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Joint attention training for children with autism using behavior modification procedures

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Background: Deficits in joint attention are considered by many researchers to be an early predictor of childhood autism (e.g., Osterling & Dawson, 1994) and are considered to be pivotal to deficits in language, play, and social development in this population (Mundy, 1995). Although many researchers have noted the importance of joint attention deficits in the development of children with autism (e.g., Mundy, Sigman, & Kasari, 1994) and have called for intervention strategies (e.g., Mundy & Crowson, 1997), few studies have attempted to target joint attention. In this study, joint attention behaviors were taught to children with autism using a behavior modification procedure. **Methods:** A multiple-baseline design was implemented to evaluate intervention effects. The following target behaviors were included in the intervention: 1) Responding to showing, pointing, and gaze shifting of adult; 2) Coordinated gaze shifting (i.e., coordinated joint attention); and 3) Pointing (with the purpose of sharing, not requesting). Generalization to setting and parent, follow-up sessions, and social validation measures were also analyzed. **Results:** Joint attention behaviors were effectively trained and targeted behaviors generalized to other settings. In addition, positive changes were noted by naïve observers using social validation measures. **Conclusions:** Integrating joint attention training into existing interventions may be important for children with autism. In addition, training parents in these techniques may help to maintain joint attention skills outside of the treatment setting. **Keywords:** Joint attention, autism, intervention, behavior therapy, child development, social skills training.

Autism is characterized by profound deficits in social behavior, language, imitation, and play skills. Recently, joint attention deficits have been cited as a potential underlying link in the abnormal development of these behaviors (e.g., Charman et al., 1997; Mundy, 1995). Joint attention is defined as the ability to coordinate attention between an object and a person in a social context (Adamson & McArthur, 1995). Joint attention has not only been linked to autism but has also been associated with the development of language, play, imitation, and social behavior in typically developing children (Baron-Cohen, 1993; Bates, Benigni, Bretherton, Camioni, & Volterra, 1979).

Joint attention has become increasingly important in autism research because it is one of the earliest emerging social behaviors and deficits in joint attention are apparent prior to language acquisition. Because autism is often not diagnosed until a child is three or four years of age (Sigman & Capps, 1997), it is critical that researchers look for indicators prior to language emergence such as joint attention so that appropriate treatment may be provided at a younger age.

What is the specific nature of joint attention deficits in autism? Most studies report that children with autism are not impaired in protoimperative gestures (i.e., the use of gestural bids to request) (e.g., pointing) (Mundy, Sigman, & Kasari, 1994). Studies on the abilities of children with autism to respond correctly to protodeclarative joint attention bids from others (i.e., the use of gestural bids to share an object rather than to request an object) is mixed. Baron-Cohen, Baldwin, and Crowson (1997) assessed the ability of children with autism to follow a speaker's gaze and found that the children used incorrect mapping between the word and the referenced object. Other studies have had similar results. For instance, Loveland and Landry (1986) demonstrated that children with autism were impaired in responding to protodeclarative joint attention bids of adults. Some studies have reported no significant deficit compared to typical peers (e.g., DiLavore, Lord, & Rutter, 1995). The literature regarding protodeclarative initiations such as pointing and showing by children with autism is also well established. These skills have been reported to be absent or profoundly impaired compared to those of typical controls (e.g., Leekam, Lopez, & Moore, 2000; Sigman, Mundy, Sherman, & Ungerer, 1986). The relationship between joint attention responding and initiations is not conclusive but it has received recent attention in the literature. It seems that although these behaviors may have similar social functions, they may have different motivational parameters. More specifically, it is possible that responding to joint attention is maintained by extrinsic reinforcement (i.e., tangible rewards) (Corkum & Moore, 1998)

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but that joint attention initiations are maintained by intrinsic rewards (i.e., social sharing) (Mundy, 1995). This theory is not empirically confirmed but new evidence suggests that these behaviors may in fact have different neurological correlates (Mundy, Card, & Fox, 2000). Deficits in supported joint attention (SJA) (i.e., the adult somehow changes the child's interaction with an object) and coordinated joint attention (CJA) (i.e., shifting gaze between an object and a person during a social interaction) are also commonly reported in the literature for children with autism (Lewy & Dawson, 1992). SJA and CJA are neither bids for nor responses to joint attention bids as they are states of engagement rather than discrete behaviors.

Although behavioral interventions for children with autism have been successful in remediating deficits in language, play, imitation, and social behaviors (e.g., Lovaas, 1987; Koegel, Koegel, & Schreibman, 1991), few studies have assessed changes in joint attention. When joint attention was used as an outcome measure, some researchers have reported increases in joint attention using behavioral interventions (e.g., Pierce & Schreibman, 1995) while most studies have reported no significant changes in joint attention following treatment (e.g., Rocha, Sherer, Paredes, & Schreibman, 1999). It is important to note that these studies did not systematically target joint attention behaviors. In order to affect increases in spontaneous joint attention, many researchers posit that joint attention behaviors should be targeted directly in early intervention studies (e.g., Mundy, 1995). In one study, some joint attention initiations (i.e., pointing and showing) were successfully taught to a single child with autism using a milieu (i.e., behavioral and developmental) approach (Kasari, Freeman, & Paparella, 2001). Because responding to joint attention emerges in typical development prior to joint attention initiations (Dunham & Moore, 1995) and because the relationship between responding and initiations is not yet clear, interventions for children with autism should follow the same pattern of development by first making sure the child can respond to joint attention bids followed by joint attention initiation training.

Although behavior modification techniques such as Discrete Trial Training (e.g., Lovaas, 1987) and Pivotal Response Training (PRT) (e.g., Koegel et al., 1991; Pierce & Schreibman, 1995) have been effective for teaching children with autism, these techniques have not yet been used to target joint attention deficits. Discrete Trial Training (DTT) involves breaking a skill into discrete components and using mass trials until the skill is mastered. Although PRT and DTT are both behavior modification interventions, they differ in that PRT emphasizes child motivation by providing choices, reinforcing attempts, and interspersing maintenance tasks (i.e., previously mastered tasks). In addition, by using reinforcers that are directly related to the task, the child is more likely to establish a connection between the target behavior and the reinforcer thus enhancing generalization to other environments. For instance, if the child was learning colors, a blue car could be shown to the child. After the child said 'blue', he would receive the car and would be allowed to play with it. This contrasts more structured learning techniques where children are shown a flashcard with a blue shape on it and are expected to say 'blue' to receive a reinforcer not related to the task (e.g., a potato chip).

The purposes of this research are to 1) assess the efficacy of teaching joint attention behaviors using a naturalistic behavior modification technique (i.e., using components of DTT and PRT), 2) assess the generalization effects of training, and 3) determine the social validity of training joint attention to children with autism.

Method

Participants

Eleven children participated in this investigation (five children with autism and six typical children). Children with autism were required to have a diagnosis of autism or another autistic spectrum disorder (i.e., Pervasive Developmental Disorder, Not Otherwise Specified) provided by an outside physician or psychologist using DSM-IV criteria (American Psychiatric Association, 1994). Children with identified organic abnormalities such as seizures were not included in this study. In addition, because joint attention behaviors do not develop in typical children until about 12–14 months, four of the participants had a nonverbal mental age above this level. One child with a nonverbal mental age below 14 months was included to assess the efficacy of the intervention on a lower-functioning child. All participants with autism were approximately four years old and were recruited from a waiting list for participation in the UCSD Autism Research Laboratory or from referrals from other research and clinical facilities in the San Diego area. See Table 1 for characteristics of participants.

In addition to participants with autism, six typical children recruited from the UCSD Human Subjects subject pool were assessed to establish a developmental norm for the purpose of setting training criteria for the children with autism. This was to ensure that children with autism were not under- or over-trained on the target behaviors. To identify typical social behaviors of preschool-aged children, only children between the ages of two and four were assessed. Mental ages and language ages of typical children were higher than those of the children with autism because typical children under the age of two would not have exhibited social behaviors similar to a preschool-aged child. Typical children did not participate in the intervention phases of this investigation and were not considered a 'control group', rather they were assessed to identify 'normal' levels of social behaviors during the preschool years.

Table 1 Presenting characteristics of participants

	Chronological age	Mental-age equivalent (Bayley)	Language-age equivalent (CDI)	Autism severity (CARS)	Autism severity (GARS)
Average of typical children	2 years, 4 months	2 years, 5 months	2 years, 8 months	Not applicable	Not applicable
Carrie	4 years, 0 months	1 year, 7 months	1 year, 4 months	31.5	90
David	4 years, 3 months	1 year, 4 months	1 year, 4 months	31	90
Alex	4 years, 1 month	1 year, 4 months	1 year, 4 months	32.5	105
Arthur	4 years, 1 month	1 year, 1 month	8 months	28	103
Brandon	4 years, 4 months	1 year, 9 months	2 years, 1 month	30	90

Design

A single subject, multiple baseline design across participants was implemented. This type of design has the advantage of controlling for developmental maturation and exposure to the treatment setting and is advantageous for assessing the efficacy of a behavioral intervention by measuring several target behaviors simultaneously. In addition, unlike many group designs, this design addresses two important issues. First, treatment was not withheld for any of the participants with autism. Second, individual treatment outcomes were not obscured by statistical analyses, rather the treatment trends for each child can be easily identified and within subject variability can be measured (Hersen & Barlow, 1976). As required for this design, baselines were staggered across participants and ranged from two–ten weeks in length with ten weeks being approximately equal to the length of the intervention. For four of the five participants, data were obtained during baseline, treatment, post-treatment, and at three-month follow-up. The fifth participant was unavailable for post-treatment and follow-up assessments due to reaching failure criteria and not completing the second phase of joint attention training. No tests of significance are necessary for a multiple-baseline design and statistical analyses are rarely cited for single-subject designs.

Setting

This research was conducted in the UCSD Autism Research Laboratory. Baseline, treatment, post-treatment, follow-up and assessment sessions took place in four similar rooms in the laboratory which included a small table, two–three small chairs, toys, pictures on the walls, and a one-way observation mirror with a viewing room on the other side from which sessions were videotaped for behavioral coding. Generalization sessions took place in a larger room in the laboratory which included a couch, a loveseat, three tables, a variety of toys, pictures on the wall, and a one-way observation mirror with a viewing room on the other side.

Procedure

Each child was administered pre-treatment assessments (see *Assessments* section below) and then participated in baseline for two–ten weeks according to the multiple baseline design. Treatment consisted of two phases: 1) Response Training in which the child was taught to respond appropriately to joint attention bids of the experimenter, and 2) Initiation Training in which the child was taught to initiate joint attention bids to the experimenter. In addition to assessments at pre-treatment, assessments were also administered in between the first and second phase of training, and following the completion of treatment. Assessments were readministered three months later for follow-up. Once all children completed the study, video clips of the children at post-treatment were shown to naïve observers to assess social validity of this intervention.

Assessments

Pre-treatment. All participants were given standardized assessments of intelligence and language prior to treatment (see Table 1), including The Bayley Scales of Infant Development, Second Edition (Bayley, 1993), the MacArthur Communicative Development Inventory (CDI) (Fenson et al., 1993), The Childhood Autism Rating Scale (CARS) (Schopler, Reichler, DeVellis, & Daly, 1988), and the Gilliam Autism Rating Scale (GARS) (Gilliam, 1995).

In addition to assessments of intelligence, language, and severity of autism, children with autism received the following behavioral assessments:

1. **Unstructured Joint Attention Assessment** (adapted from Loveland & Landry, 1986): The purpose of this assessment was to measure the child's ability to respond correctly to the protodeclarative joint attention bids of the researchers and to measure the child's unprompted joint attention behaviors (showing, pointing, supported, and coordinated joint attention). Assessment time was approximately 30 minutes for each child and involved playing with the child in a relatively unstructured setting (no table and chairs, no demands on the child, and free access to toys). Pictures were taped to the wall to provide additional opportunities for protodeclarative pointing. Two experimenters were present during the assessment. The first experimenter played with the child and administered the joint attention probes while the second experimenter recorded the child's responses. Protodeclarative joint attention bids (showing the child objects, pointing, and shifting gaze) were made by the experimenters approximately every 30 seconds. Assessments were videotaped and later scored for joint attention and interobserver reliability.
2. **Structured Laboratory Observations (SLO)**: The purpose of the SLO was to assess generalization of

joint attention behaviors in a novel setting and with an untrained therapist (i.e., the child's primary caretaker). This assessment took place in the generalization setting described above. The toys presented during the SLO were not available to the children during any other assessment nor during treatment sessions. The SLO was administered twice, once by a trained therapist and once by the child's primary caregiver. SLOs were videotaped and later scored by trained observers.

3. **Structured Joint Attention Assessment** (adapted from the Early Social Communication Scales) (Sigman et al., 1986; Seibert & Hogan, 1982): Protoimperative and protodeclarative joint attention, social behaviors, and problem behaviors were measured in this assessment. Children were seated at a table facing the experimenter on the other side of the table in a room with pictures on the wall and toys on a bookshelf behind the experimenter. Each toy was presented one at a time to the child to determine if and how the child requested items and to assess social behaviors such as joint attention and turn-taking.

Post-baseline. Following baseline, each participant was readministered the Unstructured Joint Attention Assessment in order to assess changes in joint attention due to developmental maturation, exposure to therapists, and exposure to treatment setting.

Post-response training (Phase I). Once the child completed the first phase of training (response training) (i.e., responding to the joint attention bids of an adult), the Unstructured Joint Attention Assessment, SLO with experimenter, and SLO with caregiver were readministered.

Post-treatment. Upon completion of the second and last phase of training (initiation training) (i.e., making joint attention initiations toward an adult), each child was given the Unstructured Joint Attention Assessment, Structured Joint Attention Assessment (ESCS), SLO with experimenter, and SLO with caregiver.

Three-month follow-up. Three months following post-treatment assessments, each subject was asked to come back into the laboratory for assessments. The assessments were the same as those administered at post-treatment.

Social validity. After joint attention training, did children with autism look more 'normal' in play situations? To determine the social significance of the proposed intervention, video clips of participants (typical and autistic) were shown to 54 undergraduate psychology students. These students were asked to rate the video clips using a Likert scale on social behaviors as well as state their opinion on how 'normal' they thought the child looked. Raters were not informed that any of the children they were watching had autism but were told that some of the children might have had a developmental impairment.

Video raters were randomly assigned into one of two groups. Both groups rated clips of all six typical children and the four children with autism that completed the intervention. Clips of the children with autism at pre-treatment or post-treatment were randomly assigned to one of the two groups so that each group only saw each child with autism at pre-treatment *or* post-treatment (i.e., Group 1 rated a particular child at pre-treatment while Group 2 rated that same child at post-treatment and for the next child, Group 1 rated at post-treatment while Group 2 rated at pre-treatment). Twenty-seven raters viewed the first tape and 27 different raters viewed the second tape. Ratings were compared to assess social validity of this intervention and data was analyzed using paired *t*-tests.

Session protocols

Baseline. Sessions took place three days a week for 1.5 hours each day. Each day consisted of three 25-minute sessions with a five-minute break between sessions. Different pictures were posted on the walls and different toys were placed in the room for each session (session rooms are described above). Toys were chosen using periodic informal reinforcer assessments to ensure that the toys were ones that the child was motivated to play with. The child and experimenter played with the toys available during each session. Approximately every five minutes, the experimenter provided an opportunity for the child to respond to a protodeclarative joint attention bid. That is, within the 25-minute session, the experimenter put the child's hand on an object with the purpose of showing the object to the child, tapped an object with the purpose of showing the object to the child, showed an object to the child, pointed to a picture on the wall, and shifted gaze to a picture on the wall. The child's responses were recorded in vivo but no contingencies were administered by the experimenter (i.e., the child was not *required* to respond to the experimenter's bids). Interobserver reliability data were collected by a second experimenter in the observation room. By nature of the multiple baseline design, baselines were two, four, six, eight, and ten weeks in length. This variability in baselines was employed to test whether or not the intervention was effective and to test whether or not other factors such as exposure to treatment setting, exposure to experimenters, or developmental maturation might affect the child's behavior prior to intervention.

Establishment of training criteria. Prior to starting the interventions for the children with autism, joint attention behaviors of six typical children were measured for the purpose of establishing developmental norms. The average for each joint attention behavior was calculated and used to establish mastery criteria for teaching joint attention behaviors to the children with autism.

Joint attention training. A naturalistic behavior modification technique using components from Discrete Trial Training (DT) and Pivotal Response Training (PRT) was implemented to target protodeclarative joint attention responding (Response Training) and joint attention initiations (Initiation Training). This intervention included the following components:

1. Using clear prompts that were appropriate to the task.
2. Interspersing maintenance (i.e., mastered) tasks with acquisition (i.e., unlearned) tasks. This kept the child's success rate high and therefore kept the child motivated to stay on task.
3. Allowing the child to choose the activity in order to ensure that the child was motivated to work for a particular object or activity.
4. Taking turns with the child. This provided the experimenter with opportunities to model the desired behavior and also helped to re-establish the child's attention in order to provide another prompt.
5. Contingent reinforcement was provided after the child's response.
6. Prompted responses and unprompted correct responses were reinforced.
7. Direct response–reinforcer relationships were used in order to ensure a naturalistic training scenario that was more likely to generalize to the child's natural environment. For example, if an experimenter shifted their gaze to an object in the room and the child followed the experimenter's gaze to that object, the child received the object as a reinforcer.

Joint attention training consisted of two phases: 1) **Response training** in which the child was taught to respond appropriately to joint attention bids by the experimenter, and 2) **Initiation training** in which the child was taught to initiate joint attention with the experimenter. Access to desired toys was used as positive reinforcement in both training phases. Behaviors were also negatively reinforced by allowing the child to keep the toy by engaging in joint attention (i.e., when child did not respond correctly, access to desired toys was removed). If after ten consecutive treatment days (three sessions/day) a child failed to demonstrate progress in a behavior, the child failed out of the program.

Phase I (Response training): Responding to joint attention bids of experimenter. The setting for training sessions was the same as baseline sessions. Response training focused on training the child to respond correctly to the bids of the experimenter. The behaviors trained in this phase were the same as those assessed in the unstructured joint attention assessment which is described above.

Training was divided into six levels with each participant beginning with Level 1 and moving on to the next level after reaching mastery criterion. Because there were three sessions each day and the child was required to reach mastery criterion for four sessions, the mastery criteria ensured that the child responded correctly to the experimenter over two consecutive days of treatment. Mastery criteria for Phase I were determined by taking the average percent correct for each behavior observed in the six typical children during the unstructured joint attention assessment. The average for each behavior observed in typical children was approximately 80%. Thus, in order to advance to the next level of treatment, each child with autism was required to get 80% correct for four out of five consecutive sessions.

Prior to mastery of Level 1, behavioral compliance (i.e., sitting nicely, playing appropriately with the toys, etc.) acted as a maintenance task. Once the child reached Level 2, Level 1 was used as a maintenance task and was interspersed with the new target behavior (i.e., acquisition task) during training. This continued so that Levels 1 and 2 acted as maintenance tasks during Level 3 training and continued, Levels 1–3 acted as maintenance tasks for Level 4, etc. The levels of response training included the following:

1. **Level 1 – Response to hand on object:** While the child was playing with one toy, the experimenter placed the child's hand on a different toy. If the child engaged with the newly presented toy (i.e., manipulated or looked at the toy for at least five seconds), the response was scored as correct. If the child did not respond correctly, all toys were removed for five seconds and the response was scored as incorrect. Different toys were then presented to the child and the child was allowed to choose a new toy (not from the toys that were removed due to an incorrect response). If the child had two incorrect responses in a row, a physical prompt was applied to keep the child's hand on the object for five seconds and the response was scored as a prompted response.
2. **Level 2 – Response to object being tapped:** The protocol was exactly the same as Level 1 except that the experimenter presented a new toy to the child while the child was engaged with another toy and tapped the new toy. The child was required to engage with the new toy for at least five seconds to be scored as a correct response.
3. **Level 3 – Response to showing of object:** The protocol was the same as the first two levels except that the experimenter showed a toy to the child while the child was engaged in another activity. The child was required to engage with the shown toy for at least five seconds to be scored as a correct response.
4. **Level 4 – Eye contact:** Eye contact was trained using standard PRT procedures for shaping this behavior (i.e., child was required to make eye contact with the experimenter in order to gain access to the reinforcer). Eye contact by the child was required in order to respond correctly in the last two levels of Phase I. Mastery criterion was the same as the first 3 levels.
5. **Level 5 – Following a point:** While the child was engaged with an object, the experimenter established eye contact with the child. Once eye contact was established, the experimenter turned their head and pointed to another object in the room. The child was required to turn their head in the same direction as the experimenter. If the child responded correctly, the child was allowed to choose to play with the new object or continue playing with the object they had prior to the experimenter's point. If the child did not follow the experimenter's point, all toys were removed for five seconds and the response was scored as incorrect. If the child made two incorrect responses in a row, a physical prompt was applied to turn the child's head in the appropriate direction. Prompted responses were reinforced.
6. **Level 6 – Following a gaze:** Same as Level 5 except that the experimenter shifted their gaze only and did not use a point.

Phase II (Initiation training): Initiating joint attention with the experimenter. The second phase of training focused on training joint attention initiations. Mastery criterion for the children with autism was established by observing six typical children and taking the average percent of opportunities in which the child initiated joint attention (i.e., 30% for coordinated gaze shifting and 15% for protodeclarative pointing). During joint attention initiation training, the participants were required to make an initiation toward the therapist within ten seconds of each given opportunity. An 'opportunity' was defined as every ten seconds that the child was engaged with an object. If the adult was engaged but not the child, this was not scored as anything because it was difficult to distinguish these initiations from mere requests to obtain the object. In other words, when the adult had the object, the child's initiation may have been protoimperative rather than protodeclarative. The time of ten seconds was used because the typical children initiated joint attention approximately once every ten seconds. Since typical children were not showing multiple joint attention initiations within a ten-second period, this criterion was used to establish an 'opportunity.' In addition, because joint attention initiation opportunities were conservatively defined (i.e., only when the child had access to the toy), frequency data would have been inconsistent by nature of the fact that the times of object engagement by the child varied greatly from session to session (i.e., sometimes the adult had the object and sometimes the child had the object). A full physical prompt (e.g., taking the child's finger and making it point) with a verbal prompt (e.g., telling the child 'point') was provided at the start of training each behavior. Prompts were faded in the following order: 1) Full physical + verbal prompt; 2) Partial physical + verbal prompt; 3) Gestural + verbal prompt; 4) Verbal prompt only; and 5) No prompt. Similar to response training, the child was prompted after 2 incorrect responses (i.e., no response). Initiation training consisted of training the following behaviors:

1. **Coordinated gaze shifting:** Whenever a child was playing with a toy, it was considered to be a coordinated gaze shifting opportunity. Based on observations of typical children, ten seconds was chosen as enough of an opportunity to initiate joint attention with the adult. While engaged, the children with autism were required to shift their gaze from their toy to the experimenter with the purpose of sharing the object with the experimenter within ten seconds of obtaining the toy in order for the response to be considered correct. If the children did not shift gaze within ten seconds, the response was scored as incorrect and the toy was removed. After two incorrect responses, the children were prompted in order to gain access to the reinforcer. Physical prompts were implemented by holding the child's hands on the object and moving their head in the direction of the experimenter until eye contact was established. The word 'show' was used as a verbal prompt and gestural prompts were administered by the experimenter pointing at their eyes while the child was playing to establish a gaze shift. Prompts were faded until the child could spontaneously shift gaze between the experimenter and the object. The child was required to shift gaze at least 30% of provided opportunities without a prompt for four out of five consecutive sessions to achieve mastery.
2. **Protodeclarative pointing:** During this phase, each session was altered to continually present a novel environment and thus provide more pointing opportunities. During the training of the pointing response, each treatment day consisted of 12 five-minute sessions. Each session presented new pictures on the walls and new toys (e.g., picture books) in order to provide the child with more pointing opportunities. At the beginning of each session, the child was required to point to a picture on the wall with the purpose of sharing with the experimenter (this was not considered protoimperative pointing because the child was not gaining access to an object after pointing). If the child did not point within ten seconds, they were prompted to do so. Physical prompts were implemented by taking the child's finger and pointing it toward the object in which they were engaged or to another object in the room. Gestural prompts were used by pointing and having the child imitate. The verbal prompt 'point' was used until the child demonstrated the ability to point spontaneously without prompting. Once the child pointed, they were allowed to keep playing with toys (i.e., the toy was not removed from the child). The child was required to point to something within ten seconds or the response was scored as incorrect. After five minutes, the child transitioned to another five-minute session in a different room with new pictures and new toys. The child was required to point 15% (average for typical children) of provided opportunities without a prompt to reach mastery for four out of five consecutive sessions.

Fidelity of implementation

Fidelity of implementation (FI) was scored for 10% of all joint attention training sessions in order to ensure accuracy of the implementation of training components. FI was scored by the primary investigator and by trained undergraduate assistants and included the scoring of all elements of training described above. PRT components were implemented correctly 93–100% across therapists.

Behavioral coding

Coding. The first session of each day of baseline, treatment, post-treatment, and follow-up was videotaped and coded for joint attention behaviors. All Unstructured Joint Attention Assessments and SLOs were also videotaped and later coded for joint attention behaviors. The Structured Joint Attention Assessments (i.e., ESCS) were coded in vivo by 1 or 2 experimenters using the criteria established in the literature (Sigman et al., 1986; Seibert & Hogan, 1982).

Interobserver reliability. Interobserver reliability was collected and reported for 33% of all sessions and 33% of all assessments. Interobserver reliability was calculated using the standard formula (agreements divided by agreements plus disagreements multiplied by 100%).

Kappa coefficients were computed using agreements matrixes and substracting chance agreement from interobserver reliability. Average agreement was above 80% for each behavior for sessions and assessments with Kappa values of .84 or higher except for eye contact which had a Kappa value of .69.

Results

Efficacy of training

The intervention was effective for all subjects for teaching correct *responding* to the joint attention initiations by the experimenter (i.e., Phase I) (see Figure 1). Efficacy of the intervention was assessed by calculating percent correct for the first session of each day of training. No improvements in joint attention were observed for any of the subjects during baseline (see Figure 1). *Response* training (i.e., Phase I) (not plotted) took 18 days for Carrie, 23 days for David, 16 days for Alex, and 22 days for Brandon. Due to failing out of the program during initiation training, data are not shown for the fifth subject, Arthur, who successfully completed response training in 26 days. Positive changes were observed for responding to showing and following a gaze and

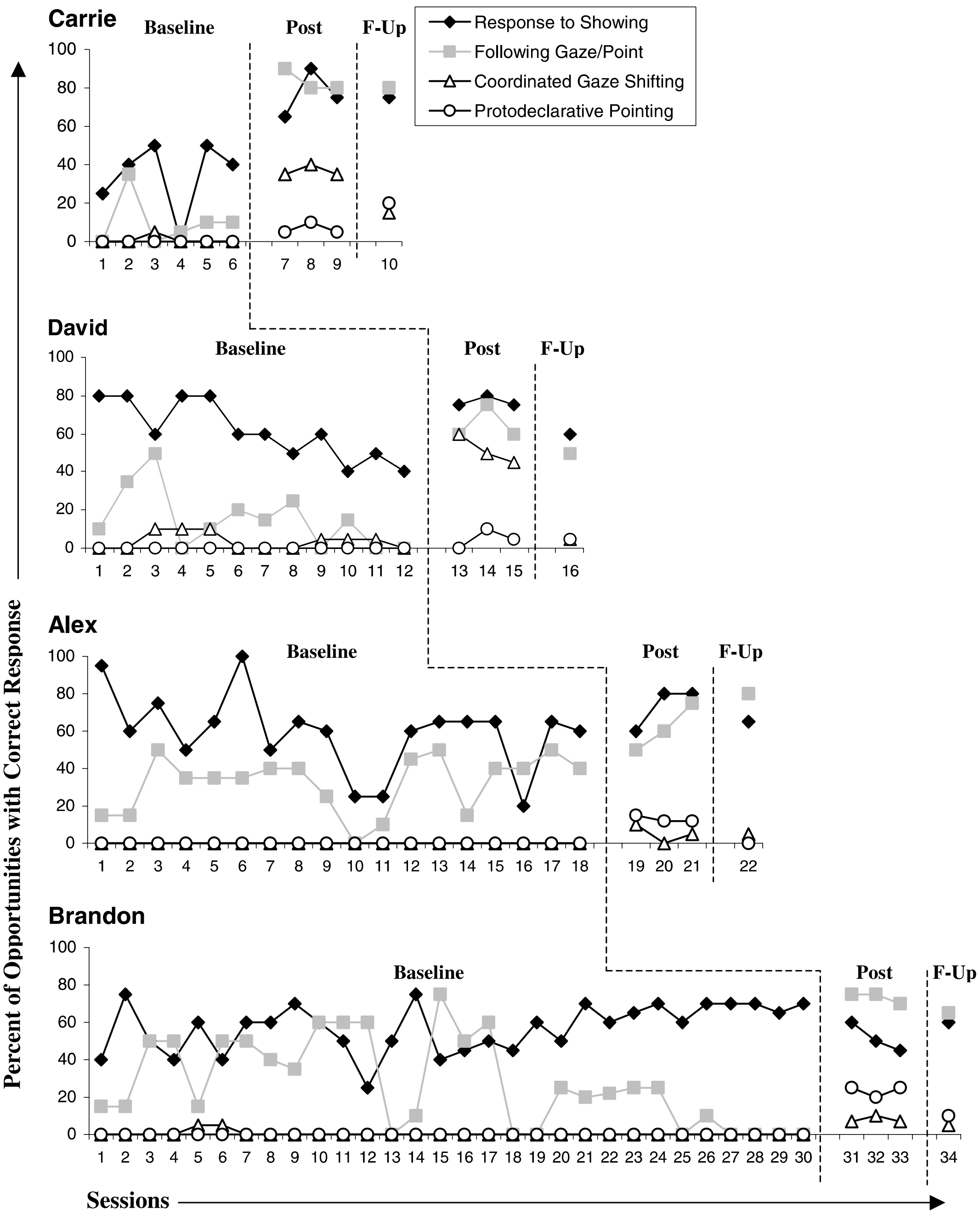

Figure 1 Percent of opportunities in which target joint attention behaviors were used correctly by participants. Data are shown for the 4 participants that completed the intervention during baseline, post-treatment (Post), and follow-up (F-Up). Data are not shown for Arthur due to failing out of treatment program

point for all five participants from pre- to post-treatment.

Teaching joint attention *initiations* was effective for four out of the five subjects (see Figure 1). Although all four subjects showed an increase in joint attention initiations from baseline to post-treatment, behaviors were not maintained at three-month follow-up for all subjects. Carrie was able to master coordinated gaze shifting in six days and mastered protodeclarative pointing after eight days of treatment. Coordinated gaze shifting and pointing were also observed during post-treatment and at three-month follow-up but coordinated gaze shifting decreased from post-treatment to follow-up. David mastered coordinated gaze shifting following seven days of treatment and mastered pointing after three days of treatment. Coordinated gaze shifting and pointing were also observed during post-treatment. However, there was a noticeable decrease in coordinated gaze shifting from post-treatment to follow-up. Alex mastered coordinated gaze shifting after 13 days of treatment and mastered pointing after three days of treatment. Coordinated gaze shifting and pointing were observed during post-treatment observations and at follow-up although coordinated gaze shifting at follow-up was less than at post-treatment. Brandon was able to master coordinated gaze shifting in two days and pointing in four days. Brandon also showed coordinated gaze shifting and pointing during post-treatment and at three-month follow-up but there was a drop in gaze shifting from post-treatment to follow-up. After ten consecutive days of treatment, Arthur was unable to show progress in coordinated gaze shifting therefore failing out of the treatment program (data not shown). Therefore, no post-treatment or follow-up observations were completed for Arthur.

Generalization of joint attention behaviors

To assess the generalization of target joint behaviors, an Unstructured Joint Attention assessment (Loveland & Landry, 1986) was administered prior to starting baseline, following baseline (i.e., prior to treatment), following *response* training, following *initiation* training, and at three-month follow-up. In addition, six typical children were given the assessment in order to establish developmental norms. Children with autism were all significantly impaired prior to treatment and following baseline compared to typical children in responding to joint attention (see Table 2). Following *response* training (i.e., Phase I), all children showed significant gains in *responding* to joint attention. Following the training of joint attention *initiations* (i.e., Phase II), *responding* to joint attention remained higher than baseline for all 4 subjects completing the study (see Table 2). At follow-up, all four participants that completed the intervention maintained the ability to *respond* correctly to joint attention at levels higher than baseline with the exception of David who decreased to baseline levels from post-treatment to follow-up (see Table 2).

Children with autism were all significantly impaired prior to treatment and following baseline compared to typical children in *initiating* joint attention (see Table 2). In fact, children with autism showed little (i.e., 2% or less) or no joint attention *initiations* prior to treatment. Slight increases in joint attention *initiations* were observed for three participants (Carrie, David, and Brandon), no differences

Table 2 Generalization of target behaviors to unstructured assessment

	Average of typical children	Carrie	David	Alex	Arthur	Brandon
Pre-treatment						
JA Responding	82	25	20	40	40	20
JA Initiations	23	2	0	0	0	2
Post-baseline						
JA Responding	NA	28	*25*	38	42	22
JA Initiations	NA	0	2	0	0	0
Post-response training						
JA Responding	NA	*78*	*55*	*60*	*70*	*75*
JA Initiations	NA	5	*5*	*15*	0	*5*
Post-initiation training						
JA Responding	NA	78	57	60	NA	60
JA Initiations	NA	*14*	*16*	*20*	NA	*10*
Follow-up						
JA Responding	NA	50	20	*80*	NA	62
JA Initiations	NA	7	7	7	NA	13

Note: Data show changes in joint attention using the Unstructured Joint Attention Assessment (Loveland & Landry, 1986). The average of typical children represents average of 6 typical children. JA responding is represented by percent of opportunities correct and JA initiations are represented by percent of intervals initiations were observed. NA indicates that the data was not available or was not applicable. Typical children did not participate in training and Arthur did not complete the program due to failing out of initiation training. *'s indicate increase of at least 5% from previous phase (indicates improvement, not necessarily statistical significance).

were observed for one subject (Arthur), and substantial gains were observed for one subject (Alex) following *response* training (i.e., Phase I). Increases in joint attention *initiations* were observed for all four subjects completing the study following *initiation* training (i.e., Phase II) (see Table 2). Decreases in joint attention *initiations* were observed for Carrie, David, and Alex from post-treatment to follow-up (see Table 2).

Generalization of joint attention behaviors was also assessed using a structured joint attention assessment (Early Social Communication Scale)(ESCS) (Sigman et al., 1986; Seibert & Hogan, 1982). Scoring criteria were established using the above references and assessments were scored in vivo or were videotaped for future coding and reliability. On a scale of 1–3 (1 = significantly impaired, 2 = somesomewhat impaired, and 3 = not impaired), all typical children received a score of 3 on both responding and initiating with the exception of one child who received a 2 on initiations. Prior to treatment, all children with autism received scores of 0–2 on responding and scores of 0–1 on initiating. Following treatment, all four participants completing the program received scores of 3 on responding and initiating with the exception of Carrie who received a 2 on initiating. At follow-up, all children with autism received a score of 3 on responding to and initiating joint attention.

To assess generalization in a naturalistic environment, the Structured Laboratory Observation (SLO) was implemented. This assessment was also administered with the child's parent to assess generalization to untrained adults. Following *response* training (i.e., Post Response Training), little or no change in spontaneous joint attention was observed for any of the children with the experimenter (see Table 3). However, following the training of joint attention *initiations* (i.e., Post Initiation Training), gains in protodeclarative pointing, supported joint attention (SJA), and coordinated joint attention (CJA) were observed for all 4 participants with the experimenter. Compared to post-treatment, decreases in protodeclarative pointing with the experimenter were observed for all four participants at follow-up (see Table 3). Decreases in supported and coordinated joint attention with the experimenter were also observed at follow-up for all participants although three out of the four children had higher levels than at baseline.

Table 3 Generalization of target behaviors to naturalistic setting and to the child's mother (i.e., Structured Laboratory Observation) (SLO)

SLO with the experimenter	Carrie	David	Alex	Brandon
Pre-treatment				
Protodeclarative pointing	0	0	0	0
Supported joint attention	0	0	2	2
Coordinated joint attention	0	0	0	0
Post-response training				
Protodeclarative pointing	0	0	0	0
Supported joint attention	0	0	4	0
Coordinated joint attention	0	0	0	0
Post-initiation training				
Protodeclarative pointing	*5*	*10*	*13*	*8*
Supported joint attention	*15*	*20*	*25*	*20*
Coordinated joint attention	*15*	*25*	*15*	*10*
Follow-up				
Protodeclarative pointing	2	4	5	2
Supported joint attention	2	12	13	18
Coordinated joint attention	2	15	10	0
SLO with the child's mother				
Protodeclarative pointing	0	0	0	0
Supported joint attention	2	0	0	2
Coordinated joint attention	2	0	0	0
Post-response training				
Protodeclarative pointing	0	0	0	0
Supported joint attention	*25*	2	0	2
Coordinated joint attention	0	0	0	2
Post-initiation training				
Protodeclarative pointing	2	*15*	2	0
Supported joint attention	28	*10*	4	*8*
Coordinated joint attention	*8*	*10*	2	0
Follow-up				
Protodeclarative pointing	2	0	*12*	*10*
Supported joint attention	0	2	2	8
Coordinated joint attention	2	0	*10*	*20*

Note: Joint attention initiations observed during the SLO. Data are represented by percent of intervals behavior was observed. *'s represent an increase of at least 5% from the previous phase (indicates improvement, not necessarily statistical significance).

Significant gains in supported joint attention were observed in Carrie with her mother but no other subjects showed changes following the *response* training (i.e., Post Response Training) (see Table 3). In the parent sessions, only David showed significant improvement in protodeclarative pointing but all children showed improvement in supported joint attention with their parents. Positive changes in coordinated joint attention were slight in Carrie, David, and Alex with their parents but no changes were seen with Brandon and his mother following joint attention training (i.e., Post Initiation Training) (see Table 3). In follow-up sessions with their mothers, Alex and Brandon showed an increase in protodeclarative pointing, David's pointing decreased to baseline levels and Carrie's pointing remained the same. Brandon did not show any change in SJA with his mother at follow-up but the other three participants all had a drop in SJA. CJA at follow-up with the mothers was varied. Carrie and David had a decrease and Alex and Brandon had an increase in CJA (see Table 3).

Social validity

Using a Likert-type normalcy scale, undergraduate students rated video clips of typical children and children with autism at either pre or post-treatment. Data were analyzed using paired t-tests ($n = 54$). Group 1 and Group 2 did not differ in their ratings of typical children ($p = .814$). When compared to the typical children, all participants with autism were rated as significantly different at pre-treatment ($p < .001$). Following treatment, Carrie, David, and Brandon were rated as significantly more normal on the normalcy rating scale ($p < .001$). Although Alex's ratings improved at post-treatment, there was no statistically significant difference from pre-treatment ($p = .463$). Compared to ratings of typical children, Carrie and Brandon did not look significantly different ($p > .01$) after joint attention training using the normalcy scale. However, David and Alex were still rated as statistically different from their peers ($p < .01$).

Discussion

Consistent with the literature on responding to joint attention (e.g., Leekam et al., 2000), the data from this research showed that children with autism showed some ability to respond correctly to the joint attention bids of adults prior to intervention. However, this ability was impaired compared to typically developing children which is consistent with other findings in the literature (e.g., Loveland & Landry, 1986). In addition, this study has shown that this ability does not appear to improve with developmental maturation over a 2–10-week baseline. Similarly, all participants demonstrated deficits in joint attention initiations with no improvement during baselines of 2–10 weeks. This is consistent with longitudinal research which has shown no improvement in protodeclarative joint attention in children with autism over time (Mundy et al., 1990).

All five children made significant gains in responding to joint attention following the first phase of training. One could argue that these children were naturally at a stage of development where they might be expected to learn joint attention responding. However, changes at the point of intervention after 2–10-week baselines suggest that it was the treatment and not just developmental maturation that resulted in the increase in responding. These improvements also generalized to the Unstructured Joint Attention Assessment. Individual differences were observed in the rate of acquisition of behaviors demonstrating the importance of criteria-based interventions for this type of behavior. Although a deficit in responding to joint attention has been demonstrated in previous research (Loveland & Landry, 1986), this is the first study to systematically train children with autism to respond correctly to joint attention. Teaching children to respond to joint attention may be important for increasing their social awareness. In other words, by teaching the child to correctly respond to what another person is doing in a social-communication context, the child is being taught that other people have social intentions and that a response is expected. In addition, joint attention response training may be useful for teaching children with autism to effectively shift their attention in a social situation. Shifting attention is a known deficit in children with autism (Courchesne et al., 1994) and is considered by many researchers to underlie many of the social deficits observed in children with autism (Swettenham et al., 1998). More research is needed to clarify this relationship.

All five children with autism also demonstrated severe deficits in coordinated joint attention (CJA) and protodeclarative pointing prior to starting treatment. In fact, little or no joint attention initiations were observed during baseline for all subjects. This is consistent with previous literature which has shown that children with autism are severely impaired in joint attention initiations (Mundy et al., 1990). All four subjects completing treatment showed significant improvement in joint attention initiations during post-treatment observations and these behaviors generalized to other settings and to the child's parent with whom the child spends most of his or her time. These results are important to the joint attention literature and to the autism literature. Recently, researchers have begun to emphasize joint attention training for children with autism (e.g., Kasari et al., 2001) due to its relationship to the development of higher social understanding (Baron-Cohen, 1995), language (Mundy & Gomes, 1998), and pretend play (Mundy & Sigman, 1989).

One subject (Arthur) was unable to show progress in joint attention initiations after ten days of treatment and reached failure criterion. These results can most likely be attributed to his low mental-age (13 months) or his low language-age (eight months). Typical children do not master joint attention initiations until about 14 months of age and it is possible that Arthur was not yet ready to acquire these behaviors. Another possibility is that Arthur's motivation for the reinforcers was not sufficient for learning later behaviors. Future research should assess the characteristics of children in order to predict which children might be appropriate for this type of intervention.

Although the four subjects completing the intervention showed more coordinated gaze shifting at follow-up than during baseline, decreases in coordinated gaze shifting were observed for all participants from post-treatment to follow-up. One possibility for this decrease is that parents were not trained in how to maintain the behaviors that their children had learned. The fact that protodeclarative pointing was still present in most participants at follow-up may be due to the fact that pointing is a more salient behavior than coordinated gaze shifting and parents are more likely to reinforce it outside of the laboratory. It is important to note that factors other than lack of parent training may be contributing to changes in joint attention *initiations* at follow-up. It will be important for future researchers to assess the efficacy of a parent-training program targeting joint attention initiations in order to determine if follow-up is better when the parents know how to maintain the behavior. Another possibility for the decrease in initiations is that joint attention initiations may be maintained by intrinsic motivation (Mundy, 1995) and because extrinsic rewards (i.e., keeping the desired toy) were used in the intervention, it was difficult to maintain improvement at follow-up. Again, because of the increases in positive affect in the follow-up study of collateral changes (Whalen & Schreibman, in progress), it seems that the joint attention bids were providing some intrinsic reward to the children but that their bids may not have been noticed in the natural environment (i.e., extinction).

The results from this research have important implications in the study of joint attention and autism. This research has demonstrated that children with autism can be taught to respond correctly to joint attention from others and can even be taught sophisticated joint attention initiations such as coordinated joint attention. Although this research shows joint attention can be taught, how do we know if the children acquired true joint attention (i.e., how do we know if they understood the intent of these behaviors)? During joint attention training, toys were removed if the child did not initiate joint attention. It is possible that this led to protoimperative gestures rather than protodeclarative bids. Because the behaviors are the same, it is often difficult to know if the child's behavior is motivated by attainment of an object (or not losing access to it) or by social sharing (Mundy, 1995). Positive affect is considered to be a critical component of protodeclarative joint attention but not of requesting and is often used to discriminate the difference between the two functions (Kasari, Mundy, Yirmiya, & Sigman, 1990). In a follow-up study, positive affect and other collateral behaviors were measured in the four participants from this intervention throughout baseline, training, post-treatment, and follow-up. All four participants showed increases in positive affect (Whalen & Schreibman, in progress). This suggests that true joint attention did improve following treatment but is not conclusive. The fact that spontaneous joint attention initiations were observed in different settings and with untrained parents also suggests that the children did understand the intentions of their actions. Although not targeted directly, positive changes in supported joint attention (SJA) were also observed in this study. This is consistent with other research which has shown that following a behavioral intervention, children with autism will show improvement in SJA (Rocha et al., 1999). These positive changes may be attributed to the fact that many behavioral interventions are aimed at increasing the child's social awareness. However, positive changes in SJA were not observed until the children were taught to *initiate* joint attention. It is possible that teaching correct responses may have a more structured stimulus–response–reinforcer relationship whereas teaching initiations may teach the child social awareness. More research is needed to address this issue.

This research demonstrated social significance by assessing social validity. The results showed that not only were changes in joint attention obvious to scientists looking at the data but that positive changes in the child's behavior were noticeable to naïve observers. Although these observers may not have been capable of observing subtle changes in behavior, they were able to identify improvements and rated the children as being more 'normal' following the training of joint attention. This supports the theory that joint attention deficits may be an important part of the reason that many children with autism are described as aloof or withdrawn (Mundy & Sigman, 1989). It is important to note that although the changes were not statistically significant for two of the participants, the fact that positive changes were identifiable by naïve observers may still have clinical and social significance.

Although important discoveries were made during this project, there were additional limitations (other than those discussed above). First, not all types of joint attention were targeted. For instance, showing and supported joint attention were not directly targeted. However, it is important to note that no instances of showing were observed in the typical children during free-play sessions and increases in SJA were observed despite not being targeted. Second, joint attention was not assessed or trained outside of the laboratory setting. Although naturalistic generalization probes were used, this is not necessarily indicative of the child's behavior in the natural environment.

It will be important for future researchers to assess joint attention in the child's natural environment in order to determine where this behavior is commonly taking place and with whom the child uses it (i.e., parents, teachers, siblings, peers). This should be studied not only in children with autism but also in typical children in order to determine where the behavior is most usefully trained. Once this information is known, joint attention training programs should be developed outside of the laboratory and should be taught to parents, siblings, teachers, and peers working with the child with autism. It has been demonstrated that joint attention can be taught to children with autism. The next step is to make these types of interventions more efficient and to determine which children might benefit from this treatment. One method that has been used to expedite training of behaviors is video modeling. This procedure could be used to teach children with autism to initiate joint attention and may make training more salient for some children such as Arthur, who was unable to learn joint attention initiations using the procedure in this study. It would be important to train for generalization by teaching multiple exemplars. The effects of joint attention training on other behaviors such as language, play, and positive affect should also be examined. In addition, future studies should begin to look at why children with autism are so impaired in joint attention skills and how existing interventions might be modified to remediate joint attention deficits in children with autism. Finally, it will be important for researchers to assess the developmental progression of joint attention and other behaviors and to study how joint attention training might impact a child's future development.

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