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Multiple Baseline Study Of The Effects Of Left Visual Field Stimulation During Emotion Recognition Training Among Four Male Children With Autism Spectrum Disorders

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MULTIPLE BASELINE STUDY OF THE EFFECTS OF LEFT VISUAL FIELD STIMULATION DURING EMOTION RECOGNITION TRAINING AMONG FOUR MALE CHILDREN WITH AUTISM SPECTRUM DISORDERS

by

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This dissertation, submitted by Rachelle Hansen in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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To 5 Reasons

ABSTRACT

Autism Spectrum Disorders (ASD) are characterized by social deficits in emotional comprehension. Research has demonstrated that for the neurotypical population, recognizing, and reacting to facial emotions improve when using the left visual field by employing the right brain hemisphere's configural processes. Behavioral, physiological, and neuroimaging findings suggest an opposite pattern within the autistic population – left hemisphere activation contributing to a right visual field preference for analyzing and assessing facial affect. The present study attempted to activate and strengthen the right hemispheric neural pathway responsible for emotion recognition using modified eyewear to contrive left visual field stimulation during an empirically supported emotion recognition intervention designed for the ASD population, *The Transporters* DVD series. A multiple baseline design across four male participants (*Mean Age* = 9.23) with similar verbal and autistic levels was used to investigate improvements in emotion recognition over the course of a 6-week intervention with the four participants viewing *The Transporters* for 3 weekly 30-minute sessions while wearing the modified eyewear for 0, 2, 4, and 6 weeks, respectively. Pre- and post-intervention tasks assessing emotion vocabulary and situation-expression matching corroborated the previously reported efficacy for *The Transporters* and provided evidence of greater gains for participants who viewed the intervention with the modified eyewear. Improvement in performance on emotion recognition tasks administered during each session supported an effect of lateralized left visual field stimulation via modified eyewear. However, an additive effect was not clearly defined. Clinical implications may include using lateralization eyewear with other social-emotional interventions to enhance social skills in children with ASD.

Keywords: autism, emotion recognition training, lateralization, left visual field, eyewear

CHAPTER I

INTRODUCTION

Human interactions rely on developing social competence for individuals to navigate successfully and effectively through the social environment. Impairments in social skills can be pervasive, extending well beyond social functioning and negatively affecting emotional, cognitive, adaptive, academic, and occupational domains (Deeley et al., 2007; Yirmiya, Sigman, Kasari, & Mundy, 1992). Children with Autism Spectrum Disorders (ASD) are at risk for social deficits, as the core features of ASD include a lack of emotional reciprocity and difficulty in recognizing and understanding affective states in themselves and others (American Psychiatric Association [APA], 2013). Emotion recognition is crucial to social development (Hobson, Ousten, & Lee, 1988) with impairments significantly reducing participation in the social environment, clouding interpretation of social interactions, and reducing overall social competence.

Cognitive Processes of Facial Affect Recognition

Recognizing facial affect involves two types of cognitive processes: analytical and holistic (Grelotti, Gauthier, & Schultz, 2002; Hobson et al., 1988). These processes are lateralized, with the left cerebral hemisphere analyzing details of the visual input and the right hemisphere synthesizing visual elements into a perceived whole (Carlson, 2008). In the left hemisphere, facial emotions are recognized by independent properties through a process known as "piecemeal encoding" (Celani, Battacchi, & Arcidiacono, 1999; Hay & Cox, 2000). The right hemisphere, together with subcortical limbic structures, uses "perceptual Gestalt" to understand the overall meanings of emotions (Brosnan, Scott, Fox, & Pye, 2004; Plaisted, Dobler, Bell, & Davis, 2006).

Numerous studies have demonstrated a lateralized process in facial affect recognition, based on the understanding that visual stimuli presented in the left visual field cross over at the optic chiasm and activate the contralateral right hemisphere of the brain (e.g., Bourne, 2008; Piggot et al., 2004; Yovel, Tambini, & Brandman, 2008). Functional magnetic resonance imaging (fMRI) has confirmed a predominance of right-side activation for social processes (Nakamura et al., 1999; Schultz et al., 2003; Yovel et al., 2008). Lateralization has also been observed within the fusiform gyrus (FG), the visual association cortex implicated in recognizing facial stimuli and other complex objects of expertise (Gauthier, Behrmann, & Tarr, 2004; Haxby, Horwitz, Ungerleider, & Maisog, 1994). More specifically, hyperactivation of the right hemisphere FG compared to the left FG has been found when individuals view emotional faces (Ashwin, Chapman, Colle, & Baron-Cohen, 2006; Schultz et al., 2003). Behavioral evidence, such as faster response times and improved accuracy, have supported a left visual field/right hemisphere bias for recognizing and comprehending visual emotions (Adolphs, Baron-Cohen, & Tranel, 2002; Bourne, 2008; Hansen, 2011; Yovel et al., 2008). Physiological indices have pointed to neurotypical lateralization in emotion recognition processes (Bölte, Feineis-Matthews, & Poustka, 2008); when viewing pictures of facial emotions, heart rates tend to increase when using the left visual field, as opposed to decreases in heart rates when using the right visual field (Hansen, 2011; Hansen Brindley, Schmidt, & Spear, 2009).

The cognitive processes for facial affect recognition have been found to differ for individuals with ASD when compared with neural processes recruited by individuals with typical development (TD). Studies using the inversion effect (Hadjikhani et al., 2004; Pierce, Müller, Ambrose, Allen, & Courchesne, 2001; Rosset et al., 2008) have demonstrated that ASD participants tend to use "piecemeal" strategies in emotion recognition. When the facial stimuli were presented upside-down, children with ASD were more accurate in labeling emotional expressions than children with TD, suggesting a memorized, rule-oriented understanding of emotional expression. ASD participants have also been found to identify emotions with the same accuracy as neurotypical controls with increased exposure time to the facial stimuli (Clark, Winkielman, & McIntosh, 2008; Humphreys, Minshew, Leonard, & Behrmann, 2007), suggesting that reliance on the right hemisphere's analytical and "piecemeal" cognitive approach may contribute to slower response times. Collective results suggest that individuals with ASD seem to deduce emotions by quantitatively assessing specific features (e.g, a turned up mouth, a furrowed brow, etc.) rather than perceptually understanding the emotion (Grelotti et al., 2002; Pellicano, Jeffery, Burr, & Rhodes, 2007).

Differences in emotional processing circuitry of the amygdala and FG have been found in individuals with ASD, including less activation in these cerebral areas than activation levels found in typical controls (Ashwin, Wheelwright, & Baron-Cohen, 2005; Piggot et al., 2004). These neuronal processes are functional, rather than organic, in nature as they respond to other areas of expertise (e.g., trains, Pokémon cards, and cartoons) but are not dominantly activated by facial stimuli (Critchley et al., 2000; Grelotti et al., 2005). Without physical brain damage implicated in the diagnosis of ASD, the pathology of symptomatic emotional deficits might be attributed to disconnections or underdevelopment of processing paths for visual face stimuli and emotional perception (Hobson, 1991; Schultz et al., 2003). Research suggests that the neuronal circuitry involved in emotional recognition is intact but improperly recruited in individuals with ASD. Thus, prospective interventions that necessitate the correct use of emotion recognition circuitry may involve training individuals to improve intact but underused attribution strategies.

In addition to finding hypoactivation of the typical neuronal pathways involved in emotion recognition, studies have also found differences in asymmetrical reactivity to facial stimuli between TD and ASD populations. Deeley et al. (2007) demonstrated that individuals with ASD show four times less activation of the right hemisphere FG than individuals with TD. Individuals with ASD were also found to demonstrate widely varying neurological patterns of responding to emotional face stimuli. Individuals with ASD were not only hypoactive for facial stimuli in the right brain hemisphere, but also hyperactive in the left hemisphere when compared with control profiles (Pellicano et al., 2007; Wang, Dapretto, Hariri, Sigman, & Bookheimer, 2004). When taking into account the lateralization found in emotional processing, the right hemisphere's FG would theoretically have a larger role in the emotional comprehension of faces. Accordingly, overreliance on the left hemisphere and underdevelopment of the right hemisphere FG are proposed factors in the deficits for emotional comprehension often seen in disorders of the autism spectrum (Yovel et al., 2008).

Adding to these literature findings, two studies (Hansen, 2011; Hansen Brindley, et al., 2009) using the same modified eyewear design employed in the present study found lateralization differences between groups of TD and ASD children. Thirty-two children with ASD were found to have a significantly faster mean pulse rate when viewing static pictures of facial affect using the right visual field as compared with pulse rates when viewing stimuli with the left or both visual fields. In contrast, pulse rates of age- and gender-matched TD controls trended toward a left visual field preference by demonstrating fastest pulse rates when using the left visual field, slower pulse rates when using both visual fields, and slowest pulse rates when using the right visual field. Child participants with ASD also tended to demonstrate shorter reaction times and higher accuracy rates when using the right visual field to assess facial emotions compared to response and accuracy rates when using the left visual field. Results also confirmed an inverse relationship between impairments in executive functioning and autistic trait level, as well as larger differences in pulse rate, reaction time, and accuracy rates measured under left and right visual field conditions. Greater differences in pulse rate, reaction time, and percent accuracy between left and right visual field performance and between both visual field performance and right visual field performance were found to be significantly predictive of increased autistic trait level. Regression models explained up to half of the variance in the level of autistic symptoms when impairments in executive functioning were included, signifying the noteworthy roles that emotion recognition skills and the lateralization processes seem to play in ASD symptomology.

Development of Emotion Recognition

The skill to recognize and discriminate emotional expressions is present in neurotypical infants from at least 10 weeks of age (Haviland & Lelwica, 1987). Emotion recognition then develops across childhood into adolescence (Herba, Landau, Russell, Ecker, & Phillips, 2006) and becomes relatively stable by early adulthood (Isaacowitz et al., 2007; Sullivan, Ruffman, & Hutton, 2007). Emotion identification processes have been found to follow non-linear developmental patterns for children (Karayanidis, Kelly, Chapman, Mayes, & Johnston, 2009). In children with typical development, emotion recognition accuracy improves substantially from infancy to preschool age (e.g., Boyatzis, Chazan, & Ting, 1993; Herba et al., 2006). A temporary plateau or “developmental dip” occurs in performance gains between the ages of 10 and 14 years (e.g., Soppe, 1988, Karayanidis et al., 2009). Inaccuracies in interpreting different emotion categories and subtlety of expressions are apparent through middle childhood and into adulthood (Gao & Maurer, 2010), suggesting that adults experience minor but continuous improvement in emotion assessment.

Furthermore, efficiency for processing emotional expressions develops at a slower rate than the ability to quickly recognize and identify faces and specific facial features of emotions (e.g., eye shape, mouth direction; Tonks, Williams, Frampton, Yates, & Slater, 2007). Older children tend to focus on eyes alone to decipher facial expressions, while younger children seem to scan a larger area of the face and spend more time exploring the mouth before identifying an emotion. A study comparing neurotypical adult and child face processing found adults to use a fast-responding right-lateralized neural pathway, while children's neural activity for facial stimuli was significantly less prominent and not lateralized (Kylliäinen, Braeutigam, Hietanen, Swithenby, & Bailey, 2006). These findings provide possible reasoning for why neurotypical adolescents are often similar to adults in accuracy and speed when making expression judgments, and why both adults and adolescents perform more efficiently than middle-aged to young children. Overall, developmental research suggests a maturation of neural pathways for face processing with children relying less on feature-based processes as they mature into adolescence and becoming more proficient in using categorical approaches to decipher emotions (Freitag & Schwarzer, 2011; Vida & Mondloch, 2009).

Developmental differences in emotional processing are relevant to individuals with ASD and are main features of autism. Indeed, the developmental course of emotion recognition skills in children with ASD has not been found to follow the same course for neurotypical emotional processing. Findings presented by Rump and colleagues (2009) suggest that the emotion recognition skills of young children with ASD lag behind same-aged peers, but "catch up" between the ages of 8 and 12 years to the level of the emotional processing skills demonstrated by typically developing peers. Emotion attribution abilities of children with ASD seem to remain relatively comparable to children with TD through early adolescence. Yet, by adulthood, individuals with ASD seem to perform no better than 8- to 12- year-old children with ASD, particularly when assessing prolonged presentations of stimuli depicting overt rather than subtle emotions (Rump et al., 2009). In contrast, individuals with typical development continue to gain expertise and refine their skills in recognizing emotion expression into adulthood.

Overall, developmental research suggests that autistic children may not be in need of developing new or different underlying process for emotion recognition but instead are delayed in their developmental progression of these skills, relying more heavily on the left hemisphere-mediated top-down configural approach. If neurotypical children seem to become emotion experts by progressively increasing reliance on the holistic understanding of emotions mediated through the right-hemisphere neural systems (Gautheir, et al., 2004; Rossion, Gauthier, Goffaux, Tarr, & Crommelinck, 2002), perhaps the right hemispheric neural pathway could be conditioned and strengthened in individuals with autism and allow them to learn and develop these needed skills.

Bölte and colleagues (2006) examined whether facial affect recognition training would increase activation of the FG in ten higher-functioning male adolescent and adult individuals with ASD. Following five two-hour weekly sessions of computer-based training designed to improve emotion recognition, blood oxygenation level-dependent functional magnetic resonance imaging (BOLD fMRI) was used to assess pre- and post-training changes in the FG and other associated regions of interest. In addition to improvement in behavioral measures, trained participants were found to have higher BOLD fMRI signals in the superior parietal lobule and maintained activation in the right medial occipital gyrus compared to pre-training imaging.

Faja and colleagues (2012) also found improvement in behavioral performance and changes in brain activity in sixteen male adults with high-functioning ASD after receiving eight computerized sessions of facial emotion training. Baseline ERP measurements prior to training found atypical P100 and N170 patterns, two areas identified in early visual analysis and structural analysis of neurotypical facial processing (Herrmann, Ehlis, Ellgring, & Fallgatter, 2005). When assessing post-intervention event-related brain potentials (ERPs), participants who received training showed electrophysiological changes to faces in the P100 component, while the control ASD group demonstrated no ERP changes.

Results demonstrate that adults with ASD, who receive emotional training, can improve in behavioral responses and experience changes in neural activation that reflect more typical patterns of facial affect processing. Considering that the developmental course of neurotypical emotion recognition abilities includes improvements occurring beyond adolescence and into young adulthood, several researchers (e.g., Dawson & Zanolli, 2003) argue that due to brain plasticity, early intervention to enhance emotion and face processing may prove even more effective in helping children with social impairments. Perhaps early and effective emotion recognition training can retrain and potentiate neural pathways in children with ASD to develop use of a more mature and efficient Gestalt-processing strategy. These neuronal changes would theoretically enable improvement in noticing and ultimately understanding a range of complex emotional cues.

Targeting Facial Affect Recognition in Social Skills Therapy

Numerous studies have demonstrated that long-term outcomes for children with ASD greatly improve with early diagnosis and interventions (Scarborough et al., 2004; Stahmer & Gist, 2001; Vismara, Colombi, & Rogers, 2009). However, establishing which interventions are most effective or appropriate becomes complicated by the scope, severity, and diversity of symptoms associated with ASD. Furthermore, the range of available interventions is as wide and varied as the individuals on the spectrum. Sorting through the overwhelming number of treatment options can be a daunting task for parents who are already occupied with the day-to-day stressors of raising a child with special needs. Further complicating the decision-making process in choosing an ASD treatment is the lack of empirical research for the majority of interventions. Most ASD therapies have yet to undergo rigorous scientific review and lack substantial empirical support. Parents are often left to rely on anecdotal evidences from other parents, developers, and advocates to determine the effectiveness of a particular treatment. According to results from a world-wide internet survey completed by over 500 parents of children with ASD (Green et al., 2006), a total of 111 treatments were identified as being currently used with parents employing an average of seven concurrent treatments to help their children with ASD. Treatment options varied in level of empirical validation with many of the most commonly used treatments lacking scientific data to help clarify which treatments are preferred (Baranek, 2002; Dawson & Watling, 2000; Heflin & Simpson, 1998).

The subset of therapeutic tools designed to specifically target social/emotional impairments are numerous as well, with empirical support varying by therapy methods, treatment targets, modalities, and dosage. Effectiveness seems to be moderated by client's developmental age, level of functioning, verbal abilities, and co-morbidity of other disorders (for review and meta-analysis of social skills interventions for children with autism, see Wang & Spillane, 2009). Social skills therapies that explicitly include emotion recognition training have also demonstrated mixed results. For example, a common approach to training emotion recognition is to include emotion vocabulary and associated social scenarios in *Social Stories*™ (Gray, 1998). By adapting a storytelling format to help children on the spectrum think through interpersonal interactions in their daily lives, Social Stories™ use both static images and text to help the individual navigate social interactions by explicitly explaining social/emotional scenarios. While this intervention seems to have practicality and is appealing to parents and practitioners, some researchers have argued that empirical support has yet to be established (Kokina & Kern, 2010; Sansosti & Powell-Smith, 2008). Kokina and Kern (2010) conducted a meta-analysis of 41 single subject studies examining the use of Social Stories™ and found Social Stories™ to have "low to questionable overall effectiveness" (median Percentage of Non-overlapping Data PND score of 62% with a 11–100% range). Overall, Social Stories™ were found to be more effective in addressing specific inappropriate behaviors than training emotion recognition or teaching social skills in general.

Another common approach used for emotion recognition training is to incorporate flashcards depicting different emotions and social scenarios into an *Applied Behavioral Analysis* (ABA) intervention program (Maurice, Green, & Foxx, 2001). ABA is based on behavior principles as a way to build socially useful skills and reduce problematic behaviors by teaching a specific skill in small measurable units through systematic practice using specific cues, prompts, consequences, repetition, and generalization to other settings (Cooper, Heron, & Heward, 2007). Positive reinforcement or motivators are used to reward children for responding correctly and may include praise, affection, food, drink, toys, or the opportunity to engage in a desired activity. Using discrete trial training (DTT) with emotion flashcards appeals to the need for predictability, routine, consistency, and preference for visuals often seen in children with ASD.

ABA has notably been the subject of numerous scientific research studies (for review and brief update of current works, see Matson, Benavidez, Compton, & Paclawskyj, 1996 and Matson et al., 2011). Hundreds of clinical studies (e.g., Dawson & Gernsbacher, 2010; Makrygianni & Reed, 2010; Smith, Groen, & Wynn, 2000), numerous meta-analyses (e.g., Eldevik et al., 2009; Reichow & Wolery, 2009; Virués-Ortega, 2010), and several strong reviews (e.g., Hayward, Gale, & Eikeseth, 2009; Myers et al., 2007; Rogers & Vismara, 2008) consistently point to the effectiveness of ABA in improving cognitive abilities, language, and adaptive functioning in children with ASD. However, due to individual variance and differences among implementations of DTT with flashcards, evaluations of DTT emotion recognition training found that DTT treatment effectiveness was not consistent across studies (Stephens, Dieppa, & LeBlanc, 2006).

Further limitations include traditional ABA therapy usually being conducted in a clinic or home setting and involving one child working individually with one tutor or therapist for ideally several hours each day (Lovaas, 1974; Lovaas, 1987; Lovaas, 2003). The availability of trained professionals, the cost of services, and the demanding time commitments often hinder the dissemination of traditional ABA therapy. Contemporary adaptations of ABA include alternate modes of delivery, such as implementation in classrooms, groups, and family systems, yet the effectiveness of the treatment is often reduced compared to traditional ABA with extensive one-one-one tutoring (Callahan, Shukla-Mehta, Magee, & Wie, 2010).

With advances in technology, the possible uses for implementing more interactive and individualized social skills therapy have increased. For many years, technology in ASD social interventions was limited to the use of videotapes for instructional *video modeling* (Bellini, Akullian, & Hopf, 2007) – a mode of training that uses video recordings to provide a visual model of the targeted behavior or skill. Video modeling has been found to be a moderately effective way to teach skills to individuals with ASD with robust Improvement Rate Differences (IRD) ranging from 0.68 to 0.83 (Mason, Ganz, Parker, Burke, & Camargo, 2012). However, when examining specific target outcomes for emotion recognition, moderating effects were indicated across levels of diagnoses, age, and verbal abilities. Others (Cihak, Kildare, Smith, McMahon, & Quinn-Brown, 2012; Sansosti & Powell-Smith, 2008) have found social skills treatment combining video modeling and Social Stories™ to be effective for improving the rates of social communication in high-functioning adolescents with ASD, though generalization did not occur.

Today's technology extends beyond simple video modeling to areas of interactive computer programs and virtual reality. Additionally, assistive technology, including personal communication devices, computers, video cameras, and cell phones, has become helpful in disseminating and implementing autism treatments (Mirenda, Wilk, & Carson, 2000). Though the study and use of assistive technology programs is relatively new, some empirical support has been found for social skills therapies using interactive media to train emotion recognition in individuals with ASD (for review, see Wainer & Ingersoll, 2011).

One program using computer technology is *Mind Reading: The Interactive Guide to Emotions* (Baron-Cohen, Golan, Wheelwright, & Hill, 2004). *Mind Reading* uses computer software to deliver video, audio, and text used to systematically introduce and teach basic and complex emotions. Users explore emotions in the emotion library, watch lessons and take quizzes in the learning center, and play games about emotions in the game zone. Golan and Baron-Cohen (2006) examined the efficacy of the *Mind Reading* program and found that adults with High Functioning Autism (HFA) and Asperger's Syndrome (AS) improved significantly in their ability to provide correct emotion words for faces, voice intonations, and scenarios when tested with stimuli used in the training program. Additionally, the intervention group improved significantly more on post-intervention tasks than individuals in the HFA/AS control condition. However, there were no differences between the intervention group and the HFA/AS control group on generalization tasks that used face and voice stimuli not included in the program or scenes from feature films. Generalization abilities did not occur even when *Mind Reading* was used in conjunction with weekly group meetings and tutor support. Results suggested that *Mind Reading* was effective in teaching emotion recognition, yet these skills did not transfer to other contexts, even with additional support.

Emotion Trainer (Silver & Oakes, 2001) is another empirically supported multimedia software program for training individuals with ASD to recognize facial emotions and reciprocate appropriately. *Emotion Trainer* utilizes photographs of real people, as well as animated emotional expressions, to teach emotions. Feedback, prompting and reinforcement are provided depending on the level of success or difficulty one experiences while progressing through the program. Silver and Oakes studied the effectiveness of *Emotion Trainer* played by 22 older children with ASD, ranging from ages 10 to 18 years. After 10 computerized sessions over three weeks, the participants who received training improved significantly more in identifying emotions from cartoons compared to age- and gender-matched ASD controls. There was no difference between the groups at pre- and post-intervention in identifying emotions from photographed facial expression. Given the inconsistency of these results, further research is needed to clarify the effectiveness of *Emotion Trainer* in fostering emotion recognition improvements in individuals with ASD, specifically its ability to generalize learned skills to real human faces.

Overall, research findings suggest that social skills therapy (Bölte et al., 2006; Silver & Oakes, 2001), including interactive computerized programs (Barry et al., 2003; Bauminger, 2002), may be effective in introducing individuals with ASD to emotion concepts. However, the potential of translating this rote knowledge to fluid real-life scenarios is yet to be established (for review, see White, Keonig, & Scahill, 2007). Several authors (Beaumont & Sofronoff, 2008; Dawson & Zanolli, 2003; Golan et al., 2010; Young & Posselt, 2012) postulate that the limited effectiveness of social interventions when working with individuals with ASD may be related to lack of intrinsic motivation to attend to the socio-emotional information presented to them.

Recently, researchers have addressed the issue of attention and motivation by developing interventions aimed at capitalizing on the tendency of individuals with ASD to be advanced "systemizers." According to Baron-Cohen (2002, 2006), systemizing is the intrinsic motivation to analyze or build systems that allow one to predict and control the behavior of the system. Systems may be mechanical, abstract, natural, or collectible. Baron-Cohen argues that systemizing occurs on a continuum among the entire population. Some individuals are likely to be more attracted to discrete systems, structures, rules, and patterns; whereas others are less likely to detect or see the world in broad systems and may better tolerate change outside of the system rules (i.e., human behavior). In further support for his hyper-systemizing theory, Baron-Cohen cites findings (Jolliffe & Baron-Cohen, 1997) that individuals with ASD scored higher than neurotypical individuals matched by age and verbal ability on the embedded figure test – a test that assesses local versus holistic perception by requiring examinees to locate a smaller shape within a larger collection of shapes. Systemizing is often apparent in the obsessions and restricted interests of individuals with ASD (Baron-Cohen & Wheelwright, 1999). Individuals with autism are markedly drawn to structured, factual, and rule-based information and frequently demonstrate obsessions with closed systems that are predictable (e.g., computer systems, electronics, trains, time tables, etc.; Baron-Cohen, 2002).

Some intervention programs that aim to target social-emotional deficits seen in ASD have attempted to harness systemizing preferences to improve attention, motivation, and overall effectiveness. For example, vehicles, spinning objects, and computer games have been used as positive reinforcers as a way to keep children with ASD intrinsically motivated during therapy (Attwood, 2000; Maurice et al., 2001). Others (Koegel et al., 2012) have successfully implemented lunch clubs based around aspects of adolescents with ASD's perseverative interests to markedly increase both social engagement and initiations. Lego Therapy (Owens et al., 2008) is based on the interest of children with ASD wanting to build orderly models with predictable components; thus, this social skills therapy requires participants to use Legos® to build models in groups as a way to introduce opportunities for social interaction. Children with ASD (*n* =60) who participated in Lego-based individual and group therapy sessions improved significantly more than controls on collaborative building skills, collaborative problem-solving, sharing, and taking turns. Yet, effectiveness of training and generalizing specific emotion recognition skills were found to be no greater than the other social skills interventions of Social Stories™, video-modeling, and group social skills training programs (LeGoff & Sherman, 2006).

In an effort to combine the effective components of Social Stories™, ABA, video modeling, and interactive media, Baron-Cohen (2004) developed an animated series called *The Transporters* with predictable systems and hyper-systemizing in mind. In *The Transporters*, real-life faces of actors showing emotions have been grafted onto the front of animated vehicles that move according to rule-based physical-casual mechanical motion. Rewards are given to viewers who answer quiz questions correctly using scenes of spinning wheels, twirling pieces, and repetitive motion. The DVD series was originally designed as a parent-supervised in-home intervention. *The Transporters* is currently promoted for use in educational and professional settings as well as at home (www.thetransporters.com).

Several studies have found empirical support for *The Transporters* as an effective emotion recognition intervention. Using an ASD intervention group (n = 20), an ASD control group (n = 18) and a TD control group (n = 18), Golan and colleagues (2010) instructed children with high functioning autism between the ages of four and seven years to watch *The Transporters* for a minimum of 20 minutes per day every day for a period of four weeks. Caregivers were provided with a detailed guide to the DVD and were given suggestions on how to facilitate the child's learning with questions and interactive activities. Participants were tested before and after the intervention on emotion vocabulary and emotion recognition at three levels of generalization similar to tasks used to study the effectiveness of the *Mind Reading* intervention (Golan & Baron-Cohen, 2006).

Golan and colleagues (2010) found that the independent use of *The Transporters* DVD with parental supervision improved emotional recognition and contextual understanding of emotions on all three levels of generalization tested. Effect sizes were large (Cohen, 1992), ranging from partial $\eta^2 = .46$ for emotion vocabulary, partial $\eta^2 = .33$ for generalizing *The Transporter* characters' emotions to familiar scenes from the series, partial $\eta^2 = .31$ for generalizing character emotions to novel scenes, and partial $\eta^2 = .26$ for generalizing novel human faces to novel social scenes. Previous studies using the *Mind Reading* stimuli and intervention (Golan & Baron-Cohen, 2006) were not able to demonstrate generalization of such skills. Golan attributed *The Transporters* being more effective in generalizing emotion recognition than *Mind Reading* to the age of the participants (child participants in *The Transporters*, adult participants in *Mind Reading*) and *The Transporters* intervention explaining emotions in context of scenarios, a strategy not used in the *Mind Reading* intervention.

Young and Posselt (2012) studied the efficacy of *The Transporters* intervention by comparing a group of children (ages 4 to 8 years) with ASD who viewed *The Transporters* DVD (n =13) for three weeks in home with a group of similarly aged children with ASD who viewed *Thomas the Tank Engine* DVD (n = 12) for three weeks in home. Children in *The Transporters* intervention group significantly improved with large effect (Cohen's d = 1.70) in their ability to identify and label basic and complex facial expressions as assessed by the Affect Recognition subtest of the NEPSY-II.

Participants in the *Thomas the Tank Engine* group showed no improvement from pre- to post-intervention. In an effort to assess generalization of skills, Young and Posselt also quantified social behaviors. Outcome measures used to assess social skills included an increase in social peer interest and eye contact, along with a reduction in gaze aversion from baseline to post-intervention. Social behaviors improved significantly in both *The Transporters* and *Thomas the Tank Engine* groups. Though findings suggested that the unique content of *The Transporters* was not essential for improvement in social behaviors in general, authors concluded that *The Transporters* is indeed an effective learning tool for teaching emotion recognition to children with ASD.

The Current Study

The first goal of the present investigation was to corroborate the results found by Golan and colleagues (2010) by offering additional empirical support for the efficacy of *The Transporters* intervention in enhancing emotion recognition in children with ASD. As the present study was not an exact replication of Golan's, the aim of the research was to demonstrate *The Transporters* effectiveness using a professional therapy modality rather than an in-home parent-supported intervention. Furthermore, findings from the present study could also offer insight into an appropriate dosage rate needed for *The Transporters* to be effective. Unlike past studies (Golan et al., 2010; Young & Posselt, 2012) in which participants were instructed to participate in the intervention for a *minimum* of 20 minutes per day with varying ranges of viewing times among the participants, the present study controlled the time spent viewing the series to be a total of 540 minutes for each participant.

The second goal of the current investigation was to test the efficacy of the modified eyewear used in previous studies (Hansen, 2011; Hansen Brindley, et al., 2009) as a possible mechanism for promoting the development of recognizing and better perceiving emotional expressions through left visual field stimulation. The current study proposed that the right hemispheric neural pathway responsible for recognizing and responding to facial affect may possibly be conditioned and strengthened in children with autism by using contrived left visual field practice. Thus, by incorporating left-visual-field stimulation during an empirically established emotion recognition training intervention, children with ASD may be able to practice processing configural information driven though top-down perceptual strategies mediated through left-visual-field/right hemisphere processes. Practice would theoretically increase reliance on the right-hemisphere neural systems similarly to how neurotypical development shifts reliance from analytical to more holistic strategies for processing facial affect (Gautheir, Behrnmann, & Tarr, 2004; Rossion, et al., 2002). If attainable, left-visual field stimulation may be able to retrain and potentiate neural pathways in children with ASD to use a more mature and efficient Gestalt-processing strategy, allowing them to improve expertise in noticing and ultimately understanding subtle and complex emotional cues.

Current Hypotheses

Hypothesis 1. All participants who participated in *The Transporters* emotion recognition training were predicted to demonstrate improvement at post-intervention performance compared with pre-intervention performance on emotion recognition tasks assessing emotion vocabulary and situation-expression matching.

Hypothesis 2. Weekly performance on tasks of emotion recognition was expected to improve across time as participants engaged in *The Transporters* intervention.

Hypothesis 3. Improvements between pre- and post-intervention assessments of the participants who received both the lateralization eyewear and *The Transporters* interventions were predicted to be greater than improvements demonstrated by the control participant who received only *The Transporters* intervention without use of the lateralization eyewear.

Hypothesis 4. Lateralized stimulation of the left visual field by wearing modified eyewear while participating in *The Transporters* intervention was predicted to produce an additive effect on individual improvement across weekly performance on tasks of emotion recognition.

CHAPTER II

METHOD

Participants

The current study attempted to match the overall group characteristics of the male participants used in the Golan study (Golan et al., 2010), in which the mean chronological age was 5.88 years (*SD* = 1.0). Male participants ranging from ages 5 to 10 years were recruited using an invitation to participate letter (Flesch-Kincaid 9th Grade Reading Level, Appendix A) and contact information sheet (Flesch-Kincaid 8th Grade Reading Level, Appendix B) distributed to 22 parents of clients of one northern Minnesota mental health clinic and one North Dakota private psychological services practice with the approval to advertise to these clients from both the clinical directors and training supervisors. Per medical record, all potential participants had a prior clinical diagnosis of ASD (Autism, Asperger's Syndrome, or Pervasive Developmental Disorder – Not Otherwise Specified) and no history of hearing impairment or epilepsy. Fourteen parents expressed interest in participating in the study. Parental written consent (Flesch-Kincaid 9th Grade Reading Level, Appendix C) was collected along with a completed Childhood Autism Syndrome Test (CAST; Scott, Baron-Cohen, Bolton, & Brayne, 2002) to assess and screen the autistic symptom level of the potential participant. Information on the parent-report contact information form was used to confirm that all potential participants had normal or corrected-to-normal vision, no hearing loss, no history of epilepsy, and no prior viewing of *The Transporters* DVD series. All potential participants were also reported to be right-handed.

Due to scheduling conflicts, two of the potential fourteen participants were not included in the study but were willing to be considered as alternate participants if needed. Of the remaining twelve potential participants, the CAST was used to quantify and compare autistic symptom level. In Golan's study, CAST scores for the ASD participants ranged from 15 to 33 (M = 24.05, SD = 5.82). Accordingly, the present study reviewed the pool of potential participants and chose eight participants who were within 12 months of age and within 6 points on CAST scores from each other (6 points based on standard deviations of norming samples for the CAST; Scott et al., 2002). Recruited participants who did not meet the screening criteria were sent a letter thanking them for their interest and referring them to information about *The Transporters* DVD series as an in-home, parent-guided social skills treatment option for their child. Parents were also provided contact information if they wished to be informed of the findings at the conclusion of the study.

ASD diagnosis was confirmed in the potential participants (n = 8) using the Autism Diagnostic Interview, Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994). Verbal ability was assessed using the US-American Peabody Picture Test (PPVT; Dunn & Dunn, 1997). PPVT scores ranged from 72 to 85 (M = 77.50, SD = 5.57), slightly lower but within the range of British Picture Vocabulary Scale II (BPVS-II; Dunn, Whetton, & Burley, 1997) scores found for Golan's participants (M = 98.21, SD =

9.37, Range 76 – 116). All potential participants were then tested for their ability to tolerate wearing the eyewear for a twenty-minute pre-study trial session during which the child watched a video of his choice. Though all participants required verbal encouragement to continue wearing the eyewear, two participants required frequent verbal reminders and were observed to be mildly distressed and distracted by the eyewear. One participant refused to wear the eyewear. Consequently, the pre-study trial session was terminated early for the three participants, who were unable to easily tolerate the eyewear, and they were no longer included in the study. Overall, five of eight participants were able to tolerate wearing the eyewear for more than fifteen contiguous minutes. The five participants seemed to habituate to the sensation of the eyewear and quickly became familiar with the expectation to wear the eyewear throughout the viewing session. None were observed to be markedly distressed or distracted by wearing the eyewear throughout any of the experimental sessions. Of the five participants, four were invited to participate in the current study with one participant serving as an alternate if needed.

All participants were treated in accordance to the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 2002) in addition to the guidelines established by the Human Subjects Committee of the University of North Dakota (UND). Participants and parents were given the option to exclude data or terminate participation in the study at any time. Approval from the UND Institutional Review Board was obtained for this project prior to starting. See

Table 1 for overall participant characteristics. Participant characteristics of Golan's study are included for comparison purposes.

Table 1
Means (SD) and Ranges of Participant Characteristics for Current Study and Golan et al. Study (2010)

Characteristic	Current Study (*N* = 4)	Golan et al. (*N* = 56)
Age (years)	9.23 (0.51)	5.88 (1.00)
	8.75 – 9.75	4.00 – 8.00
Verbal Ability (PPVT/ BPVS Standard Score)	77.50 (5.57)	98.21 (15.00)
	72-85	76 – 116
CAST	22.00 (1.83)	24.06 (6.00)
	20-24	15-33
Gender		
Male	4	47
Female	0	9
Handedness		
Right	4	56
Left	0	0

Materials

Lateralization Eyewear. Eyewear based on the Schiffer goggles (Schiffer, 1997; Schiffer et al., 2004; Schiffer, Glass, Lord, & Teicher, 2008) was used to produce lateralized stimulation of the left visual field. The eyewear was modified to have the entire right eye occluded and the inner medial aspect of the left eye occluded (see Figure 1). Isolation and/or stimulation of the left visual field was based on the premise that the eyewear's opaque lenses allow for visual stimuli to create an image on the left eye's inner retina from which the optic nerve then projects to the contralateral right brain hemisphere.

Figure 1. Example of modified eyewear with opaque lenses to occlude the right eye and inner medial aspect of the left eye used to present visual stimuli to the left visual field.

Previous studies (Hansen, 2011; Hansen Brindley, et al., 2009) have demonstrated the effectiveness of this eyewear design in producing a lateralized effect in response to still pictures of emotions. Emotional recognition studies using similar modified eyewear to isolate visual fields were not available to compare protocols. Studies have used full pictures presented on opposite sides of the computer screen to test the laterality of face processing in TD samples and found a reasonably consistent left visual field advantage (Jansari, Tranel, & Adolphs, 2000). Most studies (Ashwin et al., 2005; Bourne, 2008) measuring lateralization in face processing use the chimeric face test in which one half of the stimuli is a face expressing a particular emotion and the other half is the same face expressing a neutral expression. Visual field bias is quantified by the accuracy in identifying the emotion when it is presented in the left or right visual field (i.e., the left or right half of the chimera). A left-visual-field bias in typical populations has been extensively reported for emotion perception using chimeric faces (for review, see Adolphs, 2002).

Lateral visual field stimulation studies have been conducted using the Schiffer goggles (Schiffer, 1997; Schiffer et al., 2008), after which the present study's eyewear were designed. Though the Schiffer goggles were originally used to induce affective changes by lateral visual field stimulation in treating affective disorders of depression, anxiety, and Post-Traumatic Stress Disorder (PTSD), follow-up imaging studies found the Schiffer goggles to effectively activate contralateral extrastriate cortical areas as predicted by the stimulated visual field. Both left-visual-field and right-visual-field conditions demonstrated fMRI activation in the contralateral occipitotemporal and posterior parietal areas in addition to the contralateral dorsolateral prefrontal cortex (Schiffer et al., 2004). Schiffer goggles were also found to produce laterality in theta electroencephalogram (EEG) and ear canal temperatures in neurotypical adults with left-visual-field goggles inducing greater physiological responses to affective visual stimuli than both-visual-field and right-visual-field goggles (Schiffer, Anderson & Teicher, 1999). These collective findings not only suggest that left and right visual fields may be isolated using vision-limiting eyewear, but also support the extant literature demonstrating differential physiological, cognitive, and emotional effects from unilateral sensory (Gruzelier, Clow, Evans, Lazar, & Walker, 1998; Walker, 1980; Wittling & Genzel, 1995; Wittling & Roschmann, 1993).

Participants were expected to wear the lateralization eyewear throughout the entire session. Participants tried various sizes of eyewear to ensure a comfortable fit and were then assigned a specific eyewear piece to use throughout the study. Larger-sized eyewear was used to fit over one participant's (Participant 2) prescription glasses.

Visual inspection was used to ensure proper occlusion of the right eye and inner medial aspect of the left eye. Incentives (e.g., stickers, verbal praise, candy pieces, and touch) were provided intermittently to reinforce wearing the eyewear and attending to the experiment.

Emotion Recognition Intervention – The Transporters DVD Series. An animation series called *The Transporters* (www.thetransporters.com) created by Baron-Cohen, Golan, and colleagues was used as the empirically supported emotion recognition intervention for the current study. As discussed above, *The Transporters* was developed based on the systemizing theory proposed by Baron-Cohen (2002). In an effort to harness the tendency of children with ASD to attend to and be motivated by causal, predictable systems, *The Transporters* series is based around eight vehicles that move according to rule-based motion. Character vehicles include two trams, two cable cars, a chain ferry, a coach, a cliff railway, and a tractor. Real-life faces of actors showing emotions have been grafted onto the front of the vehicles, and the characters interact with each other to depict possible real world social interactions. The series was designed for children with ASD between the ages of three and eight years, though studies have used the protocol in children up to age 10 (Ball, 2011; Baron-Cohen, 2004; Young & Posselt, 2012). The intervention consists of fifteen 5-minute episodes. Each episode focuses on one of fifteen emotions: happy, sad, angry, afraid, disgusted, surprised, excited, tired, unfriendly, kind, sorry, proud, jealous, joking, and ashamed. The emotion of worry is presented throughout all of the episodes; thus, worry was included in the emotion recognition tasks measured in the present study as it was in the study by Golan et al. (2010).

The eight vehicle characters are part of a toy set in a boy's bedroom as a way to present an environment predictable, familiar, and appealing to children with ASD. The human faces grafted onto the vehicles are of different ages, genders, and ethnicities. Participants viewed the American English version of *The Transporters* DVD, in which an American-English speaking narrator describes the scenes (original version uses a British-English speaking narrator). The intervention purposely uses a narrator instead of talking characters. Literature has well established atypical visual fixation on the mouth rather than eyes when individuals with ASD view faces (e.g., Baron-Cohen, 1995; Klin, Jones, Schultz, Volkmar, & Cohen, 2002). Narration allows children to focus on facial expressions as an entirety rather than using a compensatory strategy of focusing on the mouth to obtain affective information from the character's speech.

The intervention videos were played using an HP E Series Pentium Dual Processor (4.0 GHz) laptop computer equipped with a separate full-color, flat-screen, 470 mm monitor. Participants were seated directly in front of the screen at an approximate distance of 400 mm from the monitor and perpendicular to the laptop. Noise-cancelling headphones delivered audio from videos and quizzes to help minimize distractions and avoid the experimenter from unintentionally providing nonverbal cues about participant's responding or episode content.

The Transporters DVD series has been empirically supported as an effective emotion recognition intervention for children with ASD for use in the home with parental supervision (Golan et al., 2010). *The Transporters* has also shown some efficacy in the school setting (Ball, 2011). To date, no studies have tested the efficacy of *The Transporters* as a one-on-one therapeutic treatment congruent with individual social skills therapy provided by clinical, speech, or occupational therapists.

Measures

Autism Diagnostic Interview, Revised (ADI-R). The Autism Diagnostic Interview, Revised (ADI-R; Lord et al., 1994) was used to confirm ASD diagnosis. The Autism ADI-R is delivered as a structured interview conducted with the primary caregiver(s) of a child with the mental age of at least 18 months. Behaviors measured by the ADI-R's 93 questions include reciprocal social interaction, communication and language, and patterns of behavior. The ADI-R is commonly used in research studies with strong reliability and validity psychometrics including inter-rater reliability ranging from $r = 0.63$ to 0.89 and internal consistency (alpha coefficients) for the domains from 0.69 to 0.95 (Lord et al., 1994). Golan and colleagues (2010) used the ADI-R used to confirm ASD diagnosis in their study, which was replicated in part by the current study.

The ADI-R has been found to have acceptable reliability over time (M Kw > .72) for children over the age of three years when re-tested at three months, six months, and one year (Cicchetti, Lord, Koenig, Klin, & Volkmar, 2008; Lord et al., 1994). Since the ADI-R was administered by a practitioner within one year of the study, ADI-R results found in the mental health records of two participants were included.

Participants' ADI-R results were used with parental permission and release of information.

The ADI-R interview was conducted for six of the participants during the screening process. Testing was completed at the clinic (*n* = 2*)* or home (*n* = 4) of the participants by the principal investigator who has clinical training and supervised experience in administering the ADI-R. A diagnosis of an Autism Spectrum Disorder was determined if the participant's scores in the three behavioral domains exceed specified minimum cutoff scores: social interaction, 10; communication and language, 7; restricted and repetitive behaviors, 3. As noted above, all participants met cut-off scores for an ASD diagnosis.

Childhood Autism Syndrome Test (CAST). The Childhood Autism Syndrome Test (CAST; Scott et al., 2002) was used in conjunction with the ADI-R to confirm ASD diagnoses and to better quantify autistic symptom level since the CAST Total score can be used as a numerical description of autistic symptom level. The same measures were used in the Golan and colleague's study (2010) in which the present study attempted in part to replicate. The CAST was formerly known as the Childhood Asperger Syndrome Test but was renamed to reflect its accurate assessment of the complete autism spectrum (Williams et al., 2008). The CAST is a 37-item parent-rating scale of behavioral indicators designed to screen school-age populations for behavioral symptoms indicative of ASD. Of the 37 items on the CAST, 31 are summed to yield an overall score. Six items addressing general development do not contribute to the total CAST score as they are control questions. For the 31 scoring items, an autism-positive response scores 1 and an autism-negative response scores 0. Some items are reverse scored so not all ‘yes’ responses are autism-positive. The cut-point for concerns of possible autism-spectrum conditions is 15.

Published psychometrics for the CAST include sensitivity of 100%, specificity of 97%, and positive predictive value of 50% using the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 1989) and ADI–R (Lord et al., 2000). Moderate to good test–retest reliability (K = .26) has been found for the CAST (Allison et al., 2007). The CAST is not recommended as a screening tool for the general population due to the low prevalence of autism spectrum disorders contributing to a high number of false positives and consequent low positive predictive power (Williams et al., 2005). Appendix D includes the 37-item CAST questionnaire that were completed by the primary caretaker of each participant during the screening process.

Peabody Picture Vocabulary Test (PPVT). The Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997) is an untimed test of receptive vocabulary, providing an estimate of verbal ability for individuals aged 2 to 90 years. The PPVT was created for assessing Standard American English vocabulary, whereas the British Picture Vocabulary Scale II (BPVS-II; Dunn et al., 1997) used in the Golan study (2010) accounts for British cultural and language differences. Administration of the PPVT takes approximately 20 minutes and does not require subjects to have reading or verbal abilities. A series of four pictures per page is presented, and the examiner says a word describing one of the pictures. The respondent is asked to point to the picture that the word describes. PPVT total score is used to estimate an individual’s verbal intelligence as a percentile rank, mental age, or a standard deviation IQ score. The test was administered to eight participants during the screening process by the principal investigator who has clinical training and supervised experience in administering the PPVT. Scores were reviewed and confirmed by one research assistant trained in PPVT scoring protocol.

Emotion Recognition Measurements. ***Emotion Vocabulary (EV).*** Emotion vocabulary words were chosen from the sixteen emotions presented in *The Transporters* series: happy, sad, angry, afraid, disgusted, surprised, excited, tired, unfriendly, kind, sorry, proud, jealous, joking, ashamed, and worried. These emotions were selected to include the six basic emotions, as identified by Ekman (1999), along with more complex but developmentally appropriate emotions and mental states that are important for everyday social functioning. Studies have demonstrated that these sixteen emotions are recognized and understood by typically developing children between the ages of 2 and 7 years (Bretherton & Beeghly, 1982; Ridgeway, Waters, & Kuczaj, 1985). Similar to the emotion vocabulary (EV) measurement used by Golan and colleagues, participants were asked to define 16 emotion words and give examples of situations that evoked the emotions. In the current study, responses were given a 0, 1, or 2-point value to increase sensitivity of the measure. An Emotion Vocabulary (EV) score was calculated based on total number of words correctly defined and total number of appropriate examples provided (maximum 32 points). Scoring was based on predetermined one-point and two-point responses based on dictionary definitions and common-sense examples using a point system similar to the scoring method used on the Vocabulary subtest of the Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV; Wechsler, 2004). The present study's total EV score was then divided by 2 as a way to compare EV scores with results found by Golan, in which maximum EV point total was 16 (1 point per response per emotion).

Situation-Expression Matching (SEM). The ability to correctly match a facial expression to a situation was tested using three levels of generalization tasks: familiar close generalization (Level I), unfamiliar close generalization (Level II), and distant generalization (Level III). The familiar close generalization task (Level I) required participants to match familiar scenes presented in *The Transporters* series to facial expression of familiar characters from the series. The unfamiliar close generalization task (Level II) required participants to match novel scenes with expressions displayed by a character from *The Transporters* which had not been shown by the character in the intervention series. The distant generalization task (Level III) required participants to match novel scenes with expressions displayed by a selection of human faces taken from the *Mind Reading* software (Baron-Cohen et al., 2004) and not used in *The Transporters* series.

Thanks to the generous support of Drs. Golan and Baron-Cohen (*via* personal communication at the 10th Annual International Meeting for Autism Research [IMFAR], 2011), the same stimuli employed in the Golan and colleagues study were acquired and used in the current study. Golan's protocol included a stimuli slide created for each of the 16 emotions targeted in *The Transporters* series. Microsoft Powerpoint 2007 software was used to create and present the slides on an HP E Series Pentium

Dual Processor (4.0 GHz) laptop computer equipped with a separate full-color, flat-screen, 470 mm monitor. Participants sat directly in front of the screen at an approximate distance of 400 mm from the monitor and perpendicular to the laptop.

Each slide included a picture depicting a scene with a short written description that was read aloud via a pre-recorded audio file. The objects or characters involved in the scene were shown in the picture but no facial expresses were shown. Three video clips were displayed at the bottom of the slide (available to play as many times as needed when clicked). The video clips were of the same character/person displaying three different emotions: one emotion applicable to the scene, one emotion of the same emotional valence for the scene but an inappropriate match, and one emotion of the opposite emotional valence depicted in the scene.

Participants were asked to point to the video that best describes how the character/person was feeling in the scene. Participant responses were recorded manually by both the principal investigator and confirmed by the accompanying paraprofessional or special education specialist. A Situation-Expression Matching (SEM) score was calculated based on the total number of correctly matched situations to facial expressions for each stimuli slide (maximum 16). Each generalization task level included a set of 16 slides, one for each emotion. Thus, an SEM score for each level at pre- and post-intervention was reported for each participant. Pre- and post-intervention tests used different versions of the slides to control for memory effect. Examples of previously published items from Levels 1 and 3 (Golan et al., 2010) are shown in Figure 2.

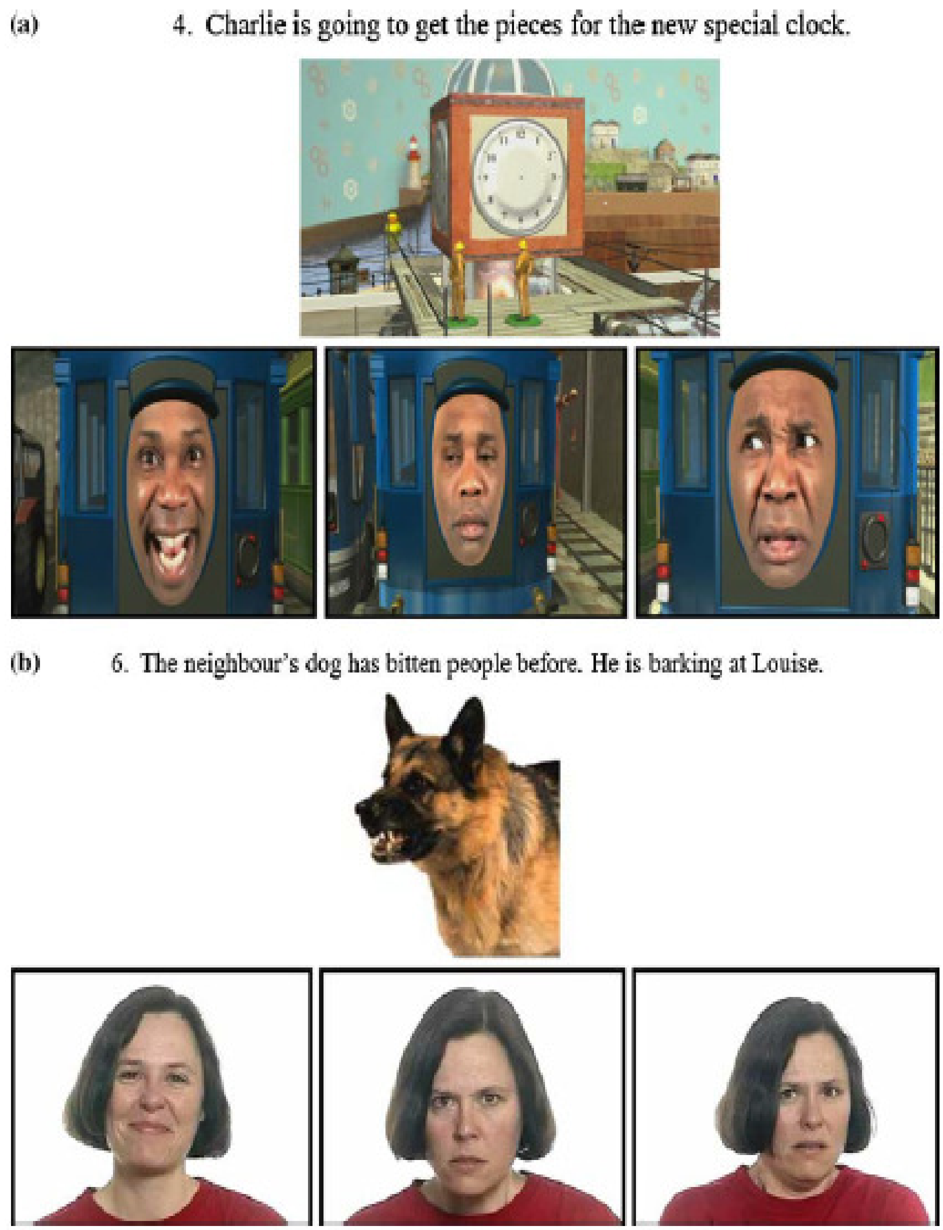

Figure 2.Examples of questions from emotion recognition tasks: a) Level I Task to match familiar scenes with faces from the series, and b) Level III Task to match novel scenes and faces using real human faces (as published in Golan et al., 2010).

Emotion Recognition Episode Quiz. The animated emotion recognition intervention (i.e., *The Transporters* DVD) used in the Golan and colleagues study (2010) included a set of two 10-item quizzes related to each of the fifteen episodes. Each quiz has two levels of difficulty: easy and difficult. Difficult quizzes use the same quiz questions used in the easy quizzes but offer three potential answers instead of two. Quizzes consist of three types of questions: matching faces to faces, matching faces to emotions, and matching situations to faces. When a question is answered correctly, the narrator offers a verbal congratulations and a reward appears (e.g., twirling wheel, moving windmill, rotating gears, etc.). If the question is answered incorrectly, an aversive picture appears (train boxcar full of rotten fish), and then the question is repeated until a correct response is provided. Once answered correctly, a reward appears accompanied by verbal praise.

Participants were required to watch each episode two times within one week. The easy quiz associated with the episode was administered immediately after the first viewing, and the difficulty quiz associated with the episode was administered immediately after the second viewing. Participant responses were recorded manually as correct (+) or incorrect (-) by the investigator for the *first* response provided for the question during each experimental session. *The Transporter* quizzes are designed so that incorrect responses result in the question being repeated until the child answers correctly. Therefore, responses provided after the initial response were not included to control for learning effects.

In an effort to check the accuracy of recording responses and ensure high inter-rater reliability, the participant responses, as indicated by clicking on the response choice, were also recorded using screen-capturing software Snagit Version 11.1 (TechSmith, 2012). However, the onscreen Snagit timer proved to be distracting to participants. Consequently, Snagit was not used after the first day of the experiment as it seemed to be potentially deleterious to experimental findings. As the experimental session proceeded, responses were easily recorded with 100% inter-rater agreement from data collected by the principal investigator and the accompanying school provider. Furthermore, a sticker was placed on a chart each time the participant provided a first-time correct answer. The chart was used as an incentive program to keep the participant engaged and motivated, along with providing another source to confirm response data. A percent accuracy score for each session was calculated by taking the number of correct initial responses divided by total number of unique quiz questions and then multiplied by 100%.

Procedures

Participants were tested individually in a quiet, familiar, private area at the participant's school under supervision of a special education teacher, paraprofessional, or school therapist. The same room was used for each experimental session. Visual and auditory distractions (closed door, toys away, etc.) were removed as much as possible. The experiment session was conducted during the participant's scheduled special education computer time and/or individual therapy time so as not to disrupt the child's routine or educational opportunities. The experiment was conducted during regular school hours for three participants (Participant 2, 3, and 4) and during after-school programming for one participant (Participant 1).

In an effort to replicate and verify the treatment effects reported by Golan and colleagues (2010), all four participants were assessed once at the beginning of the study (pre-intervention) and again seven weeks later (post-intervention). In both assessments, participants were tested at four levels of generalization using emotion recognition tasks measuring emotion vocabulary and three levels of situation-expression matching (as described in Emotion Recognition Measurements). To avoid fatigue, pre- and post-intervention assessments were not conducted on the same day as the first or last experimental session.

After pre-intervention assessment, all four participants underwent three weekly sessions over the course of six consecutive weeks. Each session consisted of an approximate 30-minute experiment that included an a) assent script stating what to expect during the session and the participant's rights to stop participating at any point of the session, b) three 5-minute episodes from *The Transporters*, and c) three accompanying episode quizzes presented after each episode. Modified eyewear were worn by the participant during the designated sessions according to the multiple baseline design (see Design). In an effort to reduce boredom or fatigue, the participant re-watched the same episode within the week (rather on the same day). The order and frequency of viewing episodes were matched among all participants. First-time responses to quiz items and behavioral observations were manually recorded by the investigator and the school provider throughout the session. There were no notable issues with participants moving from the designated viewing area or removing the eyewear. At the conclusion of each session, participants were compensated with their choice of a sticker, pencil, or candy as an incentive for completing the sticker chart that corresponded to quiz responses.

Over the course of five weeks, participants watched in sequential order all 15 episodes of *The Transporters* DVD series two times each and completed all associated quizzes. During the sixth week, all fifteen episodes were viewed once in random order. After each episode, participants completed either the easy or difficult quiz associated with each episode as determined by binomial chance with equal representation of easy and difficult quizzes. At the end of the six-week experimental study, participants returned for a one-hour post-intervention assessment of emotion recognition measures. Participants were also debriefed, thanking them for their participation and explaining that people may understand emotions better when they use their left eye compared to when they use their right eye. Families were provided a set of therapy tools (flashcards, quizzes, games) based on *The Transporters* DVD series as a thank you for their participation. Per request of school providers, a general overview of individual results was provided to each parent and the school therapist to help inform future therapeutic goals and interventions (Appendix E, Thank You for Participating Letter). Notification of future publications with the final results of the study was also offered.

Experimental Design

The present study used a multiple-baseline-across-participants-experimental design (Kazdin, 2003) to assess changes in emotion recognition skills of participants receiving *The Transporters* intervention when left-visual-field stimulation was systematically applied to the intervention. By adding use of the lateralization eyewear one participant at a time at two-week intervals, the effectiveness of *The Transporters* intervention was evaluated *before* applying the left-visual-field stimulation (contrived by wearing the modified eyewear) compared to the effectiveness of *The Transporters* intervention *after* applying left-visual-field stimulation. Figure 3 provides a visual overview of the experimental design.

A multiple-baseline design was selected for the current study, as it seemed to offer strengthened internal validity of previous demonstrations of *The Transporters* effect than the pre-post group mean analysis used in Golan et al. (2010). By using repeated measures, the data's path from baseline into the intervention phase can be predicted and the effectiveness of the eyewear intervention in changing a participant's performance can be verified without impacting other participants' behavior during baseline. Participants' exposure to the experiment were predicted to have an effect on the dependent measures and consequently making a reversal to baseline unattainable. Accordinly, a multiple baseline design was an appropriate experimental method to replicate the effects of the independent variable across participants (Carr, 2005).

The effects of *The Transporters* intervention and contrived left-visual-field stimulation using lateralization eyewear on emotion recognition was assessed by measuring *in-vivo* performance on the Emotion Recognition Episode Quizzes during each 30-minute experimental session. This dependent variable was collected four times per session with sessions occurring three times per week over the course of six weeks.

The lateralization eyewear was added to *The Transporters* intervention at systematically staggered intervals of zero, two, and four weeks with one participant receiving six-weeks of *The Transporters* intervention without the addition of the lateralization eyewear component. In an effort to gather additional data on baseline emotion recognition abilities, emotion recognition and generalization abilities were assessed one week prior to the intervention using the emotion vocabulary and the three measures of generalization used in Golan's study. Post-intervention emotion recognition and generalization abilities were assessed one week after administration of the six-week experiment using different versions of the pre-intervention assessment tasks.

Data Analyses

In an effort to replicate in part *The Transporters* intervention study published by Golan et al. (2010), performance on pre- and post-intervention measures of emotion recognition and generalization abilities were also evaluated. Golan's study used a control group design whereby mean performance of an ASD intervention group (n = 20) was compared to mean performances of an ASD non-intervention group (n = 18) and a control group of TD peers (n =18). All groups were matched for age and verbal IQ. Four Multivariate Analyses of Variance (MANOVAs) with repeated measures were conducted for the one EV and three SEM measures of emotion recognition. Group (ASD Intervention, ASD Control, TD Control) was the between-participants effect and Time (Pre- and Post-intervention) was the within-participant, repeated-measures effect. Post-hoc paired t-tests with Bonferonni corrections for multiple comparisons were used to evaluate each developmental group's improvement on EV and SEM tasks at pre- and post-intervention.

Ball (2011) replicated in part the Golan et al. (2010) study and made argument for using the more powerful repeated measures design without a control group as it controls for subject heterogeneity notable in the ASD population. Ball conducted a factorial repeated-measures ANOVA using measurements from nine subjects at three time points in which emotion recognition was measured. Follow-up paired *t*-tests were used to evaluate differences between specific time points.

The present study did not have the power ($n = 4$) nor the design (i.e., lack of no-intervention control group) to exactly replicate Golan's analyses. Furthermore, the present study collected two time-point measures of the dependent variables, unlike Ball's three measures of the dependent variable. The present study used four paired-samples *t*-tests to compare pre-intervention and post-intervention mean performance on one EV and three SEM measures of emotion recognition. An alpha level of .05 was adopted for significance in *a-priori* analyses. The Bonferroni correction method was applied to maintain the family-wise error rate of $\alpha = .05$. Thus, the statistical significance level of $\alpha = .02$ (1/3 x .05 α) was used when comparing the SEM variables. Effect sizes were reported as Cohen's *d* with the modification suggested by Morris and DeShon (2002) to correct for the dependence among means found in a within-subjects designs. Paired correlations were calculated between pre- and post-intervention measures and used to correct reported Cohen's *d* effect sizes (for more detailed explanation, see Equation 8 in Morris & DeShon, 2002).

Treatments	None	*Baseline phase*	*Participants 1, 2, 3 and 4 view episodes and take quizzes as scheduled:*						None
			The Transporters Episodes 1,2,3 (2x's each)	*The Transporters* Episodes 4,5,6 (2x's each)	*The Transporters* Episodes 7,8,9 (2x's each)	*The Transporters* Episodes 10,11,12 (2x's each)	*The Transporters* Episodes 13,14,15 (2x's each)	*The Transporters* Episodes 1 – 15 (1x each)	
		Intervention phase	*Participant 4 wears Lateralization Eyewear during sessions*						
					Participant 3 wears Lateralization Eyewear during sessions				
							Participant 2 wears Lateralization Eyewear during sessions		
Measures	Pre-intervention versions of Emotion Recognition measures: Emotion Vocabulary (EV) and Situation-Emotion Matching (SEM) Levels I, II & III	*Experiment*	Episode 1,2,3 Easy and Difficult Quizzes (1x each)	Episode 4,5,6 Easy and Difficult Quizzes (1x each)	Episode 7,8,9 Easy and Difficult Quizzes (1x each)	Episode 10,11,12 Easy and Difficult Quizzes (1x each)	Episode 13,14,15 Easy and Difficult Quizzes (1x each)	Episode 1 – 15 Easy and Difficult Quizzes (1 quiz level per episode)	Post-intervention versions of Emotion Recognition measures: Emotion Vocabulary (EV) and Situation-Emotion Matching (SEM) Levels I, II & III
Time	1 Week prior to Intervention		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	1 Week after Intervention

Figure 3. Overview of study design.

Assumptions of normality were tested using visual inspection of the histogram, box-plot and the normal probability plot (normal Q-Q plot) for paired differences since the normality test is less likely to detect non-normality with smaller sample sizes. The differences between pairs were found to be relatively normally distributed and thus the non-parametric Wilcoxon signed-rank test was not required (Sawilowsky & Blair, 1992). By employing four different pre- and post-intervention measurements, the likelihood that regression to the mean, maturation, and/or seasonality could explain the observed association between the intervention and the post-intervention outcomes was reduced (Kazdin, 2003). Furthermore, the threat of test sensitization effecting internal validity was also reduced by administering different versions of emotion recognition measures pre- and post-intervention.

A-priori statistical power analyses using G*Power version 3.1 (Faul, 2008) estimated the sample size needed to detect a mean difference that is significantly different from the null hypothesis (i.e., matched pairs *t*-test) to be six matched pairs based on the mean difference and standard deviation of differences gathered from the Golan et al. publication (2010). It is important to note that though reported for comparison purposes, the present study sample of four did not lend for data analyses beyond traditional small case design analyses (visual inspection, trend, comparison of means, percentage of non-overlapping data, etc.).

Research has established visual inspection as a useful, accurate, and conservative method of assessing the effect of an independent variable in small case designs (Baer, 1977; Michael, 1974; Parsonson & Baer, 1986).Thus, the percent correct of each Emotion Recognition Episode Quiz conducted for each session was displayed graphically as an aggregate point to enable visual inspection. To aid in determining whether adding the lateralization eyewear component to *The Transporters* intervention was responsible for change, general criteria for mean level, trend, and variability commonly used in multiple baseline design analyses (Kazdin, 2003) were used in the current study. The current study visually analyzed data patterns for a change in the mean level, trend, and variability from the baseline phase administering *The Transporters* intervention to the intervention phase of adding contrived left-visual-field stimulation via modified eyewear. Trend was calculated as the slope of the line created by mean score data points ($y = mx + y$ intercept) within each phase. Visual analysis of trend was also performed using the Nugent approach (Nugent, 2000), in which a straight line connecting the first and last data points in the baseline phase and the intervention were drawn with arrows at the end to summarize the direction. In the case of outliers, the lines were drawn from the second to the last point if the first point was the outlier or to the second to last point if the last point was the outlier. Variability was reported as a high-low range of scores and used to examine consistency of accuracy within and between phases, with the assumption that if the performance was found to be highly variable within an intervention phase there is a diminished likelihood that the behavior is under the control of the intervention (Morgan & Morgan, 2009).

Percentage of Non-overlapping Data (PND) points was also used in the present study as it can supplement traditional visual analysis and provide an estimate of the size of the experimental effect (Parker, Vannest, & Brown, 2009). PND is calculated by identifying the highest data point in the baseline phase and then determining the percentage of data points during the intervention phase that exceeds the baseline level (Scruggs, Mastropieri, Cook, & Escobar, 1986). In the present study, the baseline phase was considered the period in which *The Transporters* was administered without the participant wearing the lateralization eyewear, while the intervention phase was defined as the time in which participants received left-visual-field stimulation during administration of *The Transporters.* As follows, the PND for the current study was calculated by determining the percentage of data points during the weeks participants were wearing the lateralization eyewear (Intervention Phase) that are more extreme (in the direction of improvement) than the most extreme data point recorded during *The Transporters* only intervention (Baseline Phase). Standard interpretation guidelines were used to analyze PND data with PND < 50% reflecting an unreliable treatment, 50%<PND<70% indicating questionable effectiveness, PND 70% to 90% suggesting a fairly effective treatment, and PND> 90% considered a highly effective treatment (Scruggs & Mastropieri, 1994).

The current study also calculated and reported the non-parametric statistic of Percentage of All Non-Overlapping Data (PAND). PAND is calculated as the total number of data points that do not overlap between baseline and intervention phases (Parker, Hagan-Burke, & Vannest, 2007). The present study calculated PAND by finding the smallest number of data points from either the phase in which participants received *The Transporters* only intervention (Baseline Phase) or from the phase in which participants wore the lateralization eyewear (Intervention Phase) for which removing these data points would eliminate all data overlap between the two phases. In the case of multiple solutions, the least amount of data points needed for removal was used to calculate PAND. All remaining data points (after removing overlapping data points) are divided by the total number of data points across both baseline and intervention phases to calculate PAND. Similar to PND, standard interpretation guidelines were used to analyze PAND data with PAND < 50% reflecting an unreliable treatment, 50%<PAND<70% indicating questionable effectiveness, PAND 70% to 90% suggesting a fairly effective treatment, and PAND> 90% considered a highly effective treatment (Scruggs & Mastropieri, 1994).

In an effort to offer a more precise measurement of effect, PAND analysis was used to calculate Cramer's Phi (ϕ) based on contingency tables set up from overlapping and nonoverlapping data points (i.e., Chi-square analysis). Phi is considered the statistic of choice when reporting strength of effect size for χ^2 and can be calculated concurrently with PAND in small-case designs (Burns, Codding, Boice, & Lukito, 2010; Parker et al., 2007). After identifying the smallest number of data points needed to be removed to eliminate overlap in PAND analysis, Phi was calculated on a 2×2 table using the PAND non-overlapping line to separate high and low data points within both the Baseline Phase and the Intervention Phase. Cross-tabulation analysis was then used to yield Phi. Phi was also reported as Cohen's ω since it has been found to be identical (Wuensch, 2011) to Phi and is a more commonly used measure of effect in χ^2. Cohen's ω effect sizes are generally interpreted as 0.2 to 0.3 being a "small" effect, 0.5 as a "medium" effect, and greater than 0.8 as a "large" effect (Cohen, 1992).

Covariates

In general, potential covariates to a study comparing the emotion recognition abilities of individuals with ASD over time include age, gender, history, general intelligence, and severity of autistic symptoms. Considering that experience with viewing faces for a non-visually impaired person correlates with age (i.e., the longer one has lived, the more times she has viewed facial stimuli), the age of the participants intuitively seemed to be a predominant covariate in this study. Indeed, developmental studies have confirmed age differences in facial emotion processing (e.g., Boyatzis et al., 1993; Gao & Maurer, 2010; Gross & Ballif, 1991). Gender differences in brain lateralization may also account for changes in facial attribution performance (Everhart, Shucard, Quatrin, & Shucard, 2001; Smith, 2000). As such, the study attempted to control for the covariates of age and gender by using only male participants within 12 months of each other's age.

A concurrent multiple baseline design could possibly address the confounding variable of historical events (Kazdin, 2003) if all participants were studied over the same six weeks. However, the logistics of running four subjects concurrently for six weeks was not possible with the study's resources. Thus, a non-concurrent multiple baseline design was used for the current study. A non-concurrent multiple baseline design offered greater flexibility in testing locations, allowed more availability of participants, and is the recommended experimental design for research in a professional setting (Harvey, May, & Kennedy, 2004). Though it did not completely control for historical events over the course of the intervention, history effects were not considered a significant confounding variable for the current study as the similarly aged participants were studied within three months of each other and historical events were unlikely to affect all participants. Furthermore, three of the four participants were studied concurrently.

The potential covariate of intellectual functioning was addressed by choosing participants from the participant pool with PPVT and CAST scores within one standard deviation of each other, respectibely. The Peabody Picture Vocabulary Test (PPVT-III) highly correlates with WISC-III FSIQ scores (r =.90) and has been used successfully with the pediatric autistic population (Condouris, Meyer, & Tager-Flusberg, 2003; Edelson, Schubert, & Edelson, 1998; Hayashi, Kato, Igarashi, & Kashima, 2008). The CAST has been used successfully as a quantifiable description of autistic symptom level. Studies have shown a strong correlation between higher CAST scores and the presence of an ASD diagnosis in the general population (Williams et al., 2008) along with the CAST cut-off score of 12 or above being an externally valid measure of ASD as established through a full diagnostic assessment (Williams et al., 2005). The potential covariate of intellectual functioning seems to be adequately managed by using participants similarly matched in PPVT and CAST scores.

CHAPTER III

RESULTS

As hypothesized, all participants ($N = 4$) who participated in *The Transporters* emotion recognition training demonstrated improvement at post-intervention performance compared with pre-intervention performance on emotion recognition tasks assessing emotion vocabulary and situation-expression matching (findings support Hypothesis 1). The present study found a significant improvement between pre- and post-intervention EV scores along with a significant improvement in performance on generalization tasks of SEM Level 3. Table 2 presents mean scores and standard deviations for pre-intervention and post-intervention performances along with changes and effect sizes from pre- to post-performance.

Planned analyses for all four tasks using Bonferroni corrections for multiple comparisons revealed significant improvements ($p < 0.02$) from pre-intervention to post-intervention on all four tasks of emotion recognition: Emotional Vocabulary task, $t(3) = 6.30$, $p = .008$; Situation-Expression Matching Level I task, $t(3) = 5.68$, $p = .011$; Situation-Expression Matching Level II task, $t(3) = 4.27$, $p = .024$; and Situation-Expression Matching Level III task, $t(3) = 4.87$, $p = .017$. Effect sizes were large across all measure, including the Emotional Vocabulary task ($d = 3.49$), SEM Level I task

(d = 2.90), SEM Level II (d = 2.88), and SEM Level III (d = 3.68) tasks. Appendix F provides details of pre-post comparison analyses.

Table 2
Means (SD) and change in means for emotion tasks (with Cohen's d effect sizes) at pre- and post-intervention compared to results reported by Golan et al. (2010)

	Pre-intervention		Post-intervention		Change from Pre to Post	
	Current Study	Golan et al.	Current Study	Golan et al.	Current Study	Golan et al.
EV (max = 16)	7.75 (2.96)	8.25 (2.81)	11.50 (2.42)	12.50(3.09)	3.78** (d = 3.49)	4.25*
SEM – Level 1 (max = 16)	6.75 (1.76)	8.65 (2.54)	12.00 (1.35)	13.00 (2.45)	5.25** (d = 2.90)	4.35*
SEM – Level 2 (max =16)	5.88 (2.84)	9.80 (2.91)	10.00 (1.47)	13.45 (2.35)	4.12** (d = 2.88)	3.65*
SEM – Level 3 (max = 16)	7.38 (1.60)	9.85 (2.43)	10.25 (0.65)	13.30 (2.27)	2.87** (d = 3.68)	3.45*

EV Emotion Vocabulary task; *SEM* Situation-Expression Matching tasks (Levels I – III); ** $p < .02$; * $p < .05$

In addition to finding improvement at post-intervention performance compared to pre-intervention performance on emotion recognition tasks, weekly performance on tasks of emotion recognition were also found to improve across time as participants engaged in the six-week, 18-session *The Transporters* intervention (findings support Hypothesis 2). Graphic display and trend analysis of the aggregate percent correct on the four Emotion Recognition Episode Quizzes given per session demonstrated improvement by an upward trend in three of the four participants' set of data points (see Figure 4). Of note, Participant 1, who only received *The Transporters* baseline intervention, was the only participant to demonstrate a slight decrease in trend across the 6-week intervention (Trend = -0.10).

Another predicted finding included greater improvements between pre- and post-intervention assessments of the participants who received both the lateralization eyewear and *The Transporters* interventions (n = 3) being compared to improvement demonstrated by the participant (n = 1) who received only *The Transporters* intervention without use of the lateralization eyewear (findings support Hypothesis 3). Comparative analyses (statistical analysis unavailable due to small sample size) demonstrated that individual gains made between pre- and post-scores were greater for participants wearing protocol eyewear compared with performance gains made by the participant who did not wear protocol eyewear. As detailed in Table 3, Participants 2, 3, and 4 demonstrated greater gains in performance on all pre-post emotional tasks (Δ EV M = 4.33 (SD = 0.29); Δ SEM Level I M = 6.17 (SD = 0.29); Δ SEM Level II M = 4.83 (SD = 1.61); Δ SEM Level III M = 3.17 (SD = 1.26)) compared with performance gains made by the control Participant 1 (Δ EV = 2.00; Δ SEM Level I = 2.50; Δ SEM Level II = 2.00; Δ SEM Level III = 2.00).

A key finding of the present study was evidence of a possible additive effect for lateralized stimulation of the left visual field by wearing modified eyewear while viewing *The Transporters* intervention across six weeks of the intervention (findings support Hypothesis 4). The effectiveness of the modified eyewear in producing an effect large enough to enhance recognition and response to emotion stimuli at a level greater than viewing *The Transporters* alone was inferred using several methods, including guided visual analysis (mean level, trend, and variability), PND, PAND, and effect sizes. Although each method verified an overall effect of the both *The Transporters* baseline protocol alone and the addition of the *Lateralized Eyewear* intervention when viewing *The Transporters*, interpretation of the intervention producing a greater effect than baseline varied depending on the method used to analyze data.

Table 3
Individual participant performances (maximum score 16) and changes (Δ) between pre- and post-intervention emotion tasks

	EV			SEM – Level 1			SEM – Level 2			SEM – Level 3		
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
Participant 1	10.0	12.0	2.0	8.5	11.0	2.5	7.5	9.5	2.0	8.0	10.0	2.0
Participant 2	3.5	8.0	4.5	5.5	11.5	6.0	3.0	8.5	5.5	5.0	9.5	4.5
Participant 3	9.5	13.5	4.0	5.0	11.5	6.5	9.0	12.0	3.0	8.5	10.5	2.0
Participant 4	8.0	12.5	4.5	8.0	14.0	6.0	4.0	10.0	6.0	8.0	11.0	3.0

EV Emotion Vocabulary task; *SEM* Situation-Expression Matching tasks (Levels I – III)

First, visual analysis of data patterns found a change in the mean level, trend, and variability from the baseline phase of administering *The Transporters* intervention to the intervention phase of adding contrived left-visual-field stimulation via modified eyewear (see Figure 4). Participant 2 and Participant 3 both demonstrated greater mean level percent accuracies for the intervention phase (94.97% and 93.84%, respectively) compared to their mean level percent accuracies for the baseline phase (83.45% and 87.52%, respectively). Though step-wise increases in trend and mean level performance did not clearly correspond with the step-wise increases in the length of the intervention phase across the multiple baseline design, baseline-phase-only Participant 1 demonstrated a lower overall mean level percent accuracy and negative trend (Overall Mean Level = 88.60%; Trend = -0.10) compared to the overall mean level and trend of intervention-phase-only Participant 4 (Overall Mean Level = 93.20%; Trend = 0.94). Furthermore, Participant 1 also demonstrated the slowest rate in overall performance gains (Trend = -0.10) compared to the other participants (see Table 4).

Examination of variability within and between phases found a reduction in Participant 2's variability from *The Transporters* baseline phase to his *Lateralization Eyewear* intervention phase (21.11 spread in mean percent accuracy data points compared to 13.33 spread, respectively). Participant 3, who received two additional weeks of *Lateralization Eyewear* intervention compared to Participant 2, demonstrated essentially no change in variability of mean scores across experimental phases (10.00 spread in mean percent accuracy data points compared to 10.56 spread). Participant 1, who participated in *The Transporters* baseline-only phase, demonstrated less variability in responding (15.00 spread) than Participant 4, who viewed *The Transporter* with continual use of *Lateralization Eyewear* intervention (17.36 spread).

Second, calculated PND of mean percent accuracy scores for each weekly session fell between 39.00% and 50.00% (see Table 5) among baseline and intervention phases, suggesting "questionable effectiveness" of the *Lateralization Eyewear* intervention. When the entire data set was taken into consideration (rather than just the intervention set of data points used as the denominator to calculate PND), PAND calculations were found to be 83.33% for Participant 2 (receiving 2 weeks of *Lateralization Eyewear* intervention), 83.33% for Participant 3 (receiving 4 weeks of *Lateralization Eyewear* intervention), and 69.44% for Participant 4 (receiving 6 weeks of *Lateralization Eyewear* intervention and using Participant 1's data set as a baseline phase). PAND results indicate a "fairly effective treatment." Appendix G contains details of PND and PAND calculations.

Effect sizes were calculated using the Cramer's Phi statistic computed from the contingency table of high and low scores across baseline and intervention phases (see Appendix H for details of analyses). With Cramer's Phi values being identical to Cohen's ω, the current study found a large effect (ω = 0.64) of the *Lateralization Eyewear* intervention on Participant 2's emotion recognition quiz score accuracy, a medium effect (ω = 0.25) of the *Lateralization Eyewear* intervention on Participant 3's emotion recognition quiz score accuracy, and a small effect (ω = 0.18) of the *Lateralization Eyewear* intervention when the total data set of Participant 1's emotion recognition mean quiz accuracy scores was used as a baseline to compare the total data set of Participant 4's emotion recognition mean quiz accuracy scores. Table 5 provides a summary of PND, PAND, and effect sizes.

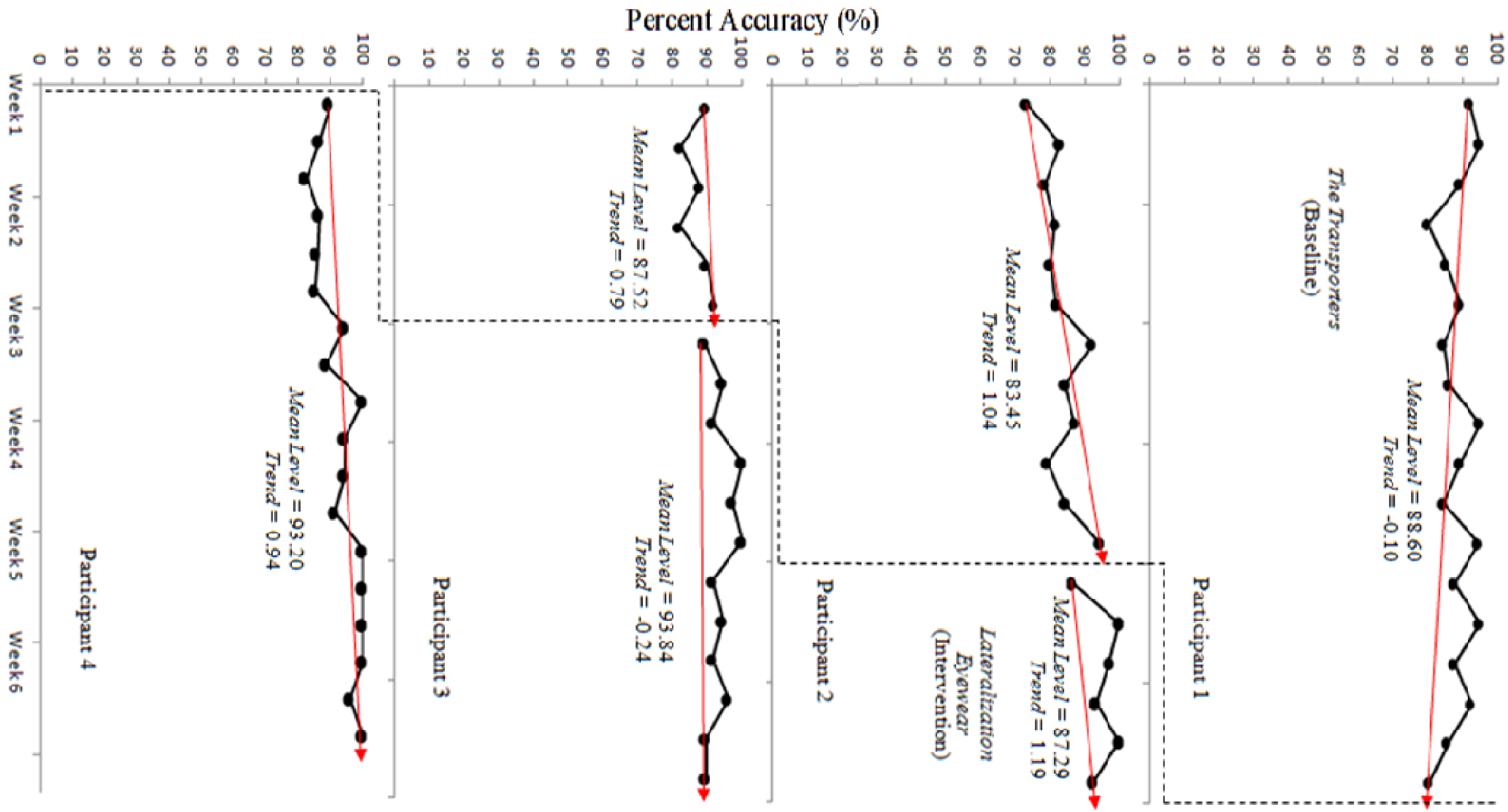

Figure 4. Mean level and trend analysis with trend lines of mean session performance (percent correct) on episode quizzes assessing emotion recognition for four participants across viewing *The Transporters* (baseline) and *Lateralization Eyewear* (intervention)

Table 4

Mean levels, trends, and variability of aggregate percent accuracy (%) quiz scores across baseline, intervention, and overall phases within multiple baseline design (N = 4)

	The Transporters Baseline			*Lateralization Eyewear* Intervention			Overall		
	Level	Trend	Variability	Level	Trend	Variability	Level	Trend	Variability
Participant 1	88.60	-0.10	80.00-95.00	----	---	----	88.60	-0.10	80.00-95.00
Participant 2	83.45	1.04	73.33-94.44	94.97	0.74	86.67-100.00	87.29	1.19	73.33-100.00
Participant 3	87.52	0.79	82.22-92.22	93.84	-0.24	89.44-100.00	91.73	0.43	82.22-100.00
Participant 4	----	----	----	93.20	0.94	82.63-100.00	93.20	0.94	82.63-100.00

Table 5

PND, PAND, and Cramer's Phi/Cohen's ω within multiple baseline design (N = 4)

	PND	PAND	*Cramer's Phi/Cohen's ω*
Participant 1	----	----	----
Participant 2	50.00%	88.88%	0.64
Participant 3	50.00%	83.33%	0.25
Participant 4	39.00%*	69.44%*	0.18*

*Calculated using Participant 1 Total Data Set as Baseline Phase and Participant 4 Total Data Set as Intervention Phase

CHAPTER IV

DISCUSSION

The first goal of the present study was to corroborate the results found by Golan and colleagues (2010), and offer additional empirical support for the efficacy of *The Transporters* as an intervention that not only enhances emotion recognition in children with ASD but also generalization of these learned skills. Indeed, the current study provided evidence of *The Transporters* overall effectiveness, as all participants demonstrated significant improvements at post-intervention performance compared with pre-intervention performance on emotion recognition tasks assessing emotion vocabulary and the ability to match facial expressions to situations for 16 key emotions. The present study demonstrated large effect sizes comparable to those found by Golan in measurements of Emotion Vocabulary (EV), Situation-Expression Matching of unfamiliar close generalization scenarios (SEM-Level I), and Situation-Expression Matching of distant generalization scenarios (SEM-Level III). That is, participants significantly improved in matching familiar situations taken from the intervention episodes to facial expressions of familiar characters from *The Transporters* along with demonstrating generalization of skills by matching unfamiliar situations with expressions using a selection of human faces not used in *The Transporters* video episodes or quizzes. Further generalization of learned skills was demonstrated as the present study also found a large effect of *The Transporters* intervention on participants' ability to match unfamiliar situations with novel expressions not shown by *The Transporters* characters during the intervention episodes (SEM-Level II).

In addition to corroborating Golan and colleague's findings by replicating, in part, their protocol, the present study also extended the research by further demonstrating *The Transporters* effectiveness through a professional one-on-one therapy modality beyond the previously tested at-home and school-group intervention modalities (Ball, 2011; Baron-Cohen, 2004; Young & Posselt, 2012). Moreover, the delivery rate and exposure time of the current study (90 minutes per week over 6 weeks for a total of 540 minutes) was found to be an efficacious dosage rate for delivering *The Transporters.* Of note, the total viewing time delivered by this study was effective even though it fell within the lower range of total viewing time reported in the literature (300 to 7,660 total minutes; *Mean* = 1963 (*SD* = 3196); *Median* = 560; Ball, 2011; Golan et al., 2010; Williams, Gray, & Tonge, 2012; Young & Posselt, 2012). Previous studies reported a wide range of delivery rate: 245 minutes to 1,915 minutes per week for 4 weeks (Golan et al., 2010); 105 minutes per week for 3 weeks (Young & Posselt, 2012); 75 minutes per week for 4 weeks (Ball, 2011); and 140 minutes per week for 4 weeks (Williams et al., 2012). While participants in the present study did not watch as many cumulative hours of *The Transporters* compared to other studies, the participants were exposed to the intervention over a longer duration (present study's 6 weeks of intervention versus other studies' 3 to 4 weeks of intervention). Therefore, the effect found in the present study may also be attributed to the delivery rate (30 minutes, three times a week for six weeks) rather than solely related to total viewing time (540 minutes).

The delivery of *The Transporters* intervention across six weeks using three 30-minute sessions was also found to be adequate in relatively maintaining and improving the weekly gains made by three participants in performance on tasks of emotion recognition (as measured by episode quizzes given each session). The consistency and strength of these gains across time varied among participants. Furthermore, control Participant 1 demonstrated a slight negative trend, indicating that not all participants who engage in *The Transporters* intervention demonstrate consistent linear gains in weekly measurements of emotion recognition skills. Significant gains made from pre- to post-measures of emotion recognition verified overall effectiveness, but do not reflect the pathway this information was learned.

The second goal of the present study was to test the efficacy of the study's modified eyewear used in previous studies (Hansen, 2011; Hansen Brindley et al., 2009) as a possible mechanism in enhancing emotion recognition processes through left visual field stimulation. Evidence of the modified eyewear's positive effect include greater improvements in accuracy of pre- and post-intervention assessments for the participants who received both the lateralization eyewear and *The Transporters* interventions (Participants 2, 3, and 4) compared with pre-post intervention gains made by the control participant (Participant 1) who received only *The Transporters* intervention without use of the lateralization eyewear. A positive effect from using the modified eyewear can also be inferred by visually comparing the data plots for Participant 4 and Participant 1. Participant 4 wore the modified eyewear for each viewing of *The Transporter,* while Participant 1 never used the lateralized eyewear to view *The Transporters*. Participant 4's mean level percent accuracy on episode quizzes and trend rate in overall gains was greater and faster than the mean level percent accuracy and negative trend of control Participant 1. Participants 2 and 3 also demonstrated noted improvements in average quiz scores when viewing *The Transporters* with the modified eyewear (Lateralized Intervention Phase) compared to average quiz scores earned during the baseline phase. However, trend and variability results were not as conclusive as there was no consistent pattern among or between participants.

Results from analysis of non-overlapping data points varied depending on the calculation used with PND values suggesting "questionable effectiveness" and PAND results indicating a "fairly effective" treatment. Lateralized stimulation of the left visual field by wearing modified eyewear was found to have a small to medium effect, yet no step-wise presentation of effect was found associated with step-wise increases in intervention dosages. Notably, the small effect found when comparing six weeks of baseline data from control Participant 1 to six weeks of eyewear intervention data from Participant 4 is not a true measure of effect as it compares data *between* subjects though a multiple baseline design is a *within-subjects* design. As a result, it is unclear if the differences in effect sizes are due to individual differences or to the dosage-dependent strength of the eyewear's dosage-related effect (i.e., two weeks versus four weeks). Though attributing a quantified effect to the intervention dosage was not conclusive, findings from pre-post comparisons, visual inspection, and non-overlapping data analysis point to the modified lateralization eyewear as having an effect on emotion recognition when participants underwent emotion recognition training while wearing the eyewear. This effect was greater than the effect found on emotion recognition when participants underwent the training without using the eyewear.

Limitations

Though promising results were found, the present study does recognize several limitations. First, the present small *n* design without a randomized ASD or TD control group does not allow for concrete cause-and-effect interpretations. Thus, caution should be taken in generalizing the findings across other individuals, settings, or behaviors (i.e., low external validity). However, the present multiple-baselines design did demonstrate generality of effects across more than one participant. Follow-up group design experiments with larger participant sizes can be used in the future to demonstrate treatment efficacy of lateralization eyewear. Even so, small sample sizes similar to the present study are common in autism research with the majority of single-case experiments ranging from two to six participants reported in the extant autism literature (Charman & Howlin, 2003).

Second, design limitations include limited allowance for stability in baseline behavior before introducing the intervention. Emotion recognition accuracy cannot remain static with subsequent viewings of *The Transporters* intervention (due to learning effects), nor were accuracy measures found to be consistent across time in both the baseline and the intervention phase. This increasing baseline trend along with variability across both phases impeded the detection of clear discontinuity from baseline to when the lateralized eyewear treatment was implemented. Furthermore, mean accuracy scores were found to be as variable within the intervention phase as the variability observed in the baseline phase, suggesting a diminished likelihood that the behavior was under the control of the intervention (Morgan & Morgan, 2009). Variability also contributed to possible misrepresentation of results using trend lines since slope analysis is susceptible to the influence of outliers. As recommended by Manolov and Solanas (2012), post-hoc analysis using regression coefficients from ordinary least square estimation of aggregate mean accuracy scores was employed to evaluate intervention effectiveness. The produced regression coefficients again found slight negative trends for the Baseline Phase of Participant 1 and the Intervention Phase for Participant 3. Nonetheless, several authors (e.g., Huitema & McKean, 2000; Maggin et al., 2011; Manolov & Solanas, 2012) have concluded that general trend rates (based on slope) and regression coefficients of data with or without elimination of autocorrelation can be insufficiently sensitive to existing treatment effects. Consequently, future regression analysis of the current study's complete data set (rather than mean aggregate scores) may be useful in describing trend and differentiating the trend in the intervention phase from a continuation of a positive trend in the baseline phase; thus, allowing for better detection of treatment effects.

The current study's variability within baseline and intervention phases of individual participants' data points may be due to the lack of precision used to measure emotion recognition (via episode quizzes included with the DVD set). Another source of variability could be from participants assimilating and applying learned skills in a nonlinear and individually unique timeframe. For example, there may be emotions among the sixteen emotions examined in the current study that are more difficult for some participants to learn, while other emotions may be more readily understood or recognized due to prior experience or exposure. Saliency of the emotion expressed may also play a factor since individual participants' perceptions of the emotional saliency may allow for particular emotions to be better remembered or learned. In fact, researchers have found differences in recognizing the emotion of sadness to be significantly correlated with the degree of impairment in reciprocal social interaction for individuals with ASD, while the recognition of the emotional expression of happiness was not correlated to ASD symptom traits (Boraston, Blakemore, Chilvers, & Skuse, 2007). Since the current study used fluid video pictures, it would be difficult to measure the perceived saliency of each emotion. Furthermore, quiz scores were collected as total points earned rather than analyzed as an item-by-item response for a given emotion. Future studies examining *The Transporters* efficacy may consider additional methods to measure emotion recognition per episode and/or record the questions missed by individual participants, as there may have been specific emotions that were difficult for participants to grasp and consequently contributed to the variability found in aggregate quiz accuracy scores.

Third, differences in interpreting the present study's findings dependent on the analysis method used demonstrate a discipline-wide lack of consensus on consistent, reliable, and accurate methods available for single-case design analysis. Though PND is the most prevalent method of reporting findings in extant small-case-design literature, several authors (Horner et al., 2005; Wendt & Lloyd, 2005) have indicated limitations of PND that may be pertinent to the present study. In multiple baseline designs, an aggregate median rather than a mean PND may have been more appropriate to account for slight non-normality in distribution of scores due to learning and ceiling effects. PND can also be misleading as it ignores all baseline data except the highest data point – a point that may be an unreliable and inconsistent finding. Limitations of PAND (Campbell, 2004) include insensitivity to ends of the scale as all data points are considered regardless of distance between data points in the two phases. Furthermore, PAND measures only mean level shifts and does not control for a positive baseline trend, which the present study demonstrated. PAND offers the advantages of using all data points across both phases and the ability to be translated into *Phi* to determine true effect sizes like Cohen's *d*. Furthermore, studies comparing effect sizes for single-subject designs found PAND to be highly correlated with traditional visual analysis methods of multiple baseline designs as compared to PND and other newer methods used to analyze single-case experiments, including Percentage of Data Exceeding a Median Trend (PEM-T) and Improvement Rate Difference (IRD) (Wendt & Lloyd, 2005; Wolery, Busick, Reichow, & Barton, 2010). Overall, the present study's interpretation of a small to medium effect of the eyewear intervention based on PAND data seems to be a relatively reliable and accurate assessment.

A fourth limitation of the current study may be that the measure used to assess emotion recognition (i.e., episode quiz scores) is not an appropriate or accurate measure for the current sample's characteristics (age, verbal abilities, and autistic symptom level). The current study attempted to use participants who after meeting the first two inclusion criteria also matched the overall group characteristics of the participants used in Golan's study. In Golan's study, the mean chronological age of participants with ASD was 5.88 years (*SD* = 1.0) and mean BPVS-II score for the ASD groups was 98.21 (*SD* = 9.37) with scores ranging from 76 to 116. CAST scores for Golan's ASD participants ranged from 15 to 33 (*M* = 24.05, *SD* = 5.82). Therefore, ideal participant characteristics for the current study would have been five males (four main plus one alternate) between the ages of 5 years 5 months and 6 years 5 months with a PPVT score ranging from 92.63 to 102.90. However, factors including the overall low prevalence rate of ASD (0.9%; Rice, 2009) combined with the rural population available to the current study and the exclusion variables discussed significantly limited the number of eligible participants. As a result, the current study placed greater emphasis on the participants being as homogeneous to each other as possible.

Consequently, the present study's participant sample was slightly older (*Mean Age* = 9.23 (*SD* = 0.51), less verbal (*Mean PPVT*= 77.50 (*SD* = 5.57), and had a lower level of autistic symptoms (CAST = 22.00 (*SD* = 1.83). Post-hoc analysis found a significant negative correlation between age of the participant and overall trend and variability in mean accuracy scores on the episode quizzes ($r = -0.96$ and $r = -0.70$, $p < .05$, respectively). Significant post-hoc correlations were not found among other characteristics and variables (PPVT, CAST, mean level, EV, and SEM scores). It may be that despite choosing participants within 12 months of each other and within the range used by Golan, age may have a more sensitive effect on this intervention and/or measure of emotion recognition (episode quiz scores) than predicted, with older participants being less sensitive to *The Transporters* intervention (i.e., slower rate of improvement) as measured by quiz accuracy scores. Of note, the present study found significant pre-post results similar to results found by Golan, again suggesting the possible limitation of using episode quiz scores as a sufficiently sensitive and/or reliable measure of emotion recognition for this age group. Interestingly, the average age of the present study's participants coincides with the beginning of a temporary plateau or "developmental dip" in emotion recognition gains occurring between the ages of 10 and 14 years in children with neurotypical profiles (e.g., Soppe, 1988, Karayanidis et al., 2009). Follow-up studies using *The Transporters* may need to employ younger participants to avoid confounding findings by this age-dependent plateau. Otherwise, the effect of left-visual-field lateralization on emotion recognition training could also be tested with older participants using an empirically supported recognition training protocol designed for older participants, such as *Mind Reading: The Interactive Guide to Emotions* by Baron-Cohen, Golan, Wheelwright, & Hill (2004).

A fifth limitation of the study is possibly the dilution of the effects found in the Golan study by the current study delivering the intervention in a controlled setting and limiting viewing to three times a week rather than the intervention delivered at home with parental support as conducted by Golan and colleagues. Ball (2011) replicated Golan et al. (2010) within the context of an educational setting using a similar cohort of children (n = 9, *Mean Age* = 7.1). Ball's participants watched *The Transporters* for four weeks, three times each school day. Performances on emotion recognition and generalization tasks were compared using a repeated measures design with assessment prior to the experiment (Time 1), after four weeks of no intervention beyond the school curriculum (Time 2) and again after four weeks of the intervention (Time 3). Ball found no significant differences between Time 2 and Time 3 performance for any of the measures. Ball attributed, in part, the study's inability to demonstrate effects reported by others (Golan et al., 2010; Williams et al., 2012; Young & Posselt, 2012) to the classroom setting where the treatment was delivered. Ball noted that parent-supported treatments in the home allow children to have greater access to the DVDs during times in which they may be more motivated to engage in the intervention. The present study's differences in setting and dosage from those of Golan may have reduced the efficacy of *The Transporter.* However, others (Baron-Cohen et al., 2004; Golan & Baron-Cohen, 2006) have demonstrated significant improvement in emotion recognition among individuals with ASD using a similar emotion-recognition DVD program (*Mind Reading*) for only 2 hours a week over a 10-week period. Furthermore, unlike Ball, the present study did find an effect in both pre-post gains and across weekly assessments.

Due to the present study's small sample size, effect sizes of pre-post gains could not be calculated as a way to quantify the reduction in effect, if any, of *The Transporters* intervention. Yet, results were comparable to those found by Golan. Furthermore, other studies (Ball, 2011; Golan et al., 2010; Young & Posselt, 2012) found no correlation between task improvement scores and the total number of episodes watched. At minimum, it can be concluded that viewing *The Transporters* three times a week over the course of six weeks in a one-on-one professional setting is sufficient for improving emotion recognition. Further study is needed to clarify if the total number of hours viewed, the length of treatment, the frequency of treatment, and/or treatment modality are sufficient *and necessary* factors for *The Transporters* and/or lateralization eyewear to be effective.

Lastly, a sixth limitation of the current study is the method used for left visual field stimulation. Some studies (Butler et al., 2005) reported problems with eye-movement patterns that disrupt the heuristics used to determine which cerebral hemisphere is being engaged in lateralization studies of visual processes. This is of particular concern for the current study's enlisting children with ASD as erratic eye-movement patterns have been well established within this population (for review, see Harms, Martin, & Wallace, 2010). Furthermore, it has yet to be determined if occluding an eye with the current study's modified eyewear is isolating the left visual field as reliably and accurately as the chimeric picture test or in the same fashion as the original Schiffer goggles. Notably, the initial pilot study using similar eyewear with children with ASD (Hansen Brindley et al., 2009) confirmed the widely reported left-visual field/right-hemisphere dominance in typical emotional processing found with chimeric tests and neuroimaging. A follow-up study (Hansen, 2011) also verified the response latencies and accuracy deficits seen with ASD participants (Bourne, 2008) and found evidence of an ASD right-visual field preference in pulse rate, reaction time, and accuracy measures. Additionally, the current study did find an effect greater than baseline when implementing the eyewear intervention to improve emotion recognition based on the theory of lateralizing and consequently enhancing facial affect processing. Future imaging studies using similar modified eyewear would help determine if the current protocol effectively lateralizes the neuronal processes of facial affect assessment as theorized.

Clinical Implications

Despite the acknowledged shortcomings, the results of the present study have important clinical implications. The present study demonstrated that a relatively short-term intervention program (three 30-minute weekly sessions for six weeks) can produce measurable improvements in emotion recognition skills in children with ASD. Dosage and exposure rates used in the present study suggest a minimum effective dosage for treatment delivery of *The Transporters* in a one-on-one therapeutic setting. A 6-week intervention not only leads to significant improvement in emotion comprehension and recognition for the16 emotions presented by the series but also improvements in generalization of knowledge beyond the training material. Being a DVD series, *The Transporters* intervention has advantages of being relatively affordable, adaptable to the specific needs of the individual child, and suitable for home, school and professional settings. Parents, professionals, and other adults working with the ASD pediatric population may consider using *The Transporters* as an easily accessible, evidence-based emotion recognition training program that targets core deficits in emotional attribution characteristic of ASD.

Clinical applications of the current study also include using the study's modified eyewear as a possible adjunct intervention to other social-emotional interventions designed for populations with difficulties in recognizing and perceiving emotional expressions. The current findings of contrived left visual field stimulation as a way to enhance emotion recognition also provides insight about the anomalies found in behavioral, physiological, and neural responses to emotional stimuli within the ASD population. The current study's modified eyewear may instigate investigation of other experimental methods to help develop greater reliance on holistic right-hemisphere processes over piece-meal left-hemisphere processes as a way to target emotion recognition impairments. Future studies may include examining the long-term effects of both *The Transporters* and the lateralized eyewear interventions. Studies using media-delivered social-emotional treatments have yet to show broad generalization to real settings by individuals with ASD (e.g., Golan & Baron-Cohen 2006; Golan et al., 2010; Lacava, Golan, Baron-Cohen, & Myles, 2007). Thus, investigating generalization of learned emotion recognition skills beyond the current study's assessment tasks to social functioning in natural settings would also be of clinical relevance.

In conclusion, the present study's modified eyewear offers a possible mechanism in promoting the development of recognizing and better perceiving emotional expressions through left visual field stimulation. Findings from the present study support the proposed theory that left-visual field stimulation can retrain and/or potentiate neural pathways that use a more efficient Gestalt-processing strategy. By contriving the use and maturation of typical emotion recognition processes, children with ASD may be able to improve noticing and ultimately understanding the often confusing nuances of emotional cues. The present findings are promising and offer direction for future studies using a larger sample size and/or a randomized control design.

APPENDICES

APPENDIX A

Invitation to Participate Letter

Hello!

My name is Rachelle Hansen. I am a doctoral student in Clinical Psychology at the University of North Dakota. For the past few years, I have been studying how children with Autism Spectrum Disorders process the emotions they see in faces. I am very grateful for families and children who have helped with this research.

I am starting a new research project, and your child may be eligible to participate. I will be offering individual training to children to help them better recognize and understand the emotions in others. Your child may be asked to wear special glasses that look like sunglasses and can fit over prescription glasses if needed. The study will run for 6 weeks during which your child will receive 3 individual therapy sessions each week *at no cost to you*. Each session will run approximately 30 minutes and can be done at your child's school or in your home – wherever is most convenient for you and your child. Children will receive a small prize (stickers, pencil, etc.) at the end of each session. At the end of the study, your family will also receive a set of therapy tools as a thank you for participating.

If you are interested in having your child be part of this study, please complete the enclosed contact information form and questionnaire and return in included addressed envelope. If you have any questions or would like more information, feel free to contact me [researchsupportund@gmail.com or 701-741-7830].

I look forward to working with you and your child!

Rachelle Hansen, M.A.
Clinical Psychology Ph.D. Candidate
University of North Dakota

THANK YOU FOR SUPPORTING RESEARCH

that helps us understand more about children and their development!

APPENDIX B

Contact Information Form

PLEASE COMPLETE BOTH SIDES AND RETURN IN THE ENCLOSED ENVELOPE

Your Child's Name:	
Age:	Birthdate:
School:	
Grade:	
Teacher:	
☐ Left-handed ☐ Right-handed	
Wears glasses or contacts ☐Yes ☐No	
Please check if your child has ever been diagnosed with any of the following:	
☐ Epilepsy	
☐ Autism Spectrum Disorder including Asperger's and Pervasive Developmental Disorder Not-Otherwise Specified (PDD-NOS), please explain :	
☐ Other, please explain:	
Has your child ever watched *The Transporters* DVD series designed for children with ASD? ☐Yes ☐No If Yes, how frequently and when:	
If we have any questions or clarifications, may we contact you?	
☐Phone Number:	Best time to call:
☐Email:	

APPENDIX C

Informed Consent Form

Multiple Baseline Study of The Effects of Left Visual Field Stimulation During Emotion Recognition Training Among Male Children with Autism Spectrum Disorders

Research criteria based on ethical guidelines established by the American Psychological Association and the Human Subjects Committee of the University of North Dakota (UND).		
Please indicate that you understand the following information by checking the appropriate box:	**□ I understand this information.**	**□ I do *not* understand this information.**
You will be asked to rate sentences about your child's social abilities in a written questionnaire that will take about 10 minutes to complete.	**□ I understand this information.**	**□ I do *not* understand this information.**
Prior to receiving social skills training, your child will be assessed by asking s/he to describe pictures and words of emotions.	**□ I understand this information.**	**□ I do *not* understand this information.**
The study will run for 6 weeks during which your child will receive 3 individual social skills training sessions each week. Each session will run approximately 30 minutes and will be held at your choice of a school or home setting.	**□ I understand this information.**	**□ I do *not* understand this information.**
Your child will be asked to watch short video clips from *The Transporters* DVD series and answer brief interactive questions about what they viewed.	**□ I understand this information.**	**□ I do *not* understand this information.**
Your child may be asked to wear glasses that have been modified to block the right eye. These glasses are designed to fit over prescription glasses if needed.	**□ I understand this information.**	**□ I do *not* understand this information.**
All activities will be explained to your child and s/he will be given the choice to participate. Your child can stop at any time. If your child shows discomfort or hesitancy, the activity will end immediately. There are no known risks for participating. If your child has any negative effects from being involved in this project, contact information for a local mental health provider will be given.	**□ I understand this information.**	**□ I do *not* understand this information.**
Your child will be given a small prize for participating (sticker, pencil, etc), even if s/he does not complete the activity. At the end of the study, a set of social skills therapy tools will be given to you and your child.	**□ I understand this information.**	**□ I do *not* understand this information.**
Your child's answers are strictly confidential. Your child's name will not be linked to the results. The research data will be stored	**□ I understand this information.**	**□ I do *not* understand this information.**

electronically and stored in a locked file cabinet. My advisor, myslef and people who audit research procedures at UND will have access to this data. Collected data and personal information, including consent forms and emails will be destroyed after three years by shredding/permanently deleting the information.		
If your child has been diagnosed with blindness in one or both eyes (glasses or contacts are OK), hearing loss or epilepsy, s/he is not able to participate.	□ **I understand this information.**	□ **I do *not* understand this information.**
If you have any questions, now or later, you may contact me (701-741-7830) or my advisor, Dr. F. Ric Ferraro (701-777-2414). If you have any other questions or concerns, you may call the UND Office of Research, Development and Compliance (701-777-4279).	□ **I understand this information.**	□ **I do *not* understand this information.**
As the parent/guardian of a research participant, I have read the above information, have had any questions answered, consider my child eligible for the project and agree to allow my child to participate. I also understand that the experimenters, the University of North Dakota or the Grand Forks/Fargo Public Schools will not be responsible for the costs of medical or psychological treatment resulting from any adverse reaction incurred from participation in this study. I will keep a copy of the consent information for my own records. I may also request a copy of this permission form.		
Signature of Parent/Guardian:		Date:

APPENDIX D

The Childhood Autism Spectrum Test (CAST)

Please read the following questions carefully, and circle the appropriate answer to describe your child.		
1. **Does s/he join in playing games with other children easily?**	Yes	No
2. **Does s/he come up to you spontaneously for a chat?**	Yes	No
3. **Was s/he speaking by 2 years old?**	Yes	No
4. **Does s/he enjoy sports?**	Yes	No
5. **Is it important to him/her to fit in with the peer group?**	Yes	No
6. **Does s/he appear to notice unusual details that others miss?**	Yes	No
7. **Does s/he tend to take things literally?**	Yes	No
8. **When s/he was 3 years old, did s/he spend a lot of time pretending (e.g., play-acting being a superhero, or holding teddy's, tea parties)?**	Yes	No
9. **Does s/he like to do things over and over again, in the same way all the time?**	Yes	No
10. **Does s/he find it easy to interact with other children?**	Yes	No
11. **Can s/he keep a two-way conversation going?**	Yes	No
12. **Can s/he read appropriately for his/her age?**	**Yes**	**No**
13. **Does s/he mostly have the same interests as his/her peers?**	Yes	No
14. **Does s/he have interest which takes up so much time that s/he does little else?**	Yes	No
15. **Does s/he have friends, rather than just acquaintances?**	Yes	No
16. **Does s/he often bring you things s/he is interested in to show you?**	Yes	No
17. **Does s/he enjoy joking around?**	Yes	No
18. **Does s/he have difficulty understanding the rules for polite behavior?**	Yes	No
19. **Does s/he appear to have an unusual memory for details?**	Yes	No
20. **Is his/her voice unusual (e.g., overly adult, flat, or very monotonous)?**	Yes	No
21. **Are people important to him/her?**	Yes	No

22. **Can s/he dress him/herself?**	Yes	No
23. **Is s/he good at turn-taking in conversation?**	Yes	No
24. **Does s/he play imaginatively with other children, and engage in role-play?**	Yes	No
25. **Does s/he often do or say things that are tactless or socially inappropriate?**	Yes	No
26. **Can s/he count to 50 without leaving out any numbers?**	Yes	No
27. **Does s/he make normal eye contact?**	Yes	No
28. **Does s/he have any unusual and repetitive movements?**	Yes	No
29. **Is his/her social behavior very one-sided and always on his/her own terms?**	Yes	No
30. **Does s/he sometimes say "you" or "s/he" when s/he means "I"?**	Yes	No
31. **Does s/he prefer imaginative activities such as play-acting or storytelling, rather than numbers or lists of facts?**	Yes	No
32. **Does s/he sometimes lose the listener because of not explaining what s/he is talking about?**	Yes	No
33. **Can s/he ride a bicycle (even if with training wheels)?**	Yes	No
34. **Does s/he try to impose routines on him/herself, or on others, in such a way that it causes problems?**	Yes	No
35. **Does s/he care how s/he is perceived by the rest of the group?**	Yes	No
36. **Does s/he often turn conversations to his/her favorite subject rather than following what the other person wants to talk about?**	Yes	No
37. **Does s/he have odd or unusual phrases?**	Yes	No

APPENDIX E

Thank You for Participating Letter

Hello!

I wanted to thank you and NAME for helping with my research project conducted at the Win-E-Mac School. After participating in six weeks of one-on-one training using *The Transporters* DVD series, NAME showed improvement in his ability to recognize and understand the emotions in others. He expanded his ability to recognize, define, and provide examples for emotion vocabulary words, learning how to define and use NUMBER more emotion words than he was able to before he began the study. NAME was also able to better match emotions to appropriate situations using characters from *The Transporters* series, everyday pictures of children and adults, and even his own personal experiences. By the end of the study, he was able to correctly match NUMBER of the scenarios and emotions – a NUMBER percentage point improvement from the beginning of the study.

For some of the sessions, NAME wore special glasses that looked like sunglasses and covered his right eye. The modified glasses were tested to see if they helped NAME rely more on his right visual field (and left brain) to decode emotions. Typically, children understand people's facial emotions by creating an overall picture that the right side of the brain can quickly interpret. Research has found that some children look at faces piece by piece to determine what another person may be feeling – a process that relies more on the right visual field and left hemisphere of the brain. This may explain why some children have difficulty understanding other people's emotions. NAME's testing results indicate that covering his right eye with the modified glasses while watching *The Transporters* may have aided in NAME's social skills training.

Based on the results of this study and NAME's individual performance, it is recommended that NAME continues to be involved in social emotional training. I have included a list of resources that you may wish to review with your child's school and/or medical providers as possible social and emotional interventions. If you have any questions or would like more information about the results of this study, feel free to contact me [researchsupportund@gmail.com or 701-741-7830]. Again, thank you for supporting research that helps us understand more about children and their development. I very much enjoyed my time working with NAME and wish him the best in this upcoming school year.

Rachelle Hansen, M.A.
Clinical Psychology Ph.D. Candidate
University of North Dakota

APPENDIX F

SPSS Output for Paired Sample T-Tests

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	EVPretest - EVPosttest	-3.75000	1.19024	.59512	-5.64393	-1.85607	-6.301	3	.008
Pair 2	PreLevel1 - PostLeve1	-5.25000	1.84842	.92421	-8.19125	-2.30875	-5.681	3	.011
Pair 3	Prelevel2 - PostLevel2	-4.12500	1.93111	.96555	-7.19782	-1.05218	-4.272	3	.024
Pair 4	Prelev3 - PostLev3	-2.87500	1.18145	.59073	-4.75496	-.99504	-4.867	3	.017

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	EVPretest & EVPosttest	4	.921	.079
Pair 2	PreLevel1 & PostLeve1	4	.315	.685
Pair 3	Prelevel2 & PostLevel2	4	.778	.222
Pair 4	Prelev3 & PostLev3	4	.766	.234

APPENDIX G

Calculations for Percentage of Non-Overlapping Data Points (PND) and Percentage of All Non-Overlapping Data Points (PAND)

	PND	PAND
Participant 2	3 of 6 intervention data points > highest baseline data point [94.44] = 50.00%	(18 – 3 overlapping intervention data points) [86.67, 92.59, 93.33] /18 total experiment data points = 83.33%
Participant 3	6 of 12 intervention data points > highest baseline data point [92.22] = 50.00%	(18– 3 overlapping baseline data points) [90.00, 90.00, 92.22] /18 total experiment data points = 83.33%
Participant 4	7 of 18 intervention data points > highest baseline data point [95.00] = 39.00%*	(36 – 11 overlapping intervention data points) [82.63, 85.38, 86.11, 86.67, 86.67, 88.89, 90.00, 91.67, 94.44, 94.44, 94.44] /36 total experiment data points = 69.44%*

*Calculated using Participant 1 Total Data Set as Baseline and Participant 4 Total Data Set as Intervention

APPENDIX H

Calculations of Effect Size (Phi) for χ2 from Contingency Tables Based on High and Low Score Frequencies of Baseline and Intervention Phases

Participant 2	**Baseline**	**Intervention**	**Totals**	**Expected Cell Frequencies per Null Hypothesis**	
High	3	5	8	5.33	2.67
Low	9	1	10	6.67	3.33
Totals	12	6	18	**Phi**	+0.55

Participant 2	**Baseline**	**Intervention**	**Totals**	**Expected Cell Frequencies per Null Hypothesis**	
High	3	9	12	4	8
Low	3	3	6	2	4
Totals	6	12	18	**Phi**	+0.25

	Baseline (Participant 1)	**Intervention** (Participant 4)	**Totals**	**Expected Cell Frequencies per Null Hypothesis**	
High	4	7	11	5.5	5.5
Low	14	11	15	12.5	12.5
Totals	18	18	36	**Phi**	+0.18

$$X^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

$$\phi^2 = \frac{X^2}{n}$$

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