Research in Developmental Disabilities 65 (2017) 35–45

Contents lists available at ScienceDirect

Research in Developmental Disabilities

journal homepage: www.elsevier.com/locate/redevdis

Research Paper

A Pilot Study Examining a Computer-Based Intervention to Improve Recognition and Understanding of Emotions in Young Children with Communication and Social Deficits

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ARTICLE INFO

No.of reviews: 0

Keywords:
Autism
Intervention
Computer-based

ABSTRACT

Background: A common social impairment in individuals with ASD is difficulty interpreting and or predicting emotions of others. To date, several interventions targeting teaching emotion recognition and understanding have been utilized both by researchers and practitioners. The results suggest that teaching emotion recognition is possible, but that the results do not generalize to non-instructional contexts. This study sought to replicate earlier findings of a positive impact of teaching emotion recognition using a computer-based intervention and to extend it by testing for generalization on live models in the classroom setting.

Method: Two boys and one girl, four to eight years in age, educated in self-contained classrooms for students with communication and social skills deficits, participated in this study. A multiple probe across participants design was utilized. Measures of emotion recognition and understanding were assessed at baseline, intervention, and one month post-intervention to determine maintenance effects. Social validity was assessed through parent and teacher questionnaires.

Results: All participants showed improvements in measures assessing their recognition of emotions in faces, generalized knowledge to live models, and maintained gains one month post intervention.

Conclusions: These preliminary results are encouraging and should be utilized to inform a group design, in order to test efficacy with a larger population.

1. Introduction

The inability to understand and recognize emotions in others affects one's social competence. Social competence refers to one's ability to successfully engage in social interactions, establish and maintain relationships, and get needs met across contexts (Merrell & Gimpel, 1998; Stichter, Randolph, Gage, & Schmidt, 2007). Social competence can have a positive effect on the overall quality of one's life (Hall, 2009). It is important in establishing and maintaining mutually satisfying relationships (Merrell & Gimpel, 1998), and leads to; increased self-esteem, self-confidence, and adaptability (Merrell & Gimpel, 1998). Social competence increases one's ability to; hold a job (Cotugno, 2009), and decreases the likelihood of; negative treatment or victimization from others (Hall, 2009). Limited social competence can result in negative responses and or evaluative judgments from others (Merrell & Gimpel, 1998), peer rejection, academic failure, and social dissatisfaction (Alwell & Cobb, 2009). The ability to connect with others through sharing thoughts, ideas, and feelings is central to being human (Hourcade, Pilotte, West, & Parette, 2004).

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http://dx.doi.org/10.1016/j.ridd.2017.04.007
Received 5 October 2016; Received in revised form 17 November 2016; Accepted 10 April 2017
Available online 23 April 2017
0891-4222/

One of the most common observations about people with autism spectrum disorder (ASD) is their lack of social competence. In fact, their social impairments may be their most striking deficit (Koegel, Koegel, Hurley, & Frea, 1992; Roeyers, 1995). Individuals with ASD have difficulty interpreting and predicting the emotions, intent, and beliefs of others, which leads to social, communication, and behavioral challenges (Baron-Cohen, Leslie, & Frith, 1985). If left untreated these social skills deficits could have long-term negative effects, such as isolation (Rogers, 2000), difficulty maintaining employment (Cotugno, 2009), and a lack of outside interests (Eaves & Ho, 1997; Stichter et al., 2007) all of which negatively impact quality of life.

Although the social impairments in children with ASD are pervasive, appropriate and well-planned interventions can lead to significant improvements in social functioning (Rogers, 2000; Swaggart et al., 1995). One area of social functioning that has been the target of a range of investigations is the ability to recognize emotions in others. Ability to recognize emotions in others is a key skill in social interactions and in the development of social competence (Baron-Cohen, Wheelwright, Lawson, Griffin, & Hill, 2002; Clark, Winkielman, & McIntosh, 2008).

Currently, there are competing theories that seek to explain why individuals with ASD have difficulty recognizing and understanding facial expressions of others. One such theory, Theory of Mind describes the ability to understand mental states of others including thoughts, intentions, and beliefs, as well as their impact on behavior. Typically developing children acquire Theory of Mind rapidly during preschool years (Wellman, Cross, & Watson, 2001). However, individuals with ASD experience delays in acquiring Theory of Mind as evidenced on lack of success in inferential false belief tasks requiring prediction of thoughts, speech, or behavior of an individual (Happé, 1995; Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998). These delays might result from inattention to the social world. Klin, Jones, Schultz, Volkmar and Cohen (2002) contend that individuals with ASD have atypical gaze and gaze following patterns; they are not attracted to the eye region when looking at faces. In contrast, neurotypical individuals are attracted to the eye region when looking at faces. Additionally, neurotypical individuals are constantly interpreting social meaning and are prone to attribute social meaning in even non-living things (Klin, Jones, Schultz, & Volkmar, 2003). Poor Theory of Mind abilities have been linked to difficulties interacting with others, especially in emotion recognition (Ashwin, Chapman, Colle, & Baron-Cohen, 2006), social competence (Bosacki & Astington, 1999) and anxiety in social situations (Coupland, 2001). Theory of Mind deficits can lead to daily difficulties and negative long-term outcomes.

Ability to attribute mental states to others requires awareness and attention to facial expressions (Baron-Cohen, Wheelwright, & Jolliffe, 1997). Facial expressions provide important clues to an individual's mental state. Inattention to facial expressions combined with a lack of social adaptation may have a negative impact on ability to perceive faces in a configural manner (Behrmann et al., 2006). Behrmann et al. suggest that face processing in individuals with ASD is under developed due to the fact that faces are both social and represent complex visual stimuli. As a result, they require configural rather than local processing. Possible difficulties with this combination of social and complex visual processing, leads to a second cognitive theory of autism: Weak Central Coherence.

Weak Central Coherence Theory seeks to explain difficulty understanding and recognizing facial expressions of others as a result of a local processing bias in individuals with ASD (Frith, 1989, 2003; Frith & Happe, 1994). According to this theory, individuals with ASD process things in a piece-meal fashion rather than by looking at things as a whole or globally. Typical children process information by extracting overall meaning. In relation to processing facial expressions, typical children are generally able to extract emotions of others by looking at and processing facial expressions. If they possess Theory of Mind, then they are also able to use the information from other people's faces and make assumptions or predictions regarding future behavior. Individuals with ASD, on the other hand, have difficulty extracting overall meaning or emotion from facial expressions of others and thus have difficulty predicting behaviors.

Researchers have employed several different techniques to teach individuals with ASD to recognize facial expressions. These techniques have included applied behavior analysis (Grindle & Remington, 2005; Shaw, 2001; Stafford, 2000), social skills groups (Cotugno, 2009; Ryan & Charragáin, 2010; Solomon, Goodlin-Jones, & Anders, 2004), direct instruction (Feng, Lo, Tsai, & Cartledge, 2008), and assistive technology incorporating virtual environments or computer technologies (Bölte et al., 2006; Golan & Baron-Cohen, 2006; Ryan and Charragáin, 2010; Silver & Oakes, 2001; Swettenham, 1996; Tanaka et al., 2010). Conclusions from the research suggest that teaching emotion recognition (ER) is possible but that the results do not generalize to non-instructional contexts.

At present, some evidence supports the use of computer interventions to teach emotion recognition to individuals with ASD (Golan, Baron-Cohen, & Hill, 2006; Golan & Baron-Cohen, 2006; Lacava, Ranklin, Mahlios, Cook, & Simpson, 2010; LaCava, Golan, Baron-Cohen, & Smith- Myles, 2007; Silver & Oakes, 2001; Weinger & Depue, 2011). One computer intervention program, *The Transporters* (Changing Media Development, 2006; Golan et al., 2010), was created to teach three to seven year old children to understand and recognize facial expressions. The program consists of 15 episodes lasting five minutes each and depicts characters with real-life faces of actors grafted onto vehicles such as a train, chain ferry, cable car, etc. Each episode is narrated, and the characters do not talk in order to allow children to focus on the facial expression rather than watching the characters talking.

Although preliminary testing of *The Transporters* produced favorable results (Golan et al., 2010; Young & Posselt, 2012), more research is necessary to demonstrate efficacy. Previous research on ER in individuals with ASD has highlighted a need to assess generalization to natural settings with peers or family members. Given that generalization of skills is another deficit of individuals with ASD (Fein, Tinder, & Waterhouse, 1979; Frith, 2003; Koegel & Koegel, 1988), the current study was designed to investigate whether computer based instruction helps students improve ER ability in computer based assessments and if ER ability generalizes to a live model. The aims of the study were to replicate existing findings regarding the positive impact of *The Transporters* on facial recognition (Golan et al., 2010; Young & Posselt, 2012) and extend those findings by determining whether improvements in facial recognition transferred to a live model in the classroom.

2. Method

2.1. Researcher

The primary researcher was a full time CSS teacher and doctoral student, during the time that the research was conducted at the research site. The school site had five classrooms designated as self-contained CSS rooms located in a separate wing of the campus. The primary researcher recruited participants from three CSS classrooms at the site; her classroom was excluded from participation due to the age of the students. The fact that the primary researcher was a teacher at the site made it ideal for conducting research. Specifically, the primary researcher had a good working relationship with the other teachers and students, as they participated in several shared activities such as: field trips, recess, lunch, and resources (P.E., art, and music).

2.2. Participants

Approval to conduct the research study was granted by the Institutional Review Board at the author's university and the participating school system. Four students were recruited to participate in the study from a public school in northeast Florida. Due to possible attrition, four students were recruited to increase the likelihood that complete data would be collected for at least three participants. One participant did transfer to another school midway through the intervention phase. As a result he did not complete the study and the available data from him has been excluded.

The criteria for participating in the study were: (1) students served in self-contained classrooms for children with communication and social skills deficits (CSS); (2) no prior experience with *The Transporters*; (3) aged between four and eight years at the onset of study; (4) ability to make choices by pointing with a finger; (5) informed written consent from parent and teacher; (6) an age equivalent of four years or greater on the Peabody Picture Vocabulary Test 4th edition (Dunn & Dunn, 2007); and (7) a pre-test score of 50% or less on the "Try a Mix of Questions" hard version from *The Transporters* program. Characteristics of the three participants who completed the study are included in Table 1. In addition, complete descriptions of social functioning for each participant are provided.

Participant one: In terms of her social functioning, Bella was very friendly and enjoyed interacting with both peers and adults. She spoke in complete sentences, answered questions, initiated greetings and conversations with others, and verbalized her wants, needs, and feelings. She preferred the company of others, either peers or adults for activities both in the classroom and outside of it. She did not seem to have a preference over interactions with peers or adults. She had difficulty interpreting social cues, and could upset her peers by close proximity or through continued questioning. She demonstrated good eye contact. She did not use gestures to supplement her verbal communication. In responding to questions, she typically responded with a few words but did not expand answers or ask questions in response. She demonstrated a range of appropriate facial expressions in conversations with others: happiness, surprise, etc. She did not participate in any general education.

Participant two: Angel responded to greetings from familiar people independently, but rarely initiated greetings. He preferred social interactions with adults over peers. During classroom center activities, he was prone to choose centers which allowed him to work independently such as the computer or listening center. When he chose to engage in activities with peers, he tended to direct others, telling them what to do or say. During recess, he preferred to play with older children with ASD, again directing play. Although he was included in a general education classroom for an hour each day, he preferred staying in his CSS classroom and made excuses on a daily basis as to why he should stay. He demonstrated good eye contact but limited range of expression. Like Bella, he did not use gestures to further communicate his speech. He was able to express wants and needs in full sentences, but did not talk about his feelings. He particularly enjoyed conversations with adults and expanded on answers readily.

Participant three: Darius exhibited variable eye contact when engaging with others. Like Angel and Bella, he did not gestures to supplement verbal communication. He had a very flat tone when talking with others. In addition, he did not employ a range of facial expressions. When responding to questions, he typically responded with a one to two word utterance or not at all. He did not initiate greetings or conversations with others and required a prompt to do so about half the time. He had a special friend in the classroom that he preferred over all others. When playing together, Darius responded with compliance of demands made by his friend, smiles or laughter, and the occasional one to two word utterances. He rarely used language in interactions with peers, including his special friend. He had the tendency to move around and fidget. When requesting a want or need, he generally used a one word statement, such as "bathroom" or "lunch", etc. He was unable to explain his feelings, but did get upset frequently. When upset, he would cry and or tantrum (yelling and repeatedly hitting or kicking the ground). Like Bella he did not participate in general education.

Table 1
Participant Characteristics.

Participant	Age	Ethnicity	Diagnosis	PPVT- Age equivalent	Pre-test score on "Try a Mix of Questions" quiz	Grade
Bella	8,0	African American	Intellectually Disabled; Language Impaired	5.3	4	2nd
Angel	4,11	Caucasian	PDD-NOS; Communicatively Disordered	4.0	2	Pre-K
Darius	6,5	African American	Infantile Autism; Communication Disorder	4.4	3	1st

2.3. Setting

The study was completed in a Title One public elementary school in northeast Florida. The school served roughly 400 students and was a site for CSS Students. There were five CSS classrooms in the school when the study took place. Pre-intervention and post-intervention assessments as well as both baseline and intervention data collection occurred in each students' self-contained special education classroom or the therapy lab where the students received speech or language instruction and or occupational therapy. In both the baseline and intervention phases, data collection took place in each student's special education classroom during electives/resource time. The student was assessed with only the researcher and the classroom paraprofessional present. The in-vivo assessments took place in the therapy lab for two students, and in the special education classroom for the third student in both pre- and post-assessment. Again, the in-vivo assessments occurred during the resource period, when other students left the classroom to participate in art, media, or physical education. The in-vivo assessments were conducted with the researcher, classroom teacher, additional CSS teachers, the speech and language pathologist, and the occupational therapist.

2.4. Materials and measures

The Transporters consists of 15, five-minute animated episodes that each focus on an emotion or mental state. The 15 emotions addressed in *The Transporters* are happy, sad, angry, afraid, disgusted, surprised, excited, tired, unfriendly, kind, sorry, proud, jealous, joking, and ashamed. The series includes eight characters, all vehicles, which are part of a toy set in a boy's bedroom. All of the vehicles run on tracks, cables, or otherwise have limited degrees of freedom of motion that are predictable. In addition, the vehicles have real human faces grafted onto them of different ages, sex, and ethnicity. Incorporating diverse age, sex, and ethnicity was intentional in order to enhance generalizability of effects. The assumption was that children with ASD would look more often at faces attached to mechanical systems (vehicles) than they would under normal circumstances (Golan et al., 2010). Additionally, a narrator was utilized instead of talking characters, in order to allow children to focus on facial expression as a whole rather than trying to obtain affective information from the character's speech. The program includes a selection of quizzes that relate to each episode, as well as "Try a Mix of Questions" quiz which presents random questions from the episodes, that can be accessed from the main menu. Participants began the intervention phase by watching each episode 3 times per day, and completing the "Try a Mix of Questions" immediately following the 3rd viewing. After all 15 episodes were shown, and for the last 5 days of the intervention, the participants chose the video he/she preferred, watched the video 3 times, and again completed the quiz following the 3rd viewing.

2.5. Dependent variables

There were six variables that were measured in order to assess any effects from watching episodes from *The Transporters*. Three of these variables were measured through taking the hard version of quizzes from *The Transporters*. These included: ability to identify from a field of three, the character feeling a particular emotion; ability to match similar emotions of characters; ability to select the appropriate emotion displayed in a character based on a given scenario. In each episode quiz and in the "Try a Mix of Questions" quiz, there is a total of eight questions. Three types of questions are utilized in each of the quizzes: (a) matching faces with faces (match the two characters that are feeling the same); (b) matching faces to an emotion (identify the face that portrays a specific emotion); (c) matching situations with faces (identify the correct emotion that might be displayed in a given situation). Each "Try a Mix of Questions" and episode-based quiz has two questions each for matching faces with faces, and matching faces to an emotion. The final type question, matching situations with faces is asked four times in each quiz. Each quiz has two levels of difficulty, easy and hard; hard quizzes repeat the easy quizzes but offer three potential answers as opposed to two. Only the hard versions of quizzes were utilized for this study. The total number of questions in the Try a Mix of Question pool was 120 questions for the easy version and 120 for the hard version.

The other variables assessed performance in live conditions. These included: the ability to identify a person's facial expression from a live model**;** ability to match similar emotions in live models; ability to match appropriate emotion to an enacted scenario in a live setting. Performance on specific variables during computer-based baseline and intervention sessions was recorded on checklists that denoted type of question asked. These checklists also addressed times videos were shown, whether the session was recorded, and whether the session was baseline or intervention. Each quiz followed a similar format of first asking a participant to match a character with another character displaying the same emotion, followed by a question involving theory of mind, followed by a question involving matching an emotion to a character, next another theory of mind question is presented, and finally this sequence is repeated so that there are a total of 8 questions. Performance was graphed in order to examine trends in the data.

2.6. Design and procedures

A multiple baseline probe design across participants was used in order to assess changes in ER tasks as a result of using *The Transporters*. At the start of the study all four participants were presented daily with "Try a Mix of Questions Quiz", which features randomly presented questions about different emotions from a variety of episodes from the DVD to establish baseline. Although the questions consist of material from all of episodes, the questions are posed in such a way that the participants would not require prior knowledge of the episodes in order to respond correctly to the ER tasks if they had emotional recognition skills. If the quizzes were used in the standard manner, after a participant chose the correct answer, he/she was rewarded with verbal praise, such as "you're doing great!" and presented with animation showing a moving wheel or wheels. When a participant chose an incorrect answer, the

response from the DVD was "No, that's not right. Try again" and a picture of smelly fish was shown on screen. The scenario was then played out again and the same three choices were available. For this study, the participants were asked to point to their choice as opposed to clicking a mouse in order to eliminate feedback and prevent learning correct responses as a result of repeating the quizzes.

Once the intervention began for the first participant, the remaining participants were presented with quizzes every third day, rather than daily. However, prior to introducing the independent variable, the researcher conducted a short but continuous baseline measure (3 consecutive days) for each individual. The purpose for utilizing a probe design instead of the standard multiple baseline design was to minimize any possible negative reactions to repeatedly taking the "Try a Mix of Questions" quiz.

In an effort to promote attention to task and participation in baseline trials, prior to the start of each quiz, participants were presented with a choice of preferred items (stickers, small piece of candy, bubbles, time to play Wii, etc.) to work towards. After responding to each question, a mark was made in a chart, so that the participant had a visual representation of the expectations and how many responses they had to give prior to being rewarded with the reinforcing item of their choice. No other feedback was given, with the exception of marking each box on the chart. Upon completion of the quiz, the participant was given their self-nominated preferred item for participating regardless of his/her performance.

In addition, before initiating the multiple probe across participants design, all participants completed an in vivo pre-test assessment of their ability to recognize emotions in the faces of adults they know and work with regularly. In order to assess emotion recognition ability in live models pre-intervention, the circumscribed interests of the subjects were identified via observations of the child and parent questionnaires. The researcher created eight different scenarios incorporating one or more of the circumscribed interests of each participant and a corresponding emotion to be acted out or narrated by teachers, the communication and social skills site coach, occupational therapist, and the speech and language pathologist in front of the participant. The scenarios mimic the design of *The Transporters* quizzes in that two scenarios focus on matching two characters displaying the same emotion, two more focus on matching a face to an emotion, and four questions center on matching a face to a situation. The interest of the child was incorporated, in an effort to increase the likelihood that he/she would watch the scenario play out. The participant sat at a table with familiar adults acting out scripts. Each session was recorded for interobserver reliability

The baseline phase utilizing the "Try a Mix of Questions" hard quiz was presented in a familiar classroom and the researcher sat with the participant and recorded his/her answers. All baseline sessions were videotaped and every fifth session was shown to two independent reviewers who recorded the participants' answers in order to determine reliability. The quiz was given daily to all participants until a minimum of three stable baseline measures were obtained for the first participant. At this point, the first participant was presented with the pre-intervention in vivo assessment. Next, the intervention phase and episodes of *The Transporters* was introduced for the first participant, while baseline data collection continued for the other participants. Probes were conducted every third school day for the two participants who were in the baseline phase. After stable performance on the quizzes was obtained for the first participant, the intervention began for the second participant. Prior to beginning the intervention phase, the participant was presented with the "Try a Mix of Questions" hard quiz for at least three consecutive school days in order to assist in establishing a true representation of baseline level responding. Next, the participant was given the in vivo assessment and then the intervention phase began for her. Similarly, this format was repeated for the third participant.

After baseline was established with the first participant, and he completed the live pre-assessment, he watched the first episode at three different times during the day but did not participate in taking the quiz until immediately following the third viewing. Responses to the quiz, as well as times episodes were shown, were recorded on a fidelity checklist. The rationale for repeated viewings is to increase familiarity, predictability, and mastery of content. Distractions were identified and minimized so that the participant paid attention to *The Transporters* episodes. The following day, the second episode was shown three times daily, followed by a quiz after the third viewing. The same pattern was followed for subsequent episodes. The second participant began watching the videos and taking the quizzes after the first participant had established stable performance following the introduction of the intervention. The second participant completed the live pre-assessment following the same guidelines described for the first participant. Prior to the introduction of the independent variable, the second participant took the "Try a Mix of Questions" quiz daily for at least three consecutive school days, (as opposed to every third day) data were recorded for question responses, and participation was videotaped. The third participant began watching the videos and taking the episode quizzes after following the same guidelines described for the first two participants.

Each participant watched episodes from *The Transporters* and was tested using the random quizzes after every third viewing. After the first participant had watched and completed quizzes for all 15 episodes and had five days of choosing any episode to watch on three different times each day, followed by the "Try a Mix of Questions" quiz after the third time, the same in-vivo, live play scenarios used in the pre-assessment were reenacted. These play scenarios were again conducted by researchers and school staff and videotaped. Participant responses were recorded and independent blind reviewers viewed segments of the videotape to determine the participant's selection.

The multiple baseline design presents the opportunity to demonstrate experimental control over three different points in time (Horner et al., 2005; Kazdin, 1982), whereas the pre-test/post-test design allows comparison of emotion recognition tasks performance before and after the intervention was implemented. In this way, divergent information was collected in order to ascertain whether the computer program is an effective intervention in improving performance on emotion recognition tasks both in computer based assessments and in live conditions.

2.6.1. Social validity

Upon completion of the post-test, the parents and teachers were given a short questionnaire. The questionnaire asked these adults whether any changes were noted in the identification of facial expressions and or reaction to facial expressions (the intervention

worked) outside of the intervention. It also asked about the accessibility of the intervention and whether or not the teacher or parents would continue to use *The Transporters* upon completion of the study. Finally, the questionnaire probed whether either group would recommend *The Transporters* to other parents and teachers of children with autism spectrum disorder.

2.6.2. Treatment fidelity

Treatment fidelity was maintained throughout the intervention by documenting when episodes were shown and recording target responses via checklist and videotape. Furthermore, sections of the recorded sessions were shown to two independent blind reviewers in order to insure fidelity of recording participant responses and determine inter-observer reliability. Teachers were also provided with explicit instructions for showing the episodes to each participant. In addition, teachers were provided with forms to document when the episodes were shown. Participants watched the episode in their classroom twice, and watched the third time and took the quiz with the researcher.

2.6.3. Interobserver reliability

Interobserver measures were calculated for 20% of computer-based baseline and intervention sessions for all participants. All in-vivo sessions and follow-up computer sessions were viewed by two independent blind reviewers and there was 100% agreement for all sessions. For the computer-based baseline and intervention sessions, interobserver agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. The mean agreement for recording of participant responses was 97% for Angel, 98% for Bella, and 95% for Darius.

3. Results

Overall, the results indicate improved performance on measures related to emotion recognition and understanding of others following the introduction and continued viewing of episodes within *The Transporters*. Visual analysis of the data depicts an accelerated trend direction for all participants. In order to examine maintenance, a follow-up probe was conducted one month post-intervention. Participant scores suggest that treatment effects were maintained for all participants in the absence of watching episodes from *The Transporters*. Fig. 1 shows group data on performance during baseline, intervention, and follow-up.

Figs. 2–4 display the results by question type in order to provide more specific information to determine whether participants were better able to respond to questions involving matching an emotion to a face, matching emotion to emotion, or scenarios involving theory of mind. In Fig. 2, which depicts scores from 0 to 2 correct responses on the match facial expression to another facial expression questions (i.e. “Barney is feeling surprised? Who else is surprised? Is it Sally? Or Jennie? Or Charlie?”), the only participant who demonstrated marked gains was Bella. The trend for correct responses was evident in her scores, which consisted of perfect responses from the 20th session through the rest of the intervention, as well as the follow-up. Both Angel and Darius showed more variability in their scores, and as such a trend was not evident. Darius particularly showed more variability in his responses by scoring 0–2 throughout the baseline and intervention phases.

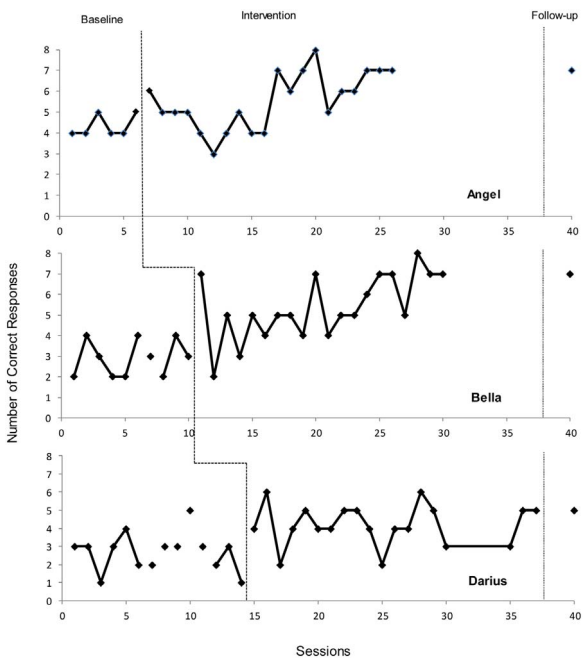

Fig. 1. Participant Scores on Hard “Try a Mix of Questions” Quiz.

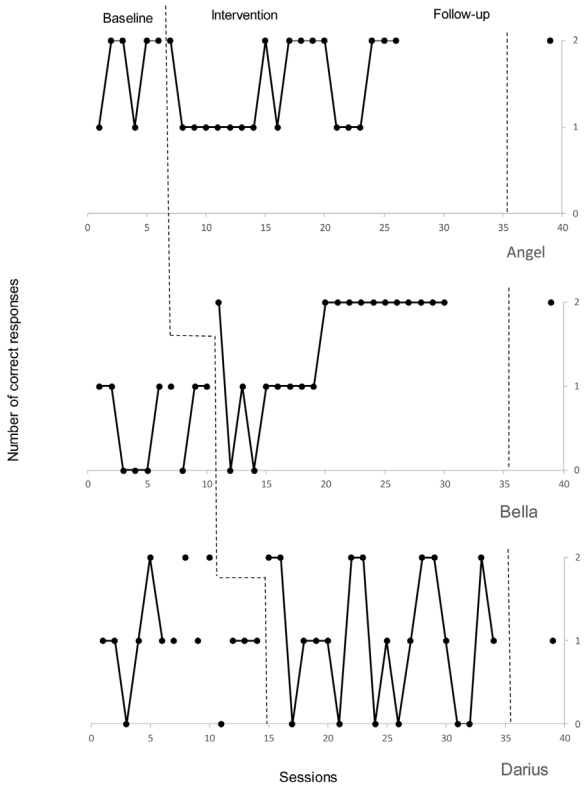

Fig. 2. Participant Scores on Match Facial Expression to Facial Expression Portion of "Try a Mix of Questions" Quiz.

3.1. Angel

In terms of Angel's level changes, his performance on quizzes went from a mean of 4.3 to a mean of 6 (+1.7) during the intervention phase. Level change calculations suggest that his scores were stable on ER quizzes in the baseline phase and improved by +2.5 in the intervention phase. Immediate change in level for phase change was +1, which suggests that the intervention has had some effect. The accelerated trend direction suggests that he was improving in ER tasks.

In examining variability, data of both conditions is considered stable (80% of data points fall within 25% of the median values for each condition). The percentage of non-overlapping data is 55%. His performance on the follow-up probe, 7/8 correct, was consistent with his scores during the final week of the intervention, which suggests maintenance.

3.2. Bella

Bella's performance on quizzes went from a mean of 2.9 to a mean of 5.5 (+2.6) during the intervention phase. Level change calculations suggest that her scores improved by +1 on ER quizzes in the baseline phase and by +1.5 in the intervention phase. Immediate change in level for phase change was +4, which suggests that the intervention has had some effect. In reviewing Bella's data, the accelerated trend direction suggests that she improved in ER tasks. In terms of stability, data of the baseline condition is considered stable (80% of data points fall within 25% of the median values for each condition). Data of the intervention condition is considered variable as only 55% of the data points fell within 25% of the median value. Percentage of non-overlapping data is 75%. Similar to Angel, Bella also scored 88% on the follow-up probe, which was consistent with her performance during the last week of the intervention.

3.3. Darius

His performance on quizzes went from a mean of 2.7 to a mean of 4.4 (+1.7) during the intervention phase. Level change calculations suggest that his scores were stable on ER quizzes in the baseline phase and increased by +0.5 in the intervention phase. Immediate change in level for phase change was +3, which suggests that the intervention has had some effect. The accelerated trend direction suggests that he improved in ER tasks with the introduction of the IV. In examining stability, data of both the baseline condition and intervention condition are considered variable as only 71% of the data points fell within 25% of the median value in the baseline condition and only 75% fell within 25% of the median value in the intervention condition. The percentage of non-overlapping data is 15%. His performance on the follow-up probe was 63%, which was somewhat consistent with his scores during

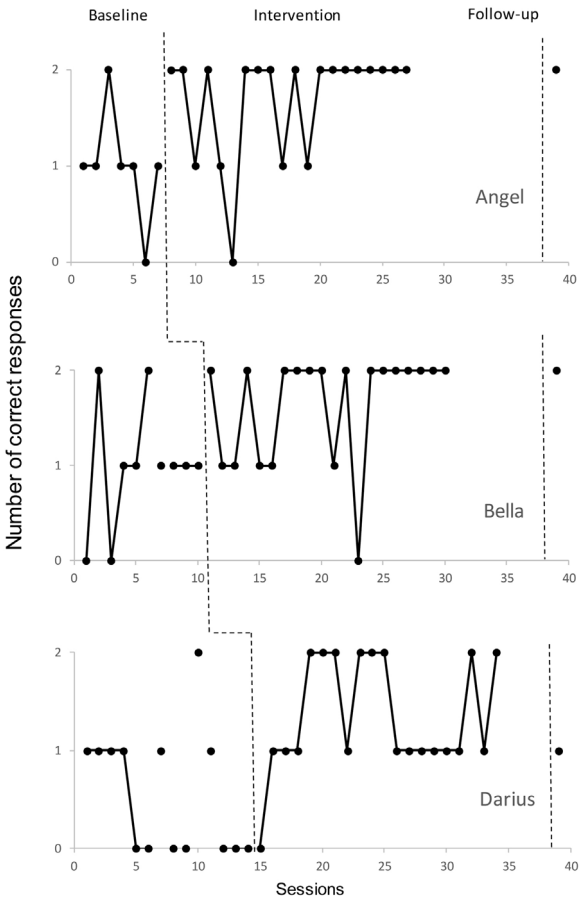

Fig. 3. Participant Scores on Matching Facial Expression to an Emotion Portion of "Try a Mix of Questions" Quiz.

the last week of the intervention.

Fig. 5 displays the data in percentages of correct responses to quizzes during the baseline and intervention phases. Angel increased his percentage of correct responses from 54% during baseline to 70% during the intervention and follow-up phases. In calculating the percent increase by subtracting one number from the other and multiplying by 100, Angel improved his quiz scores by 30% from baseline to the intervention phases. Bella scored an average of 36% correct responses during baseline to an average of 68% correct responses during the intervention phase and follow-up phase. In using the same calculations cited above, she increased her score by 89%. Darius increased his score by 62% with an average of 34% correct responses on quizzes during the baseline phase to an average of 54% correct responses during the intervention phase.

3.4. Participant performance on ER tasks involving a live model from pre- to post- intervention

It was also hypothesized that use of *The Transporters* would improve performance on emotion recognition tasks involving a live model from pre- to post-intervention. Fig. 6 displays the results of performance on the in vivo quizzes both at baseline and post-intervention for all participants. All participants made gains from pre-intervention to post intervention, which suggests that the participants were able to generalize the information learned from watching *The Transporters* and were better able to recognize and understand emotions of familiar adults in live settings.

3.5. Social validity results

The results of the social validity survey for teachers and parents were positive. All three teachers and two of the parent participants responded to the survey following the intervention phase and the in vivo post-test. The third parent was sent the information three times, but failed to respond. Overall, teachers and parents who responded felt that the intervention benefitted the participants. These results suggest that the raters viewed the treatment as socially valid.

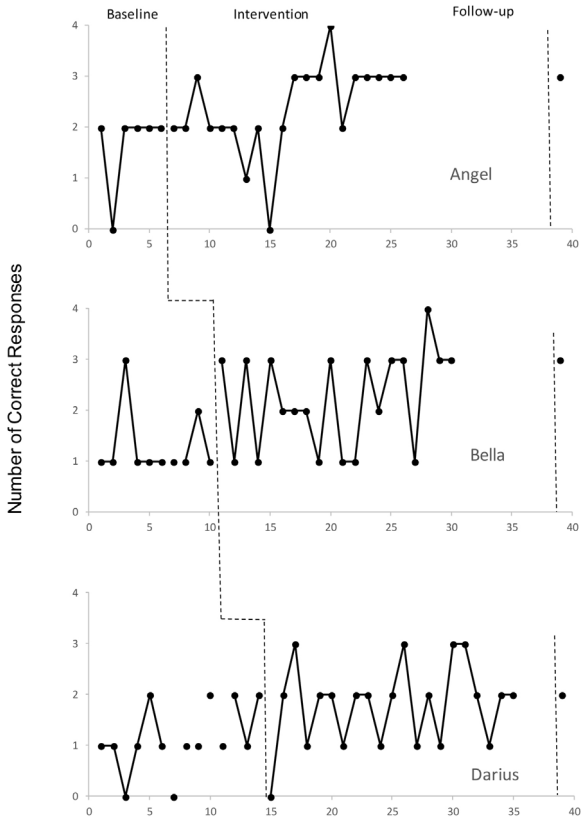

Fig. 4. Participant Scores on Theory of Mind Portion of "Try a Mix of Questions" Quiz.

4. Discussion

The major rationale for the current study was to determine whether the use of *The Transporters* in a school setting led to an increase in scores on emotion recognition measures for young children with autism spectrum disorders (ASD). This is the first study using *The Transporters* in a school setting versus a home setting, and it is the first to assess the impact of the intervention on in vivo recognition of emotions. *The Transporters* is a relatively new intervention designed to teach emotion recognition to young children. The effectiveness of individual use of *The Transporters* was evaluated in a school setting over a four-week period with follow-up one month post-intervention. It was hypothesized that the viewing of episodes from *The Transporters* would increase emotion recognition ability in participants during intervention. Significant increases in emotion recognition tasks were evident from baseline to intervention phase for all three participants. Furthermore, the improvements in emotion recognition and understanding for all three participants were evident in the follow-up phase, which suggests that treatment effects were maintained. Overall, the results suggest that *The Transporters* could be an effective tool in teaching emotion recognition and understanding to young children with significant social deficits and impaired ability to recognize emotions in others. This finding supports previous research supporting the efficacy of utilizing *The Transporters* to teach emotion recognition in young children with ASD (Golan et al., 2010; Young & Powell, 2012) and extends findings by also demonstrating that the positive results transfer to live contexts.

In a relatively short amount of time, 15 min per day over a 4- week period, all participants made gains in tasks involving both emotion recognition and understanding. The fact that all participants learned to extract overall meaning from different features of

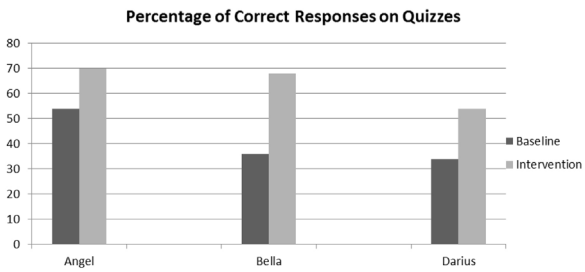

Fig. 5. Average Participant Scores on *Transporters* Quizzes From Baseline Through Intervention and Follow-up.

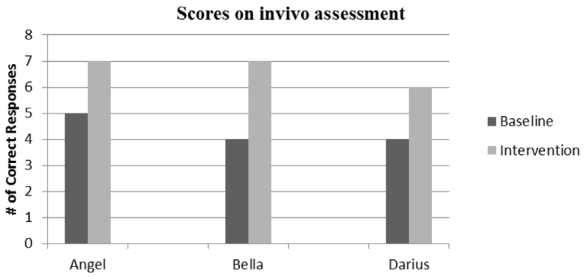

Fig. 6. Participant Scores on In Vivo Quizzes.

faces in the video and live conditions demonstrate marked gains in ability to process features globally. The data suggests that the participants, in a short amount of time, experienced changes in ability to process information from more local to global processing of faces. In addition, participants made gains in attributing mental states to others as a result of the intervention. These gains in theory of mind tasks could be a result of increased attention to faces as a result of watching *The Transporters* series.

In terms of practical implications, *The Transporters* could be used by teachers in classrooms to support social skills training in individuals with ASD throughout all English- speaking countries. If future participants/students make similar gains, the potential impact on the social skills of children with ASD could be outstanding. *The Transporters* could be used independently by students in multiple settings (home, school, therapy lap, etc.) and it could be individualized to address students' needs. For example, the teacher might only show episodes that focus on a certain emotion that a particular student has difficulty recognizing.

Limitations of this study include the small sample size and the variability of symptoms present in each individual child. Specifically, as autism is a spectrum disorder, there is a wide degree of variation in the way it affects people. The diverse presentation of symptoms in children with ASD may limit generalizability of results, as each child with ASD is unique.

Another limitation of the study is lack of information regarding the psychometric properties of the assessments that are part of *The Transporters*. While the results of the current investigation suggest that they measure what is being taught, there is no available information regarding the reliability and validity of these quizzes. The same can be said for the researcher-created in vivo assessments.

5. Conclusion

Given the positive findings of this particular study and in light of the practical implications of using *The Transporters* in a school setting, more research is needed to support the use of *The Transporters* as evidence-based practice. Further study of this program should include group studies, longer intervention periods, diverse settings, and more careful control over the population under study. Continuing this line of research is necessary as preliminary research has demonstrated that ER skills can be acquired through appropriate teaching methods. Recognizing and understanding emotions and mental states of others may allow individuals with ASD improved social integration in both school and community.

Acknowledgements

A special thanks to the child participants and their families, the teachers, and the school district in northeast Florida for taking part in this research.

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