this study was justified. Reviewing the parent daily log books, it is evident that some parents used the parent guide more than others. In addition, the parents of one child receiving *TRANS* intervention reported that during one week, they forgot to record intervention minutes in the child's daily log book. The family was advised to retroactively fill in the time, in a conservative manner and to the best of their abilities. For the remainder of the study, these parents were consistent in their documentation. In sum, the trend was for parents to provide more or enhanced versions of the interventions than may have been intended. Despite these efforts, as previously stated, no intervention effects were found, making the variations in the implementation of the interventions very likely not important considerations given the purpose of this study.

Future Directions

This study provides useful guidance for future research efforts. It is evident that intervention as experimental research using a repeated-measures design requires a large sample size. Indeed, Tabachnick and Fidell (2007) suggest that mixed randomized-repeated measure designs as in this study should consist of more than 20 degrees of freedom for the randomized groups error term. Following their recommendation, the current study should have allocated at least 23 children into each of the three intervention (*TRANS*, *LFI!* and no treatment control) groups. Larger sample sizes in future studies would lend to greater statistical power to reduce Type II error levels that were substantial in the current study.

Further study should investigate how to improve the transfer of computer-based face training to real world environments. Bolte et al. (2000) reported that computer-based face intervention did not produce any significant intended behavior modification beyond the specific task fostered. However, new mediums for computer-based training may increase positive learning experiences for children with ASD. For example, integrating the use of smart phone applications into face-based intervention may improve portability and allow for practice to take place in multiple social environments (i.e., at home, school, and with grandma and grandpa). Encompassing the user's existing social community may provide greater generalization of learning with transfer of meaningful skills to the real world. Developing new forms of social media may unlock previously untapped sources of benefit to individuals with ASD.

Further investigation into the etiology of facial expression understanding difficulties experienced by individuals with ASD is required. This study was able to provide only limited explanation for predictors of post performance. While studies have documented predictors in the typical population (Albanese, De Stasio, Di Chiacchio, Fiorilli, & Pons, 2010), better understanding of the variables that predict facial expression understanding difficulties in individuals with ASD would allow for improved investigation of the *TRANS*, and *LFI!* interventions, and the WCC, ToM, and EMB explanatory models.

Mapping areas for growth should enable future researchers to develop face-based learning curriculum. Long term training integrating computer-based interventions such as *TRANS* and *LFI!* with more traditional practices such those described Ryan and Charragain (2010) may provide greater social benefits to individuals with ASD. They taught emotion recognition in hour-long sessions, once a week, for four weeks. Through emotional role playing, production of facial expression artwork, and completion of homework workbooks, 20 children significantly improved their understanding of facial expressions.

In closing, the current study found that *TRANS* and *LFI!* intervention had no significant effect on improving facial expression understanding across a wide range of measures. Due to the lack of effect of these interventions, but in consideration of the limitations of the present study, especially the small sample size, there was insufficient evidence to make judgements on the soundness of the WCC, ToM, and EMB theoretical models. Yet, as an exploratory work, the current study has merit in highlighting areas of future study that may provide meaningful social benefit to individuals with ASD and their families.

Table 1. Means (SD's) and ranges of background variables for the *TRANS*, *LFI!*, and control groups

	TRANS group (n=8)	*LFI!* group (n=6)	Control group (n=7)	*F*(2,18)
Age (in months)	83.1 (31.6) 61-104	79.5 (9.4) 68-92	83.7 (17.5) 51-103	.26
PPVT-4 raw score	103.3 (34.5) 48-151	100.5 (34.6) 51-135	106.9 (27.6) 74-155	.07
PPVT-4 standard score	94.6 (22.3) 68-126	94.8 (25.6) 65-126	97.9 (19.7) 67-124	.05
Days between assessments	60.3 (23.5) 46-116	79.5 (27.5) 48-109	53.1 (11.4) 46-71	2.52

Table 2. Means (SD’s) of the *TRANS*, *LFI!*, and control groups on tasks at Time 1 and 2

	TRANS group		*LFI!* group		Control group	
Tasks	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
TEC						
Emotion recognition (max = 5)	3.88 (1.36)	4.63 (.75)	3.67 (1.75)	4.00 (1.68)	4.72 (.49)	4.72 (.49)
External causes (max = 5)	3.48 (1.69)	3.63 (1.69)	3.34 1.64	3.50 (1.76)	4.00 (1.16)	3.32 (1.07)
TRANS situation facial expression matching test						
Familiar close generalization (max = 15)	10.62 (3.85)	11.75 (3.99)	10.00 (4.20)	10.33 (4.46)	9.71 (3.54)	11.29 (3.86)
Unfamiliar close generalization (max = 15)	9.87 (4.58)	11.13 (4.85)	10.17 (4.62)	10.5 (5.50)	10.57 (3.36)	12.00 (2.52)
Distant generalization (max = 15)	10.38 (5.34)	10.88 (4.12)	9.50 (3.94)	9.67 (4.13)	10.57 (3.29)	10.71 (2.87)
LFI! skills battery: Emotion module						
Name game (%)	56.1 (31.5)	62.7 (30.9)	51.5 (31.0)	55.8 (33.6)	52.2 (24.0)	57.1 (27.2)
Match maker-expression (%)	56.9 (23.4)	63.1 (17.3)	47.5 (25.8)	55.0 (18.4)	52.1 (24.0)	60.0 (19.6)
Parts/whole-Expression (%)	70.4 (18.8)	76.5 (17.5)	72.4 (17.3)	69.9 (19.1)	66.6 (11.6)	66.6 (20.6)

Table 3. Means and (SD's) of implementation fidelity variables for the *TRANS* and *LFI!* groups

	TRANS group (n=8)	*LFI!* group (n=6)
Number of days that participants played the intervention	33.63 (8.68)	38.67 (12.66)
Number of hours that participants played the intervention	23.15 (3.55)	21.13 (1.40)
Number of minutes/day that participants played the intervention	44.00 (13.38)	36.23 (13.02)

Table 4. Repeated measures ANOVA *F* scores and effect sizes

	Time		Group x Time	
Tasks	*F*(1, 18)	η_p^2	*F*(2, 18)	η_p^2
Emotion recognition	5.50*	.23	2.16	.19
External Causes	1.16	.06	.04	.004
Familiar close generalization	11.11**	.38	.88	.09
Unfamiliar close generalization	6.46*	.26	.49	.05
Distant generalization	.59	.03	.12	.01
Name game	2.90	.14	.05	.006
Match maker-expression	5.00*	.22	.98	.003
Parts/whole-expression	.24	.01	1.07	.11

η_p^2 = partial eta squared, ***p* < .005, * *p* < .05

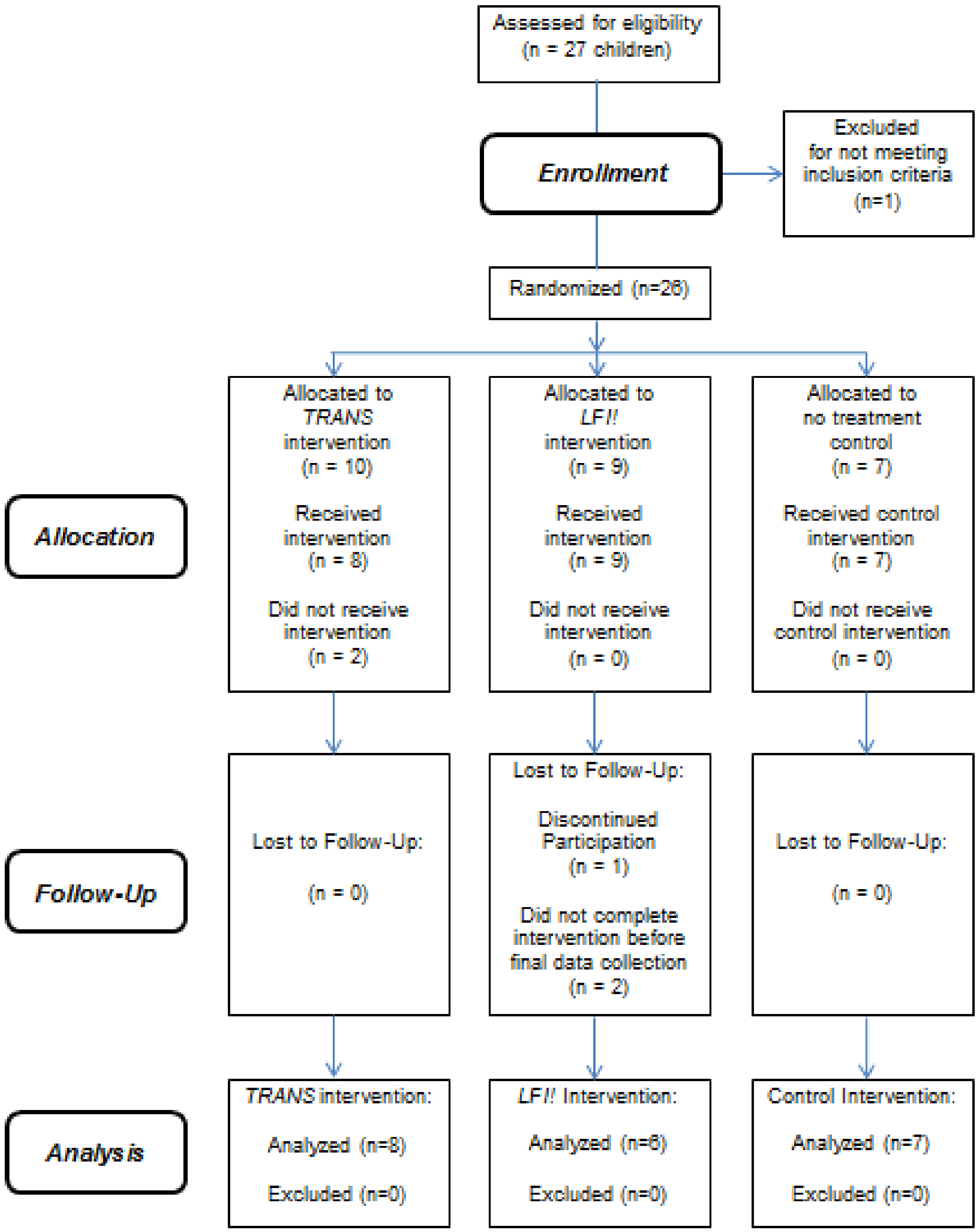

Figure 1. Diagram showing children's progress through the enrollment, allocation, follow-up and analysis phases

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Appendix A,

Parent information letter

UNIVERSITY OF ALBERTA
Department of Educational Psychology
Faculty of Education

6-102 Education North
Edmonton, Alberta, Canada T6G 2G5
www.uofaweb.ualberta.ca/edpsychology
Tel: 780.492.5245
Fax: 780.492.1318

LETTER OF INTRODUCTION

Study Title: A Comparison of Two Computer-Based Programs Designed to Improve Facial Expression Understanding in Children with Autism.

Dear Parents:
This letter introduces the study that we will be undertaking during this school year. We will be undertaking this research as part of the principal investigator's Master's Degree thesis in Special Education. The principal investigator will be supervised under the direction of Dr. Veronica Smith, Associate Professor in the Department of Educational Psychology at the University of Alberta.

Purpose of our study: To learn how to better design programs that improve facial processing and emotional identification skills in children with autism spectrum disorders

What does it mean to participate? In this study we will be comparing two computer-based interventions, both geared to improving facial emotion understanding. Intervention will take place over a recommended six-week period inside the child's home. Three assessment sessions – screening, pre-testing, and post-testing – will take place at either the University of Alberta Education Clinic, or the homes of participants, depending on the wishes of the family. Each assessment session will take approximately 45 minutes and will be administered by a trained graduate student Research Assistant.

Participation will include:

1.) Diagnostic assessment to determine inclusion into the study.
    a. Only children aged 5-8, with normal range verbal ability will be included in this study
    b. We will be using the Peabody Picture Vocabulary Test to assess verbal ability

2.) Children's facial expression understanding will be assessed before the intervention.

3.) Thirty-minute parent consultation in which an intervention kit with detailed program instructions will be shared with primary care givers. Together, we will go over what the intervention will look like and what will be expected from children and parents. This consultation will also enable parents to address any questions or concerns they may have regarding the home-based intervention.

4.) Six weeks of AT-HOME facial emotion understanding intervention. PARTICIPANTS WILL BE RANDOMLY PLACED INTO ONE OF THREE STUDY GROUPS!
   a. Intervention A
   b. Intervention B
   c. No intervention (delayed-intervention control group)
      i. These participants will receive copies of an intervention upon completion of the study.

5.) Parents will keep a record of child use of the intervention (i.e., days and amount of time)

6.) Children's facial emotion understanding will be assessed upon completion of the study

After we have completed the measures with your child, we will be happy to provide you with a report summarizing your child's data.

Family Rights and Confidentiality: If you choose to participate, you will be asked to sign a consent form. You have the right to cancel your permission to use and disclose the information collected about your child at any time. All of the assessment data will be kept completely confidential. **No specific child/family will be referred to by name or identified in any way in the reporting of results.** Only the primary researchers will have access to the data. **The data will not be available to anyone else without your written consent.**

Ethics: The plan for this study has been reviewed for its adherence to ethical guidelines and approved by the Faculty of Education, the Faculty of Extension, and Augustana Research Ethics Board (EEA REB) at the University of Alberta. For questions regarding participant rights and ethical conduct of research, contact the Chair of the EEA REB at (780) 492-3751.

If you are willing to participate in this study, please read and complete the accompanying Consent Form. Please also keep this study introductory description as a piece of your records. If you would like any more information please feel free to contact us via the email addresses or phone numbers below.

Principal Investigator
Andy Sung, B.Ed.
ansung@ualberta.ca
(780) 492-1359

Academic Supervisor
Dr. Veronica Smith
Vs2@ualberta.ca
(780) 492-7425

Thank you for considering your family's participation in our study!

Sincerely,

Andy Sung, B.Ed.

Veronica Smith, Ph.D.
Associate Professor

Appendix B,

Parent consent form

UNIVERSITY OF ALBERTA
Department of Educational Psychology
Faculty of Education
6-102 Education North
Edmonton, Alberta, Canada T6G 2G5
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Tel: 780.492.5245
Fax: 780.492.1318

PARENT CONSENT FORM

Study Title: A Comparison of Two Computer-Based Programs Designed to Improve Facial Expression Understanding in Children with Autism.

Researchers: **Veronica Smith, Ph.D**.
Assistant Professor, Department of Educational Psychology, University of Alberta, 6-102 Education North, Edmonton, AB T6G 0A5
Phone: (780) 492 –7325, Email: veronica.smith@ualberta.ca

Andy Sung, B.Ed.
Masters Student, Department of Educational Psychology, University of Alberta
Phone: (780) 492-1359, Email: ansung@ualberta.ca

(KEEP THIS PORTION FOR YOUR RECORDS)

I have read and understand the attached letter regarding the study entitled, "A Comparison of Two Computer-Based Programs Designed to Improve Facial Expression Understanding in Children with Autism." I have also kept copies of both the letter describing the study and this permission slip.

_____ Yes, I would like my child to participate in this study
_____ No, I do not wish my child to participate

Signature________________________ Name____________________________________

Date____________________________

(DETACH HERE AND RETURN TO RESEARCHERS

I have read and understand the attached letter regarding the study entitled, "A Comparison of Two Computer-Based Programs Designed to Improve Facial Expression Understanding in Children with Autism." I have also kept copies of both the letter describing the study and this permission slip.

_____ Yes, I would like my child to participate in this study.
_____ No, I do not wish my child to participate

Your Child's Name: ____

Signature________________________ Name____________________________________

Date_____________________________ Preference for contact: ______ phone ______email

Please provide your email address if this is your preferred contact:
____

Appendix C,

Examiner's Protocol for TEC, Emotion Recognition subtest,

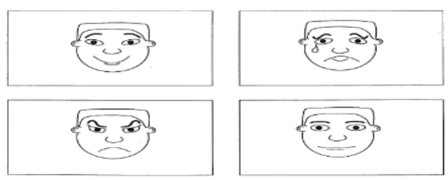
and External Cause of Emotion subtest

Introduction

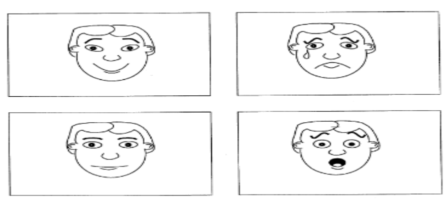
Thank you for helping me with my work. I am going to show you some pictures and then ask you some questions. For every question give me the answer that you think is best by pointing to the picture that you choose. If there is something that you don't understand just tell me, okay? [Turn to p.1.] ***I'm going to write down your answers as we go along.***

Component I: Recognition (pp. 1-5)

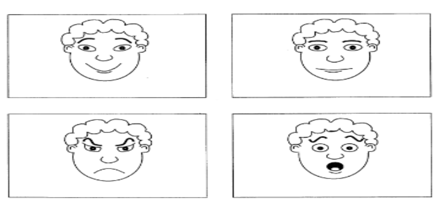
Let's look at these four pictures. Can you point to the person who feels:



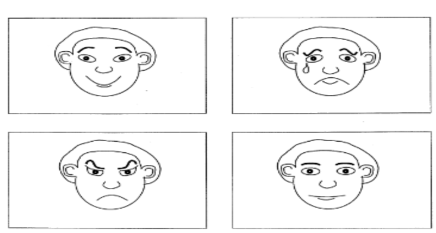
(p.1) ***sad?***



(p.2) ***happy?***

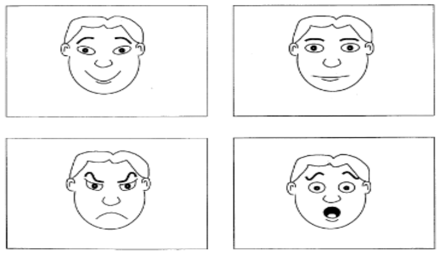


(p.3) ***angry?***



(p.4) ***alright?***

(p.5) ***scared?***



Transition

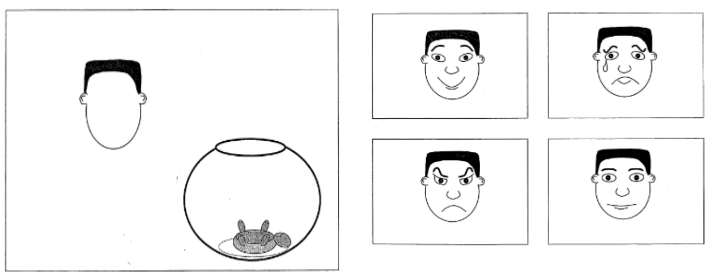
Okay, now we are going to see some stories. I want you to listen to the whole story and then I'll ask you a question. Wait until I've shown you all the pictures before you point to the answer. (go to page 6.)

Component II: External causes (pp.6-10)

(p.6) Turtle

This boy (girl) is looking at his (her) little turtle, which has just died.

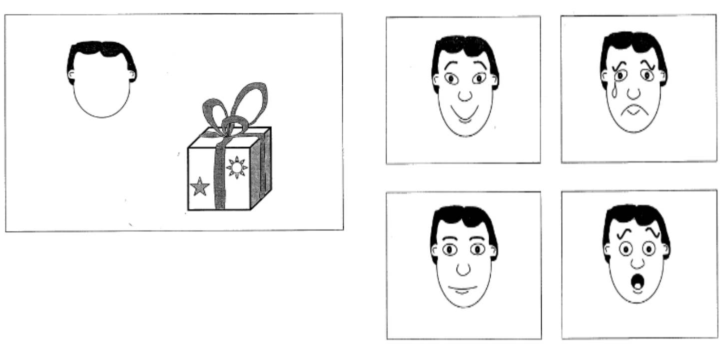
How is this boy (girl) feeling? ***Is he (she) happy, sad, angry or alright?***



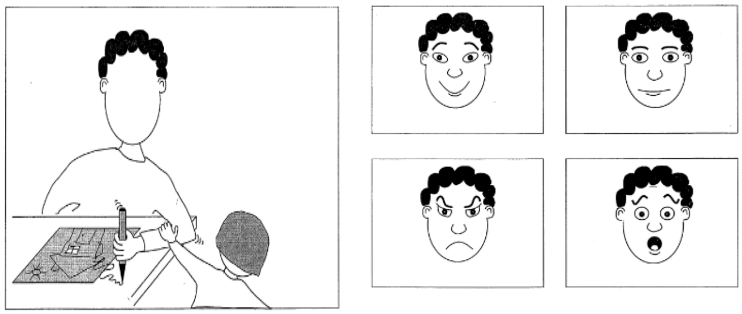
(p.7) Birthday

This boy (girl) is getting a birthday present.

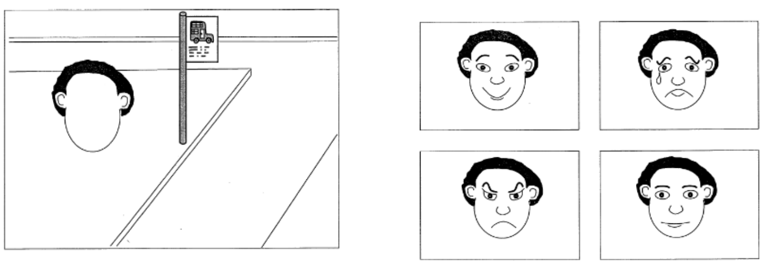
How is this boy (girl) feeling? Is he (she)* happy, sad, alright or scared*?



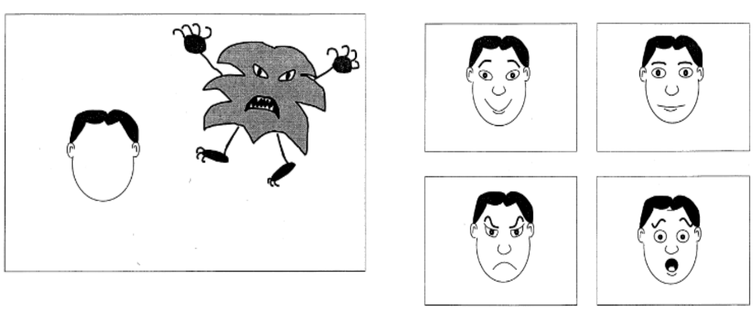
(p.8) Brother
This boy (girl) is trying to do a drawing but his (her) little brother (sister) is stopping him (her). How is this boy (girl) feeling? Is he (she) happy, alright, angry or scared?



(p.9) Bus
This boy (girl) is standing at the bus stop.
How is this boy (girl) feeling? Is he (she) happy, sad, angry or alright?



(p.10) Monster
This boy (girl) is being chased by a monster.
How is this boy (girl) feeling? Is he (she) **happy, alright, angry or scared*?***



Additional Remarks:

Appendix D,

Examiner's Protocol for Situation Facial Expression Matching Test,

Familiar Close Generalization Subtest

A comparison of the effectiveness of two computer-based interventions for improving emotional understanding in children with autism spectrum disorder

Protocol for Administration of Measures

January 2011

SITUATION EXPRESSION MATCHING TEST, FAMILIAR CLOSE GENERALIZATION SUBTEST

MATERIALS NEEDED

- Before administering this test, please be familiar with the **Preliminary Remarks** as outlined below.
- **Situation Expression Matching Test,** Student Version.
- **Situation Expression Matching Test,** Examiner Version.
- A pen/pencil

Preliminary Remarks

- ***The tone of story presentation should be emotionally neutral.***
- ***Always record the child's answer on each item***
- ***Never ask the child to justify his/her answer (only at the end if necessary)***
- If the child responds positively to two or more of the pictures then the examiner asks, while pointing to the options:
- ***Choose the best one for*** *(target emotion)***!**
- ***Always point to the three possible answers before reading the script to the child***
- ***If the child just names the answer then the experimenter has to ask him/her to point the answer. The child does not need to name the answer.***
- If the child fails to produce a response then the examiner points to each picture in turn (left to right,) and asks, while pointing:
- ***Do you think he (she) is****...?*
- If the child responds positively to two or more of the pictures then the examiner asks, while pointing to the options:
- ***Choose the one that you think is best!***
- *Allow enough time to respond.*
- Don't omit any of the items
- Encourage the child to look at all of the picture choices before answering
- Give positive feedback while testing, such as saying

Good!

You are doing well!

That's fine!

- *IMPORTANT NOTE: positive feedback should be similar for both correct and incorrect answers. We don't want to have the child know that they are answering correctly or incorrectly.*

Introduction: Please read the following…

We are going to be looking at some pictures with faces. Your job is to pick the best face that matches each story. Let's start with an example.

For ALL test items, remember to first point to each of the three possible answer pictures. Then, read out loud to the child the caption that appears above each scene picture. Have the child point to the picture they think is correct. Indicate the child's answer on this form with a check mark.

Practice Page 1

(Happy)

Point to each face picture below

You SAY:

Nigel is finished school. It's home time! Point to how Nigel feels.

Indicate the child's answer with a check mark.

If the child gets the right answer, say **great job*!*** *If the child gets the wrong answer, reread the question, point to happy and say,* **"Nigel is happy."**

Angry Happy Sad

Question 1/15

(Tired)

Point to each face picture below

You SAY:

William is moving very slowly. He doesn't have any energy. Point to how William feels.

Tired	Joking	Kind
		

Question 2/15

(Excited)

Point to each face picture below

You SAY:

Charlie is going to get the pieces for the new special clock. Point to how Charlie feels.

Afraid

Ashamed

Excited

Question 3/15

(Angry)

Point to each face picture below

You SAY:

Nigel is stuck in traffic. Nigel honks his horn. Point to how Nigel feels.

Excited

Angry

Tired

Question 4/15

(Happy)

Point to each face picture below

You SAY:

Barney is getting painted nice and shiny. Point to how Barney feels.

Happy

Afraid

Unfriendly

Question 5/15

(Sad)

Point to each face picture below

You SAY:

Jenny is broken. She is stuck. Point to how Jenny feels.

Joking

Happy

Sad

Question 6/15

(Proud)

Point to each face picture below

You SAY:

Charlie finished fixing the broken clamp. Point to how Charlie feels.

Proud

Jealous

Unfriendly

Question 7/15

(Disgusted)

Point to each face picture below

You SAY:

Jenny has to pick up stinky fish. Point to how Jenny feels.

Kind Surprised Disgusted

Question 8/15

(Afraid)

Point to each face picture below

You SAY:

Sally is stuck and it is dark and stormy outside. Point to how Sally feels.

Afraid	Kind	Excited
		

Question 9/15

(Surprised)

Point to each face picture below

You SAY:

When Barney returned from work, his friends were waiting for him and everyone said, "Happy birthday!"
Point to how Barney feels.

Tired	Surprised	Jealous
		

Question 10/15

(Unfriendly)

Point to each face picture below

You SAY:

Charlie does not want to talk with anyone. Point to how Charlie feels.

Kind

Afraid

Unfriendly

Question 11/15

(Kind)

Point to each face picture below

You SAY:

Oliver took the children up the hill. Point to how Oliver feels.

Afraid

Sorry

Kind

Question 12/15

(Jealous)

Point to each face picture below

You SAY:

Oliver is slow, but wants to be faster like a bus. Point to how Oliver feels.

Jealous

Surprised

Tired

Question 13/15

(Sorry)

Point to each face picture below

You SAY:

Nigel broke the window in an accident. Point to how Nigel feels.

Kind

Sorry

Excited

Question 14/15

(Joking)

Point to each face picture below

You SAY:

Dan likes playing around. Point to how Dan feels.

Afraid

Joking

Ashamed

Question 15/15

(Ashamed)

Point to each face picture below

You SAY:

Jenny was late to pick up the people. Point to how jenny feels.

Proud Joking Ashamed

Finish the test: Please read the following…

Thank you again for helping me. Let's move on to something else.

Test Answer Key

Training Page 1:	B
Question 1:	A
2:	C
3:	B
4:	A
5:	C
6:	A
7:	C
8:	A
9:	B
10:	C
11:	C
12:	A
13:	B
14:	B
15:	C

Record Child's Answers as correct (✓) or incorrect (X) in the table below:

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15

Appendix E,

Examiner's Protocol for Situation Facial Expression Matching Test,

Unfamiliar Close Generalization Subtest

A comparison of the effectiveness of two computer-based interventions for improving emotional understanding in children with autism spectrum disorder

Protocol for Administration of Measures

January 2011

SITUATION EXPRESSION MATCHING TEST, UNFAMILIAR CLOSE GENERALIZATION SUBTEST

MATERIALS NEEDED

- Before administering this test, please be familiar with the **Preliminary Remarks** as outlined below.
- **Situation Expression Matching Test,** Student Version.
- **Situation Expression Matching Test,** Examiner Version
- A pen/pencil

Preliminary Remarks

- ***The tone of story presentation should be emotionally neutral.***
- ***Always record the child's answer on each item***
- ***Never ask the child to justify his/her answer (only at the end if necessary)***
- If the child responds positively to two or more of the pictures then the examiner asks, while pointing to the options:
- ***Choose the best one for*** *(target emotion)****!***
- ***Always point to the three possible answers before reading the script to the child***
- ***If the child just names the answer then the experimenter has to ask him/her to point the answer. The child does not need to name the answer.***
- If the child fails to produce a response then the examiner points to each picture in turn (left to right,) and asks, while pointing:
- ***Do you think he (she) is****...?*
- If the child responds positively to two or more of the pictures then the examiner asks, while pointing to the options:
- ***Choose the one that you think is best!***
- *Allow enough time to respond.*
- Don't omit any of the items
- Encourage the child to look at all of the picture choices before answering
- Give positive feedback while testing, such as saying

Good!

You are doing well!

That's fine!

- *IMPORTANT NOTE: positive feedback should be similar for both correct and incorrect answers. We don't want to have the child know that they are answering correctly or incorrectly.*

Introduction: Please read the following…

We are going to be looking at some pictures with faces. Your job is to pick the best face that matches each story. Let's start with an example.

For ALL test items, remember to first point to each of the three possible answer pictures. Then, read out loud to the child the caption that appears above each scene picture. Have the child point to the picture they think is correct. Indicate the child's answer on this form with a check mark.

Practice Page 1

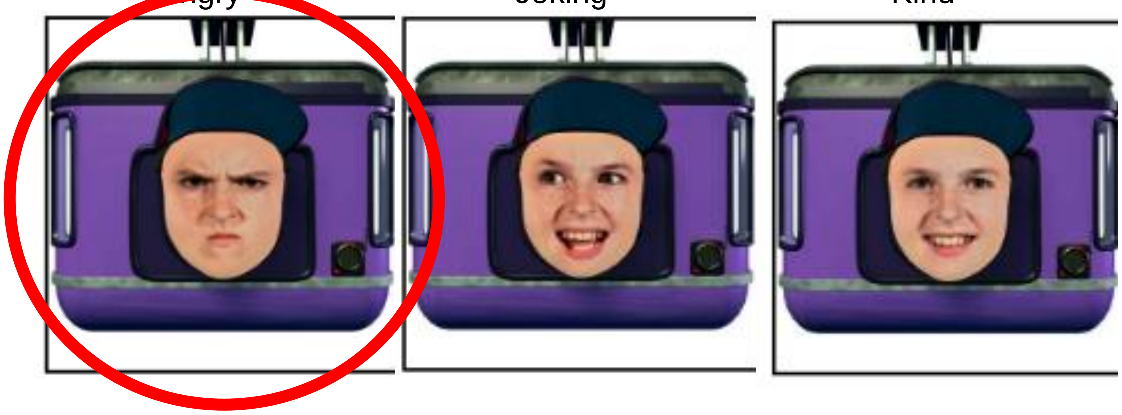
(Angry)

Point to each face picture below

You SAY:

Dan does not like waiting in line. Point to how Dan feels.

Angry Joking Kind



Question 1/15

(Afraid)

Point to each face picture below

You SAY:

William sees a hungry shark in the water. Point to how William feels.

Happy

Afraid

Kind

Question 2/15

(Excited)

Point to each face picture below

You SAY:

Oliver got ice cream and candy at the party. Point to how Oliver feels.

Excited

Ashamed

Disgusted

Question 3/15

(Angry)

Point to each face picture below

You SAY:

Sally was late and missed the class fieldtrip. Point to how Sally feels.

Joking

Kind

Angry

Question 4/15

(Happy)

Point to each face picture below

You SAY:

Dan is having his picture taken. Point to how Dan feels.

Tired

Happy

Jealous

Question 5/15

(Sad)

Point to each face picture below

You SAY:

Everyone is yelling at William. Point to how William feels.

Joking

Proud

Sad

Question 6/15

(Proud)

Point to each face picture below

You SAY:

Jenny won first place in the race. How does Jenny feel?

Proud

Ashamed

Unfriendly

Question 7/15

(Disgusted)

Point to each face picture below

You SAY:

Somebody made a mess inside Nigel's bus. Point to how Nigel feels.

Joking

Disgusted

Tired

Question 8/15

(Afraid)

Point to each face picture below

You SAY:

Jenny is lost from her mom. Point to how Jenny feels.

Jealous

Excited

Afraid

(Surprised)

Point to each face picture below

You SAY:

The fire drill suddenly rang while Dan was at school. How does Dan feel?

Tired

Surprised

Unfriendly

Question 10/15

(Unfriendly)

Point to each face picture below

You SAY:

William wanted everybody to go away and leave him alone. Point to how William feels.

Unfriendly

Surprised

Kind

Question 11/15

(Kind)

Point to each face picture below

You SAY:

Dan always shares his toys with his little brother. Point to how Dan feels.

Afraid Angry Kind

Question 12/15

(Jealous)

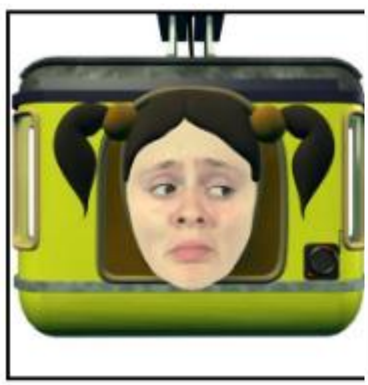
Point to each face picture below

You SAY:

Sally wants a later bedtime but her mom and dad said no. How does Sally feel?

Happy

Jealous



Excited

Question 13/15

(Sorry)

Point to each face picture below

You SAY:

William was sent to time out for shouting. Point to how William feels.

Joking

Happy

Sorry

Question 14/15

(Joking)

Point to each face picture below

You SAY:

Nigel likes to be funny and make people laugh. Point to how Nigel feels.

Joking

Unfriendly

Sad

Question 15/15

(Ashamed)

Point to each face picture below

You SAY:

Charlie forgot to visit his grandpa. Point to how Charlie feels.

Joking

Ashamed

Excited

Finish the test: Please read the following…

Thank you again for helping me. Let's move on to something else.

Test Answer Key

Training Page 1:	A
Question 1:	B
2:	A
3:	C
4:	B
5:	C
6:	A
7:	B
8:	C
9:	B
10:	A
11:	C
12:	B
13:	C
14:	A
15:	B

Record Child's Answers as correct (✓) or incorrect (X) in the table below:

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15

Appendix F,

Examiner's Protocol for Situation Facial Expression Matching Test,

Distant Generalization Subtest

A comparison of the effectiveness of two computer-based interventions for improving emotional understanding in children with autism spectrum disorder

Protocol for Administration of Measures

January 2011

SITUATION EXPRESSION MATCHING TEST, DISTANT GENERALIZATION SUBTEST

MATERIALS NEEDED

1. Before administering this test, please be familiar with the **Preliminary Remarks** as outlined below.
2. **Situation Expression Matching Test,** Student Version
3. **Situation Expression Matching Test,** Examiner Version
4. A pen/pencil

Preliminary Remarks

- ***The tone of story presentation should be emotionally neutral.***
- ***Always record the child's answer on each item***
- ***Never ask the child to justify his/her answer (only at the end if necessary)***
- If the child responds positively to two or more of the pictures then the examiner asks, while pointing to the options:
- ***Choose the best one for*** *(target emotion)****!***
- ***Always point to the three possible answers before reading the script to the child***
- ***If the child just names the answer then the experimenter has to ask him/her to point the answer. The child does not need to name the answer.***
- If the child fails to produce a response then the examiner points to each picture in turn (left to right,) and asks, while pointing:
- ***Do you think he (she) is****...?*
- If the child responds positively to two or more of the pictures then the examiner asks, while pointing to the options:
- ***Choose the one that you think is best!***
- *Allow enough time to respond.*
- Don't omit any of the items
- Encourage the child to look at all of the picture choices before answering
- Give positive feedback while testing, such as saying

Good!

You are doing well!

That's fine!

- *IMPORTANT NOTE: positive feedback should be similar for both correct and incorrect answers. We don't want to have the child know that they are answering correctly or incorrectly.*

Introduction: Please read the following…

We are going to be looking at some pictures with faces. Your job is to pick the best face that matches each story. Let's start with an example.

For ALL test items, remember to first point to each of the three possible answer pictures. Then, read out loud to the child the caption that appears above each scene picture. Have the child point to the picture they think is correct. Indicate the child's answer on this form with a check mark.

Practice Page 1

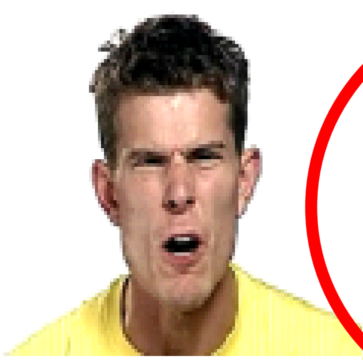
(Happy)

Point to each face picture below

You SAY:

Kyle found his favorite book. Point to how Kyle feels?

Angry



Happy

Sure

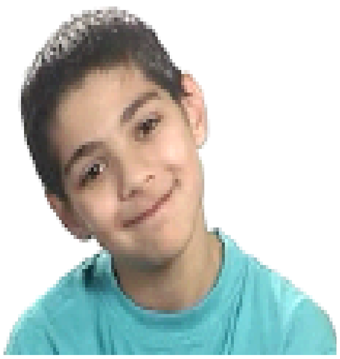
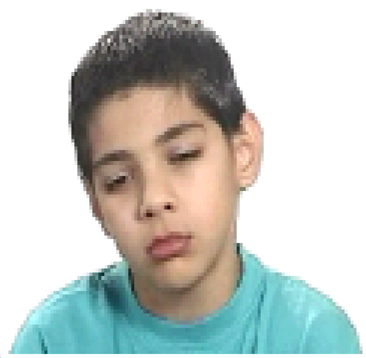
Question 1/15

(Tired)

Point to each face picture below

You SAY:

**Tommy is home from school. Tommy wants to lay down.
Point to how Tommy feels.**

Proud	Angry	Tired
		

Question 2/15

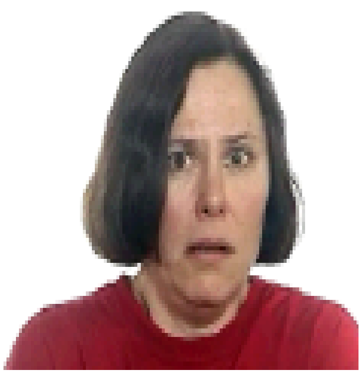
(Afraid)

Point to each face picture below

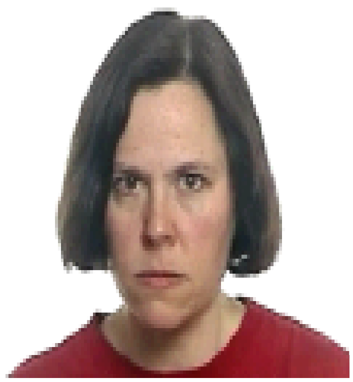
You SAY:

The neighbor’s dog has bitten people before. He is barking at Louise. Point to how Louise feels?

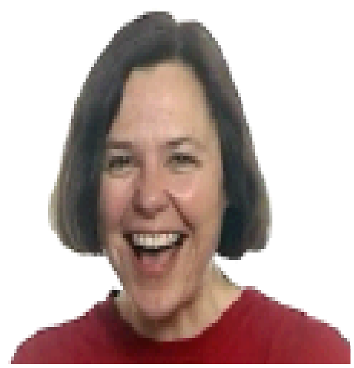
Afraid



Angry



Joking



Question 3/15

(Excited)

Point to each face picture below

You SAY:

**Andy is going to the store to buy his favorite movie DVD.
Point to how Andy feels.**

Excited

Thinking

Afraid

Question4/15

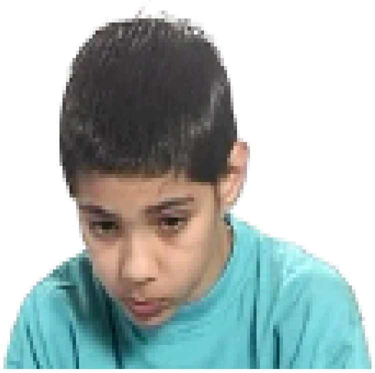
(Proud)

Point to each face picture below

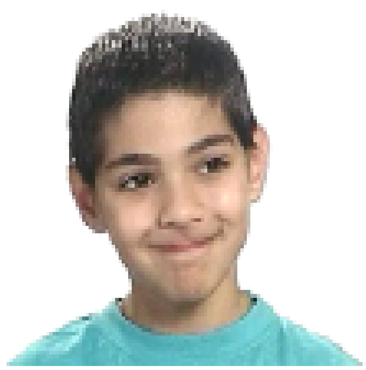
You SAY:

**Tommy helped his mom to bake cookies.
Point to how Tommy feels.**

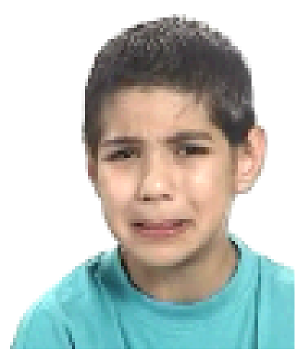
Ashamed



Proud



Sad



Question 5/15

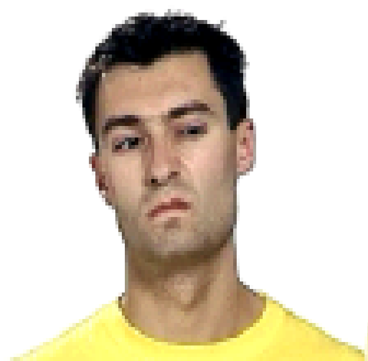
(Sorry)

Point to each face picture below

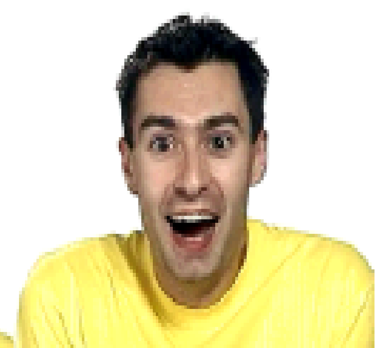
You SAY:

. **Jacob spilled paint on the teacher. Point to how Jacob feels**

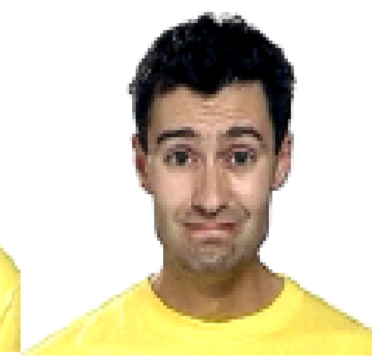
Jealous



Excited



Sorry



Question 6/15

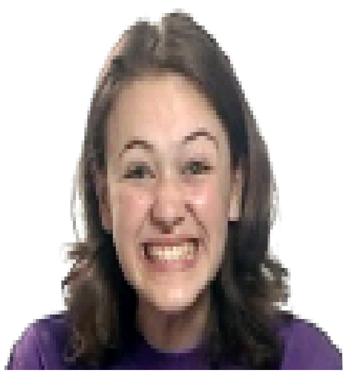
(Unfriendly)

Point to each face picture below

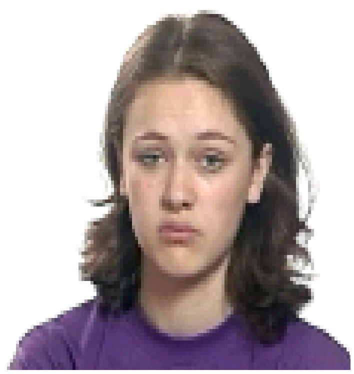
You SAY:

Tanya does not want anyone to bother her. Point to how Tanya feels.

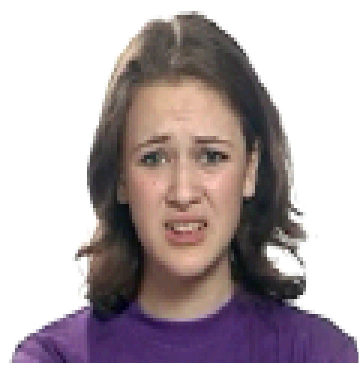
Excited



Unfriendly



Afraid



Question 7/15

(Joking)

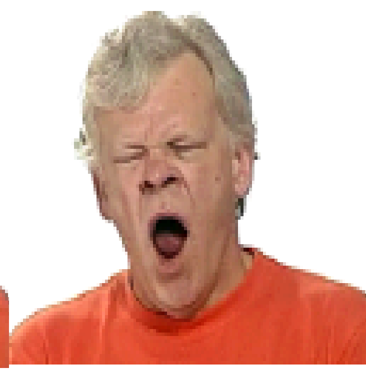
Point to each face picture below

You SAY:

Henry is very funny and likes to make people laugh.
Point to how Henry feels.

Joking

Tired



Sorry

Question 8/15

(Ashamed)

Point to each face picture below

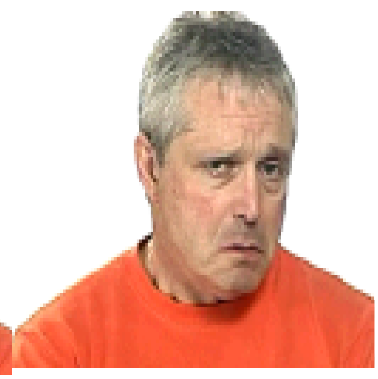
You SAY:

**Bill was mean to his friend. Now he wishes he hadn't been.
Point to how Bill feels.**

Happy

Safe

Ashamed



Question 9/15

(Disgusted)

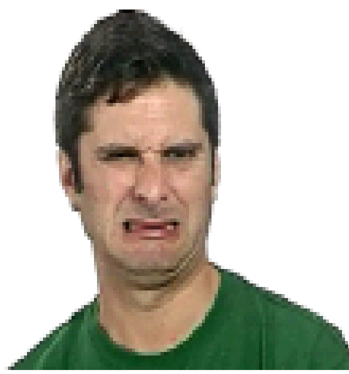
Point to each face picture below

You SAY:

Kyle's mom made liver. Kyle hates liver. Point to how Kyle feels.

Kind

Disgusted



Cheerful

Question 10/15

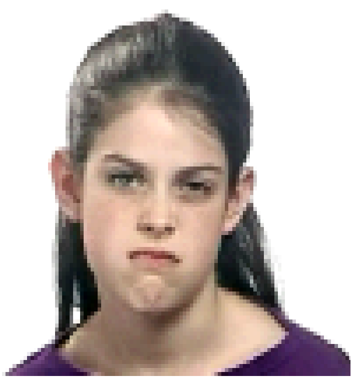
(Surprised)

Point to each face picture below

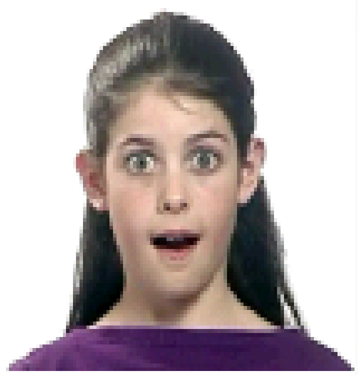
You SAY:

Shelly came home and found a new bike for her. Point to how Shelly feels.

Kind



Surprised



Sad

Question 11/15

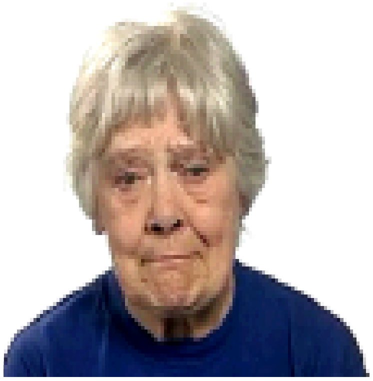
(Sad)

Point to each face picture below

You SAY:

Carly's son promised to buy her flowers. He forgot and Carly did not get any flowers. Point to how Carly feels.

Sad



Caring

Playful

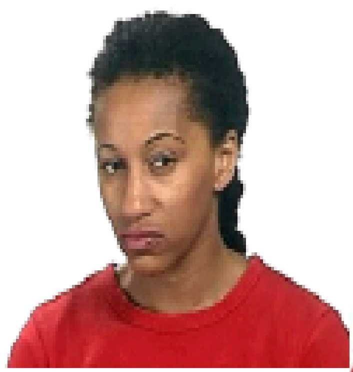
Question 12/15

(Jealous)

Point to each face picture below

You SAY:

Sandy and her brother always get candy, but today, only her brother got candy. Point to how Sandy feels.

Adventurist	Jealous	Liked
		

Question 13/15

(Kind)

Point to each face picture below

You SAY:

**Theresa picked flowers and gave them to her daughter.
Point to how Theresa feels?**

Disgusted | Complaining | Kind

Question 14/15

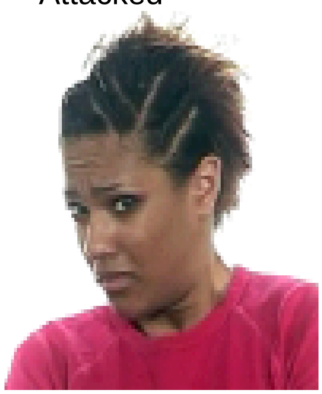
(Happy)

Point to each face picture below

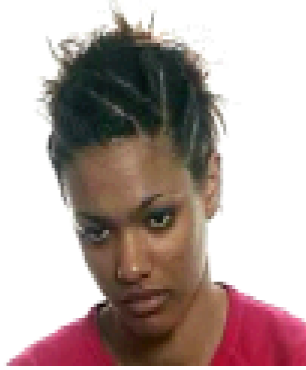
You SAY:

Katy’s class went on a zoo fieldtrip. Point to how Katy feels.

Attacked



Tired



Happy

Question 15/15

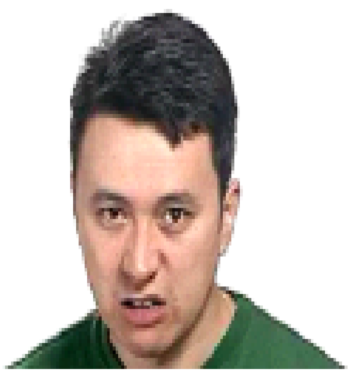
(Angry)

Point to each face picture below

You SAY:

Eric lost his favorite train. Point to how Eric feels.

Angry



Kind

Happy

Finish the test: Please read the following…

Thank you again for helping me. Let's move on to something else.

Test Answer Key	
Training Page 1:	B
Question 1:	C
2:	A
3:	A
4:	B
5:	C
6:	B
7:	A
8:	C
9:	B
10:	B
11:	A
12:	B
13:	C
14:	C
15:	A

Record Child's Answers as correct (✓) or incorrect (X) in the table below:

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15

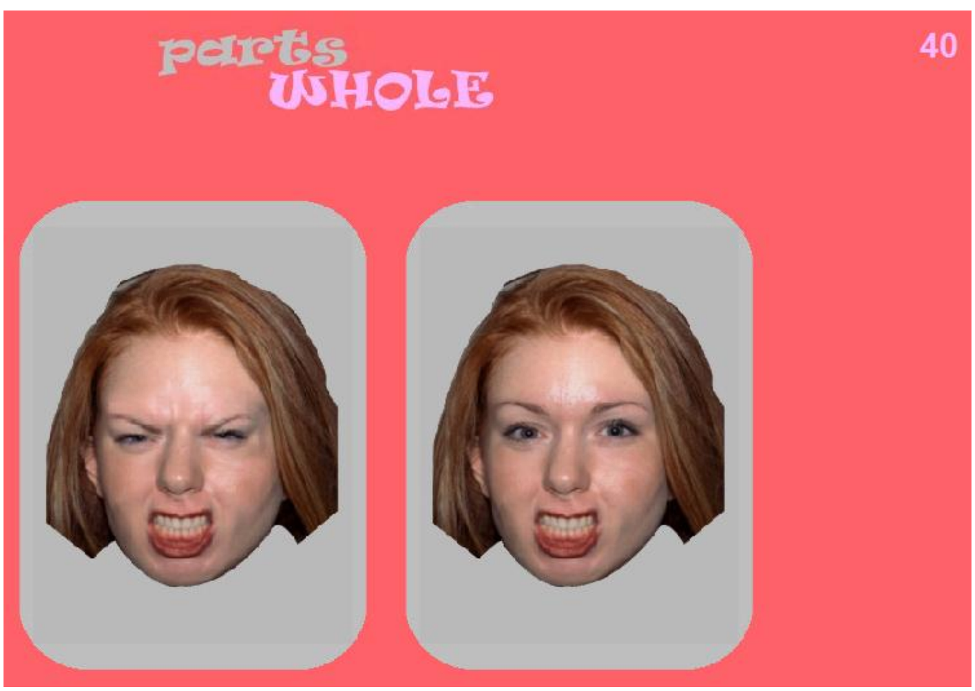
Appendix G,

Screen Capture from the LFI! Skills Battery: Emotion Module,

Name Game Subtest

Study face depicting consistent facial expression

Face part and its foil embedded within a whole face

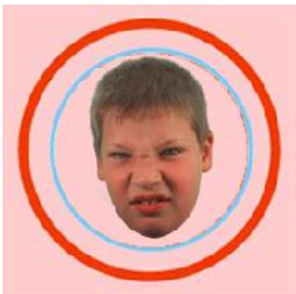


Appendix H,

Screen Capture from the LFI! Skills Battery: Emotion Module,

Match Maker Expression Subtest

Study face depicting happy, angry, sad, disgusted, or frightened



Three probe faces of different identities

Appendix I,

Screen Capture from the LFI! Skills Battery: Emotion Module,

Parts/Whole-Expression Subtest

Study face depicting happy, angry, sad, disgusted, surprised, and fearful

Appendix J,

The Transporters Time Log

Child name:________________ Person Completing Form:_________________

Date:	Number of Minutes Playing DVD:	Total Number of Episodes Viewed:
Child's Level of Enjoyment 1 Did not enjoy 2 3 somewhat enjoyed 4 5 really enjoyed		
After playing, did you ask questions from the Transporter's User's guide? YES / NO		
Additional questions, thoughts, or comments:		

Date:	Number of Minutes Playing DVD:	Total Number of Episodes Viewed:
Child's Level of Enjoyment 1 Did not enjoy 2 3 somewhat enjoyed 4 5 really enjoyed		
After playing, did you ask questions from the Transporter's User's guide? YES / NO		
Additional questions, thoughts, or comments:		

Date:	Number of Minutes Playing DVD:	Total Number of Episodes Viewed:
Child's Level of Enjoyment 1 Did not enjoy 2 3 somewhat enjoyed 4 5 really enjoyed		
After playing, did you ask questions from the Transporter's User's guide? YES / NO		
Additional questions, thoughts, or comments:		

Appendix K,

Let's Face It! Time Log

Child name:________________ Person Completing Form:_________________

Date:	Number of Minutes Spent Playing Game:			
Child's Level of Enjoyment				
1 Did not enjoy	2	3 somewhat enjoyed	4	5 really enjoyed
Additional questions, thoughts, or comments:				

Date:	Number of Minutes Spent Playing Game:			
Child's Level of Enjoyment				
1 Did not enjoy	2	3 somewhat enjoyed	4	5 really enjoyed
Additional questions, thoughts, or comments:				

Date:	Number of Minutes Spent Playing Game:			
Child's Level of Enjoyment				
1 Did not enjoy	2	3 somewhat enjoyed	4	5 really enjoyed
Additional questions, thoughts, or comments:				