Evaluating the Feasibility and Effects of the Complexity Account of Treatment Efficacy (CATE) for Joint Attention Intervention with Children with ASD

By

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Abstract

Much discussion in recent years has focused on the topic of Joint attention (JA) in children with autism spectrum disorders (ASD). The literature demonstrates the crucial role of JA in developing social-communicative competence in typically developing (TD) children (Meindel & Cannella-Malone, 2011; White et al., 2011). One specific JA skill that has been highlighted in the research is the use of gestural pointing for social purposes (Colonnesi et al., 2010). Children with ASD use few, if any, points to share interest with others about objects and events (Baron-Cohen, 1989; Carpenter et al., 2002). Consequently, deficit in JA pointing is a key early indicator of autism, even for infants as young as 12- months (Werner & Dawson, 2005). JA pointing can be considered a pivotal skill in development given that it predicts long-term language development (Colonnesi et al., 2010). Treatment of JA pointing for children with ASD has been promising (Jones, Carr, & Feeley, 2006; Kasari, Freeman, & Paparella, 2006), although often time intensive (Whalen & Schreibman, 2003). The efficient use of therapy time, especially during the early years, is of vital importance. The focus of this study is to investigate a novel, and hypothetically beneficial, approach to improving the efficiency of treatment focused on JA pointing for children with ASD. This novel approach to JA treatment, referred to as the Complexity Approach to Treatment Efficacy (CATE), is based on treatment efficiency demonstrated in other areas of intervention research (Gierut, Morrisette, Hughes, & Rowland, 1996; Thompson, Shapiro, Kiran, & Sobecks, 2003). In the present study, a hierarchy of non-verbal JA skills is constructed from least to most complex skills. Treatment of the most complex skill is then targeted in therapy to evaluate the feasibility and effects of this approach for children with ASD.

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Complexity Account of Treatment Efficacy (CATE)

When selecting targets for communication intervention, two general approaches can be applied. Traditional speech-language therapy follows a developmental model, with simpler, earlier developing skills treated prior to more complex, later developing skills. In contrast, an alternate approach has been proposed that initiates treatment with more complex targets as a means of improving treatment efficiency (Gierut, 2007; Kiran, 2007; Thompson, 2007; Thompson & Shapiro, 2007; Thompson, Shapiro, Kiran, & Sobecks, 2003). This non-developmental approach has been referred to by Thompson and colleagues (2003) as the "complexity account of treatment efficacy" (CATE). According to this model, structures must be selected that are linguistically (or communicatively) related. Complexity hierarchies ranging from least to most complex are established for these structures. Even though treatment related gains are expected to be slow at first, treatment initiating with the most complex structures is predicted to result in more efficient gains in therapy because the complex targets will likely generalize to the simpler targets. In contrast, selecting the simplest targets and moving from least to most complex targets likely requires that each skill be taught within the sequence, with minimal generalization to more complex skills that the child has not already begun to use productively.

While this approach seems in many ways counterintuitive, recent findings based on single-case research designs have provided some evidence that initiating treatment with more advanced structures may in fact result in generalization to simpler structures and be more efficient. Within the field of communicative disorders, this has been demonstrated in adult syntax (Thompson, Ballard, & Shapiro, 1998; Thompson & Shapiro, 2007; Thompson et al., 2003), adult semantics

(Kiran, 2007; Kiran & Thompson, 2003), adult speech (Maas, Barlow, Robin, & Shapiro, 2002), and child phonology (Gierut, Morrisette, Hughes, & Rowland, 1996; alternatively Rvachew & Nowak, 2001).

For adults with aphasia, Thompson et al. (1998) found that initiating treatment with more complex sentence structures was more efficient than initiating treatment with simple targets and moving to complex targets. This was observed for eight participants when the results of three single subject design studies were combined (Thompson et al., 1998; Thompson et al., 1997; Thompson & Shapiro, 1994). Participants were trained in Object Cleft (e.g., *It was the artist who the thief chased.*) and Who-question (e.g., *Who has the thief chased*?) structures. Passive structures (e.g., *The artist was chased by the thief.*) were monitored for generalization. Training of the more complex Object Cleft structure generalized to the less complex Who-question structure. In contrast, training of Who-questions did not generalize to Object Clefts. Generalization only occurred for those structures that were linguistically related (Who-question structure and Object Clefts) but did not occur for the structure that was not linguistically related (Passives).

Similarly, Thompson, Shapiro, Kiran, and Sobecks (2003) used a single subject design to compare treatment efficiency in four adults with agrammatic aphasia. Those patients receiving treatment on the most complex sentence structure (Object-relative constructions) generalized to the least complex structure in the complexity hierarchy (Wh-movement); however, generalization in the reverse order was not observed.

Adults with aphasia (*n*=4) also showed greater efficiency in semantic treatment when more complex stimuli were used (Kiran & Thompson, 2003). Within this single subject design, categories were trained using either typical category items having semantic features similar to the category prototype, or atypical category items having features dissimilar to the category prototype. For example, for the category of "bird", the characteristic of "has a beak" was categorized as "typical" whereas "lives near water" was considered "atypical". Each participant received training on one category using typical items (less complex input) and on one category using atypical items (more complex input). Generalization was greater for categories taught using atypical items. The use of more complex input possibly aided in understanding the featural variation of the category. Complex items contain more features than those found within simpler items of the category. This greater complexity provides more information about the variability of the category. Consequently, if the participants were exposed to the more complex items, rather than the simpler items, they were more likely to identify new items presented from the category.

Mass and colleagues (2002) investigated the complexity approach on word and non-word repetition tasks with two adults having both aphasia and apraxia. Using an alternating treatment design, each subject received treatment in the complex syllable condition and the simple syllable condition. Pre-post measures for each treatment were compared. The evidence indicated that treatment of more complex syllables may promote greater generalization to simpler syllables; however, this was only evidenced by one of the participants and not the other. In contrast, treatment of the simple syllable structure did not generalize to the complex structure for either participant.

In the area of child phonology, Gierut and colleagues (1996) found that children treated for later-acquired phonemes showed both within-class and across-class generalization of sounds, whereas children treated for early-acquired phonemes only showed within-class generalization. As an example, a participant treated on the later acquired sound "r" showed generalization to both other liquids as well as to fricatives; whereas, a participant receiving treatment on the early acquired sound "g" showed generalization to other stops, but not to sounds of other classes, such as liquids. These findings were based on a single-subject multiple baseline design (*n*=6) study of children three to five years of age. Results indicated that a phonetic hierarchy could be established for early versus late acquired sounds. Teaching the late-acquired sounds in this hierarchy resulted in generalization to early acquired sounds.

Powell, Elbert, & Dinnsen (1991) also investigated the impact of intervention target complexity on sound generalization in preschoolers. They compared intervention outcomes for sounds categorized as stimulable (10% or more accuracy on probes) or non-stimulable (less than 10% accuracy on probe) prior to treatment. In general, for these preschool children (*n*=6), non-stimulable sounds did not require more treatment than stimulable sounds. Additionally, non-stimulable sounds appeared to be the best targets for treatment in that non-stimulable sounds did not show improvement unless directly targeted whereas stimulable sounds showed improvement regardless of whether or not they were directly taught.

Although the evidence for targeting more complex targets in treatment is promising, it is not conclusive. Rvachew and Nowak (2001) addressed the same question of target selection using a group design (*n*=48). They observed no differences in sound generalization between groups of preschool children treated with either early or later-acquired sounds.

The progression of early to later acquired skills based on ease of production or complexity observed during typical development may indeed indicate a need for mastery at each point along the developmental continuum. It may be, however, that JA skills can be organized within developmental hierarchies such that later developing skills rely on or embed advanced features that are characteristic of the earlier developing skills. If so, then focused treatment on the later developing skills may serve to teach the advanced features in such a way that generalization can be made to the simpler/earlier developing features. Such an approach could serve to reduce the amount of time needed to teach a word or grammatical construction. No studies have been identified that address the utility of target selection based on traditional or complexity model approaches for children demonstrating delays in JA. The primary objective of this study is to determine whether it is feasible and possibly even efficacious to apply the complexity approach to JA intervention for children with ASD.

Pre-Verbal Communication Functions

Well before children begin using words and sentences, they learn to communicate through sounds and gestures, shifting eye gaze between objects and communication partners. By 9 to 12 months of age they begin to use these nonverbal components in ways that are more clearly intentional (Harding & Golinkoff, 1979). These pre-verbal forms of communication highlight the social-pragmatic basis for language development, as these acts occur within the context of social interactions (Bruner, 1981). Bruner outlined three primary functions of early communication: (a) joint attention to indicate interest in an object or event for declarative purposes, (b) behavior regulation to request an object or event, and (c) social interaction to draw attention to oneself within social turn-taking. Each of these primary functions of communication are demonstrated by typically developing (TD) children by 12 months of age (Wetherby, Cain, Yonclas, & Walker, 1988).

Joint Attention in Typically Developing Children

Joint attention plays an important role in language development. It describes the ability of a person to share attention with a communication partner about an object or event of mutual interest (Bakeman & Adamson, 1984). In highlighting the social context in which language develops, Bruner (1981) emphasized the role of JA in the infant's development of language; "The management of joint attention is probably as ubiquitous and dominant a form of human species-specific behavior as any that exists. It begins with the irresistible tendency for mother and child to make eye-to-eye contact, but that soon passes into other equally irresistible elaborations. I believe it to be the impelling force behind early indicating forms of communication" (p. 162). As early as 3 months of age, infants will share eye contact and show enjoyment with a caregiver and then turn to look at what the adult looks at (D'Entremon & Muir, 1997). Beginning around 8 months of age, children will share attention by shifting gaze from person to object and back to the person, and around 12 months they use gestures to direct attention (Beuker, Rommelse, Donders, & Buitelaar, 2013). By 12 to 15 months of age, this develops into coordinated joint attention that involves following the adult's lead in play as well as initiating turns (Bakeman & Adamson, 1984).

Pointing in Typically Developing Children

Prior to the production of first words, the gestural point is often one of the earliest means of intentional communication demonstrated in infants. Bates, Camaioni, and Volterra (1975) observed pointing as a communicative act in infants 10 months of age. The gestural point was part of a developmental sequence leading to first words and was related to Piaget's sensorimotor stage five.

Gestural pointing can be used to indicate multiple social intentions in communication in the same way that expressive language does. Around 12 months, TD infants point for both behavior regulation to direct the behavior of others and for joint attention, to direct and share attention with an adult (Carpenter, Nagell, Tomasello, 1998;

Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004). They also point to show the adult something that the adult was not aware about, to share an attitude with the adult, to locate an absent reference, and to correct misunderstandings (Liszkowski, Carpenter, & Tomasello, 2007a, 2007b; Liszkowski, Schafer, Carpenter, & Tomasello, 2009). TD infants show awareness of the other person's knowledge and purposes when pointing, and they use pointing flexibly to communicate with others for countless reasons.

Gestures appear to play a pivotal role in development. In fact gestures, including pointing, precede and predict language development in TD infants (Carpenter, Nagell, & Tomasello, 1998; Fenson, 1994; Iverson & Goldin-Meadow, 2005; Luyster, Kadlec, Carter, & Tager-Flusberg, 2008; Mundy, Fox, & Card, 2003; Mundy & Gomes, 1998; Ozcaliskan & Goldin-Meadow, 2005, Rowe, Ozcaliskan, Goldin-Meadow, 2008). In a study by Beuker, Rommelse, Donders, & Buitelaar (2013), JA behaviors were correlated with later language skills. Those children who used declarative gestures at 9 months had higher expressive vocabularies at 18 months. Brooks and Meltzoff (2008) found that the JA skills of declarative pointing together with visual attention toward the target object during gaze-following predicted vocabulary growth up until age two for TD children. Similarly, the use of higher level JA acts (pointing with or without eye contact and showing an item with eye contact) on the Early Social Communication Scales (ESCS; Mundy, Delgado, Block, Venezia, Hogan, & Seibert, 2003) in TD toddlers 21 months of age predicted receptive and expressive language at 26 months (Vuksanovic & Bjekic, 2013). Multiple studies support this relationship between pointing and both current and later language use. In a meta-analysis of 25 studies that included 734 TD children (Colonnesi, Stams, Koster, & Noon, 2010), pointing in general was concurrently related to language development (r=.52, p<.001). Additionally, declarative pointing was significantly correlated with later language production for both comprehension (*r*=.42) and for production (*r*=.38). In contrast, imperative pointing was not significantly related to later language use (*r*=.04). Pointing gestures may be exhibited on their own or in combination with words, leading a child from prelinguistic to advanced linguistic forms (Iverson & Goldin-Meadow, 2005).

While gestural pointing itself appears as a simple act, it contains the essential elements of shared intentionality that are foundational to language (Tomasello, Carpenter, & Liszkowksi, 2007). Tomasello et al. (2007) theorized that infant pointing by 12 months of age was used to share intentionality with others in order to influence their mental state. He and his colleagues proposed that the infant attempts to direct the attention of another to something of interest while assuming that the communication partner will understand the underlying social intentions of the act. These intentions could include sharing interest, helping others, requesting, providing information, or unlimited other purposes. This social theory of pointing is based on the "uniquely human" capacities for shared intentionality and cooperation that form the basis for both gesture and language development.

Joint Attention Delays in Children with ASD

In contrast, children with ASD do not appear to develop JA skills in the same manner as TD infants. These JA deficits are a core feature in a diagnosis of autism. The American Psychiatric Association's Diagnostic and Statistical Manual, Fifth Edition (DSM-5; 2012) includes the following as part of the diagnostic criteria for ASD: (1) deficits in social-emotional reciprocity and (2) deficits in nonverbal communication behaviors used for social interaction, including abnormalities in eye contact and body language or deficits in understanding and use of gestures. These deficits in JA for children with ASD include decreased response to eye contact compared to children with developmentally delayed (DD) (Leekam, Lopez, & Moore, 2000), reduced gaze shifting between toy and adult compared to children who are TD and those with DD (Charmen, et al., 1997), reduced responses to bids for attention from an adult compared to children with DD, as well as overall fewer initiations of JA to the adult relative to children with DD (Leekman & Ramsden, 2006). As with TD children, JA abilities in children with ASD also predicted later receptive and expressive language skills (Charman, Baron-Cohen, Swettenham, Baird, Drew, & Cox, 2003; Mundy, Sigman, & Kasari, 1990; Sigman & Ruskins, 1999; Thurm, Lord, Lee, & Newschaffer, 2007).

Pointing in Children with ASD

Children with ASD demonstrate deficits in initiating JA pointing compared to both children with DD and with TD who were matched for mental and/or verbal age (Baron-Cohen, 1989; Carpenter, Pennington, & Rogers, 2002; Chiang, Soong, Lin, & Rogers, 2008; Warreyn, Roeyers, & de Grotte, 2005). As young as 12 months of age, infants with ASD use declarative pointing less frequently than TD peers (Werner & Dawson, 2005). This lack of pointing, especially for social reasons, may be one of the first symptoms of autism prior to 18 months of age (Baird et al., 2000; Scrambler, Rogers, & Wehner, 2001; DSM-5; American Psychiatric Association, 2012). Consequently, it serves as an early prognostic indicator of social-communicative deficits on autism assessments such as the Modified Checklist for Autism in Toddlers (M-CHAT; Robins et al., 2001) and the Autism Diagnostic Observation Schedule, Generic and Second Editions (ADOS-G; Lord et al., 2000; ADOS-2; Lord et al., 2012).

For those children with ASD who do use a gestural point, imperative point production precedes declarative point production. Declarative points serve to direct the communication partner for the purpose of sharing enjoyment, while imperative points are used for behavior regulation, such as to request an item. For children with ASD, both comprehension (following a point and understanding the meaning) and production of imperative points emerge prior to comprehension or production of declarative points (Camaioni et al., 1997; Camaioni, Perucchini, Muratori, Parrini, & Cesari, 2003). As noted previously, only declarative points differentiated 12-month infants with ASD from TD peers. Imperative points were not significantly different (Werner & Dawson, 2005). For preschoolers with ASD who do use points, the frequency of declarative points is significantly less than imperatives compared to other children with DD and TD (Baron-Cohen, 1989; Carpenter et al., 2002).

In addition to a delay in declarative point emergence, children with ASD continue to follow declarative points at a lower rate, for both proximal and distal points compared to matched peers with TD and DD (Chiang et al, 2008; Mundy et al., 1986; Wimpory et al., 2000). Baron-Cohen (1989) found that children with ASD followed and understood the meaning of 10% of declarative points compared to 70% of imperative points. The reduced ability to follow and understand a declarative point used by another person likely reflects underlying deficits in the social cognitive abilities needed to infer the intentions of the person who is pointing.

Treatment with JA Pointing Outcomes

Numerous interventions have been developed over the last several decades, addressing joint attention from naturalistic (Houghton, Schuchard, Lewis, Thompson, 2013), behavioral (MacDuff, Ledo, McLannahan, & Krantz, 2007), and combined approaches (Prizant, Wetherby, Rubin, & Laurent, 2003; Kasari, et al., 2006; Koegel,

Koegel, Harrower, & Carter, 1999; Landa, Holman, O'Neill, & Stuart, 2011). Many of these approaches include pointing as a part of the intervention without controlling the frequency of its use; therefore, pointing may or may not be incorporated in treatment for a given child. For example, milieu teaching and responsivity education/prelinguistic milieu teaching (Fey, Warren, Brady, et al., 2006; Warren, Yoder, Gazdag, Kim, & Jones, 1993) facilitate reciprocal social communicative interactions between a child and his or her caregiver through sounds as well as gestures and eye gaze. This may include a point toward an object with a look to the adult or simply a look with a vocalization; however, the amount of pointing used within a therapy session may be high or nonexistent. While these studies clearly address JA and incorporate pointing, many do not consistently use JA pointing or provide specific outcomes for pointing. The following describes intervention studies for children with ASD that provided outcomes specific to declarative pointing.

One of the first studies specifically targeting pointing in intervention for children with ASD was conducted by Whalen and Schreibman (2003). They employed a behavioral approach, combining Discrete Trial Training (DTT; Maurice, Green, & Luce, 1996) with pivotal response training (Koegel et al., 1999) techniques, in order to teach eight JA skills, including pointing. The preschoolers in the study were four years of age with mild autism (CARS ratings of 28.0 to 32.5). Four of the participants had nonverbal mental ages (NVMA) of at least 14 months (range 16-21 mo), while one participant had a NVMA of 13 months. Eight JA skills were taught in a developmental progression, moving from response to JA to initiated JA. Initiate a point (without gaze shift) was the last skill targeted in the developmental sequence. Each skill was mastered at the 80% level during treatment sessions before the next skill was initiated for treatment. To elicit pointing, the investigators placed toys and pictures around the room that might prompt pointing. Every five minutes, the child transitioned to a new room where new items were arranged to elicit a prompt. Upon seeing the new items, the child was expected to point to the new items. A lack of a point within ten seconds was counted as an incorrect response. The intervention lasted 1.5 hours a day for three days a week. The total time spent in therapy ranged from 42.0 to 49.5 hours per child. The four participants with NVMA of 14 or greater progressed through both levels of treatment. The fifth participant, with a NVMA of 13 months, achieved mastery during therapy sessions for response to JA but did not show progress within ten days for the first initiated JA skill, coordinated gaze shift, and was therefore discontinued from treatment. Post-treatment measures showed minimal declarative pointing, ranging from less than 10% to 40% (Participant 1 <10%, Participant 2 <10%, Participant 3 <20%, Participant 4 20%-40%). At the three month follow-up, declarative pointing ranged from 0% to less than 20% (Participant 1 20%, Participant 2 <10%, Participant 3 0%, Participant 4 <10%).

Ferraioli & Harris (2011) later replicated this study but used siblings as intervention agents. The intensity was decreased to 30-45 minutes a day for 1-2 days a week. The total number of hours in intervention per child ranged from 8.0 to 9.25 hours. As with Whalen and Schreibman, toys and pictures were placed around the room to elicit pointing, and the children rotated through rooms to see new presentations of items. The participants were not required to use eye contact when producing a distal point. The children with ASD had mental ages of 17 to 29 months. Outcomes were modest. Post-treatment spontaneous use of pointing ranged from a mean of 0 to 26.4% across the participants (P1 M=26.4%, P2 M=0, P3 M=6.4%, P4 M=16.25%).

Kasari, Freeman, and Paparella (2006) employed a different method to teaching seven JA skills, including pointing. They evaluated the effects of two interventions on JA and play skills for children with ASD. They used a combined DTT (5-8 minutes) and play-based (22-25 minutes) approach to teach the skills. Within the JA group, at least part of the children received intervention targeting pointing, and pointing was provided as an outcome measure. The preschoolers were three to four years of age from a local early intervention preschool. The participants were randomized to JA, play, or control groups. The mean mental ages for the groups ranged from 21 to 26 months. Autism severity ratings were not provided. The specific JA skills targeted for intervention varied by child based on baseline measures and included: coordinated joint look, showing, give to share, proximal point (without eye contact), distal point (without eye contact), following a proximal point, and following a distal point.. It was not specified how many of the children received intervention targeting distal point. Treatment was provided 30 minutes per day, five days a week, for five to six weeks. The total amount of treatment time per child in the intervention ranged from 12.5 to 15 hours. Children in the JA group showed significantly more responses to JA than the play or control groups on the ESCS. They also demonstrated more gives and shows than the Play group and more child-initiated joint engagement than the Control group during mother-child interaction. Both the JA and Play treatment groups used more shows on the ESCS and more coordinated JA looks on the mother-child interaction than the Control group. However, neither the JA group nor the Play group demonstrated a greater use of points when assessed using the ESCS. All groups showed an improvement over time in pointing for mother-child interaction. A follow-up study of these participants by Kasari, Paparella, Freeman, and Jahromi (2008) found that the JA group showed greater gains in expressive language 12 months later.

Jones and colleagues investigated JA intervention targeting pointing in a series of studies. Jones, Carr, and Feeley (2006) used a behavioral approach to teach two JA skills: (1) respond to JA bid with gaze shift and (2) initiate a point with gaze shift between person and object. In these studies, the authors elicited the JA skills by activating remote controlled toys that lit up, played music, or moved. They treated five young children two to three years of age with mental ages ranging from eight to eighteen months and receptive language ranging from six to twelve months. Ten opportunities were provided per session. The length of session and number of days per week of treatment was not reported. All five children mastered initiated JA point with gaze shift at 80% accuracy for two consecutive days. The amount of time required for mastery of initiated point varied considerably from 26 sessions to 157 sessions. The total number of sessions for acquisition of JA response with gaze shift ranged from 19 to 78. The treatment showed indications of feasibility and efficacy, especially given the young age of the group and the fact that cognitive and language skills were below 12 months of age.

A follow-up study by Jones and Feeley (2007) replicated the approach but this time used parents as the intervention agents. The three children in their study ranged from 3;0 to 4;0 in age with cognitive and language abilities ranging from moderate to severe delay. Again, all three participants mastered initiated JA point with gaze shift. The number of sessions needed for mastery ranged from 24 to 117, similar to their previous findings. The total number of session required for the participants to acquire both skills (response with gaze shift and point with gaze shift) was 31, 171, and 214. The amount of time spent in each session was not reported. These findings provided further evidence of efficacy through generalization to intervention agent.

Jones (2009) next extended the findings to investigate the impact of increasing the complexity of the JA skill targeted in treatment. The type of materials and approach replicated

Jones et al. (2006); however, instead of teaching follow a point with gaze shift first, the participants were taught a more complex initiate JA target. In this case, the initiate a point target was increased in complexity to include: initiate a distal point with eye gaze and use of a one-word vocalization. This was taught in three steps (a) respond to toy activation with gaze shift, (b) initiate point with gaze shift, and (c) initiate point with gaze shift and use one word vocalization. The two children participating in this study were ages 3;2 and 4;11 with severe developmental delays. Both children mastered this skill at 80% accuracy after 56 and 16 total treatment sessions, respectively. The treatment approach, including use of engaging materials and incorporation of eye gaze in treatment appeared successful. For all three studies completed by Jones and colleagues, a multiple baseline design across skills design was employed. The first skill targeted for treatment was respond with gaze shift, while the second skill, initiate a point with gaze shift, acted as the control.

Two additional studies used complex JA pointing skills as outcomes. MacDuff, Ledo, McClannahan, & Krantz (2007) taught three children ages three through five to use button-activated voice recorders to initiate JA scripts while pointing to an object and orienting to the conversation partner. The participants pointed to pictures and toys hung in a hallway in the school. The voice recorders were faded so that the child produced the script spontaneously. The use of spontaneous points during treatment ranged from a mean of four to seven across participants. This skill was generalized to other materials and was maintained at follow-up. The amount of time required to master the skill was not reported. This approach to treating a complex JA skill showed viability with children having severe delays. Participant 1 (4 years of age) and Participant 3 (5 years of age) both exhibited a language age equivalent of 21 months and adaptive behavior of 22 months. Participant 2 was 3 years of age with language and adaptive behavior age equivalents of 17 months.

Taylor & Hoch (2008) targeted a similar JA skill but did not use scripts. They targeted two complex skills: (1) follow a point, make a comment, and look back to the instructor, and (2) point with gaze shift and the word "look" to direct the conversation partner to toys that were novel, visually enticing, or used in an unusual way. Three children age three to eight learned to spontaneously produce these skills. They started intervention with some knowledge of these skills. Baseline for point following was 62% to 88%, comments were 3% to 38%, and gaze shift was 4% to 15%. After treatment of the first skill, the children each demonstrated at least one bid initiation prior to starting treatment for that skill. The mean number of spontaneous points with gaze shift and word "look" during treatment ranged from 2.8 to 3.3 per session. These numbers were slightly lower than those of MacDuff et al. Although the amount of spontaneous pointing during treatment was not high, each of the children did produce the complex skill. The amount of treatment required to acquire this skill was unknown. The intensity of treatment and number of sessions for mastery were not reported.

Across these studies, treatment of JA skills showed minimal to high levels of success. Interventions that had a specific event occur, such as a toy light up, tended to have the greatest results (Jones, 2009; Jones, Carr, & Feeley, 2006; Jones & Feeley, 2007). Complex targets appeared to show promising outcomes (Jones, 2009; MacDuff et al., 2007; Taylor & Hoch, 2008). Almost all of the studies targeted response to JA prior to initiation of JA. None of these studies demonstrated generalization to untreated JA skills. The amount of treatment time needed to acquire a distal point was not regularly reported. The number of sessions required for acquisition ranged from 16 (Jones, 2009) to 214 (Jones & Feeley, 2007). For those studies that reported treatment intensity, the number of hours in treatment ranged from 8.0 (Ferraioli & Harris, 2011) to 49.5 (Whalen & Schreibman, 2003). These last two studies targeted distal point without eye contact and had low rates of occurrence even with a high amount of treatment hours. The Complexity Account of Treatment Efficacy (CATE) is an approach to treatment target selection that could reduce the amount of time needed to teach joint attentional skills such as distal pointing.

JA Complexity Hierarchy

To apply the complexity model to JA intervention, a developmental hierarchy of simpler to more complex skills must first be established. Several studies have investigated the general developmental progression of non-verbal JA skills in TD children as well as those with ASD, DD, Learning Impairment, and Language Delay (Beuker, et al., 2013; Camaioni, Perucchini, Muratori, & Milone, 1997; Camaioni, Perucchini, Muratori, Parrini, & Cesari, 2003; Carpenter, Nagell, & Tomasello, 1998; Carpenter, Pennington, & Rogers, 2002). These studies are presented in Table 1 (p. 77). Skills are ranked in order from 1 to 8 based on order of emergence. Table 2 (p. 78) presents JA intervention studies that included pointing. The intervention studies do not show the order of skill development, but rather the order in which the skills were targeted in treatment. The JA skills are ranked 1 to 8 based on the order of presentation in treatment.

Joint attentional skills can be categorized into those acts that are either responses to joint attentional (RJA) bids from a communication partner or initiations of joint attention (IJA). Acts that could be considered response to joint attention include respond to eye contact, follow a proximal point, and follow a distal point. Initiations of JA could include items such as initiate eye contact, use a coordinated gaze shift between an object/event and a person, show an item, and point to items (proximal or distal).

Traditionally JA treatments have targeted RJA prior to IJA skills (Ferraioli & Harris, 2011; Isakesen & Holth, 2009; Jones, Carr, & Feeley, 2006; Schertz & Odom, 2007; Taylor & Hoch, 2008; Whalen & Schreibman, 2003). For example, within these studies the RJA skills of respond to eye contact and follow a distal point were targeted prior to the IJA skills of coordinated gaze shift and initiate a distal point. Across the studies, JA skills were targeted in the following order: eye contact, follow a point, coordinated gaze shift, and use a JA point.

The developmental literature shows a more varied emergence of skills, shifting between emergence of RJA and IJA skills. Even within a general pattern of development observed for a given study, there is great diversity between the children. Beuker and colleagues (2013) completed a longitudinal study of JA skills for 23 TD children 8 to 24 months of age and found that only 35% of these children followed a common developmental pattern. The skills emerged between 8 and 15 months. Based on mean age of acquisition across the group, the order of emergence of JA skills was as follows: eye contact (M=8.09 mo), coordinated gaze shift (M=8.48 mo), follow a gesture (M=10.35 mo), initiate a show or give without gaze shift (M=11.48 mo), initiate a distal point (M=11.70 mo), follow a gaze (M=13.17 mo), follow gesture outside visual field (M=13.39 mo), follow gaze outside visual field (M=13.91 mo), initiate a distal point with gaze shift object-adult-object (M=14.00 mo), and initiate a show or give with gaze shift object-adult-object (M=14.26). This developmental progression alternates between RJA and IJA with the overall progression of (a) eye contact, (b) direction attention with gaze shift (show/give or point) (c) coordinated gaze shift, (d) following attention within visual field (gaze or gesture), (e) directing attention with gaze shift (show/give or point), and (f) following attention outside visual field (gaze or gesture). Again, great variability was noted with this progression, given that only 34% of the children followed the general order of JA emergence. This variability could also be seen for individual skills. The emergence of following a gesture ranged from 8 to 16 months, and initiating a distal point with eye gaze ranged from 9 to 20 months across the children.

Another longitudinal study of twenty-four TD children (9-15 months) by Carpenter, Nagell, and Tomasello (1998) measured comparable JA skills. They observed a similar order of emergence based on the number of children passing tasks used to elicit JA with an examiner. Their findings differed from Beuker and colleagues (2013) in that directing attention preceded following attention in the study by Carpenter and colleagues. As noted by Beuker et al., this difference may have been due to the scoring criterion. Carpenter et al. accepted dyadic JA (e.g., shift from object to person or vice versa); whereas, Beuker et al. only accepted triadic JA (e.g., shift object-person-object or person-object-person). In this case, directing attention using a two-way gaze shift emerged prior to following attention (Carpenter et al.), while directing attention using three-way gaze shift sequence emerged after following attention (Beuker et al.).

Other studies have explored JA progression in children with ASD and other DD (Camaioni, Perucchini, Muratori, & Milone, 1997; Camaioni, Perucchini, Muratori, Parrini, & Cesari, 2003; Carpenter, Pennington, & Rogers, 2002). Two of these studies followed JA skills longitudinally, but included few joint attentional measures, and the sample sizes were small, ranging from three to five participants (Camaioni, Perucchini, Muratori, & Milone, 1997; Camaioni, Perucchini, Muratori, Parrini, & Cesari, 2003). Camaioni et al. (1997) observed three children with ASD ages 2;1 through 4;6 and found that point comprehension and point production emerged at a similar time; however, few point points were observed, possibly resulting in floor effects. Camaioni et al. (2003) followed five children with ASD ages 3;3 through 4;10. Within this study, point comprehension emerged prior to use of a declarative point. Carpenter, Pennington, and Rogers (2002) evaluated JA skill emergence based on the proportion of children who demonstrated the each skill at a single point in time. They observed 12 children with ASD 40 to 57 months of age and 11 children with DD age 31 to 60 months. The children with ASD followed the same pattern of emergence demonstrated by Beuker et al. for TD children. This showed an alternation between RJA and IJA skills in the order of emergence. The children with DD in this sample showed a much higher use of JA skills compared to the children with ASD, even though the groups were matched for age, non-verbal mental age, and verbal abilities. Most of the children with DD had acquired the JA skills at the time of the assessment (82% to 100%), reaching a ceiling effect. Two skills were mastered by 100% of the children, coordinated gaze shift and follow gaze, and two skills were mastered by 82% of the children, point following and use of declarative gestures, at the time of the observation. When comparing the two groups, coordinated gaze shift appeared prior to declarative gestures for both groups. One difference between the groups was that more children with ASD used a declarative gesture prior to following gaze; whereas, more children with DD followed a gaze prior to using a declarative gesture. This difference may not have been statistically significant.

As noted earlier, there is great variability between TD children in the order of JA skill emergence (Beuker et al., 2013). There is also variability in the literature in terms of the order of emergence of JA behaviors as well as in the order that these skills are targeted in intervention. In an attempt to follow previous intervention research (Ferraioli & Harris, 2011; Isaksen & Holth, 2009; Schertz & Odom, 2007; Taylor & Hoch, 2008; Whalen & Schreibman, 2003), this study will order targets from RJA to IJA. The primary difference between the intervention literature and the longitudinal literature is that the IJA skill of coordinated gaze shift appears to develop prior to the RJA skill of following a look or gaze. There is considerable consistency, however, in the ordering of the following behaviors for intervention: (1) respond to eye contact, (2) follow a proximal point, (3) follow a distal point, (4) initiate coordinated gaze shift object/person, (5) initiate a show/give to share object, (6) initiate a proximal point with eye contact, and (7) initiate a distal point with eye contact. Each of these skills was targeted by at least one of the JA intervention studies. These JA behaviors also overlap with all of the skills taught by Kasari, Freeman, and Paparella (2006). Respond to eye contact was included in the above ordering of JA skills for treatment; although it was not targeted by Kasari et al. They also did not require eye contact with a point. It should be noted that across both longitudinal and intervention studies, the JA skill of distal point with eye contact is ranked as one of the most complex skills. Consequently, these seven behaviors will be either monitored or targeted for treatment in the current study. See Appendix A for specific definitions of these JA skills.

Phase of Research

This study provides the first step in testing the CATE model within JA intervention. It is important to consider the appropriate phase of research that needs to be investigated when designing a new intervention approach. This may assist in the decision-making process and provide a systematic means of evaluating a communication intervention (Fey & Finestack, 2008). Fey and Finestack describe this process and provide guidelines for testing a potential new treatment approach. Within their 5-phase model, studies are categorized as pre-trial, feasibility, early efficacy, later efficacy, and effectiveness. Characteristics may overlap, but in general, each phase represents a sequential progression towards evaluating the effectiveness of an intervention. New intervention approaches are developed based on theory and empirical outcomes from studies of language that are not meant to be tests of intervention. The viability of the new approach is tested with one or more populations of children with language impairments who are deemed to be appropriate candidates for the intervention. Next cause-effect relationships are investigated and the intervention is compared to other treatments in laboratory conditions. Finally the effectiveness of the intervention is examined in a clinical context that allows variability in delivery and uses functional outcome measures.

The CATE model has been tested and applied within other populations, such as children with phonological disorders (Gierut et al., 1996), and its feasibility has been demonstrated with those targets and populations. The studies investigating the CATE approach were single-subject experiments with minimal replication and no generalization to other areas of child speech and language intervention (Gierut et al., 1996; Kiran & Thompson, 2003; Mass et al., 2002; Thompson, Ballard, & Shapiro, 1998; Thompson et al., 1997; Thompson et al., 2003; Thompson & Shapiro, 1994). These studies most closely represent the early efficacy phase, showing a cause-effect relationship between intervention using the CATE model and positive outcomes for the specific individuals participating in the studies.

The first step in exploring the possible advantage of applying the CATE model to JA intervention for children with autism would be to evaluate this model at the feasibility and early efficacy levels. According to Fey and Finestack, the feasibility level of research typically addresses how well the intervention will be tolerated by participants, appropriateness of materials and activities, the intensity of treatment required to produce an effect, amount of training required for intervention agents, and suitability of outcome measures. The early efficacy level of study would primarily be concerned with exploring the cause-effect relationship in a controlled environment that focuses on internal validity and replicability. Such intervention studies are experimental in nature and typically address a single intervention procedure. They tend to have a smaller number of homogeneous subjects and focus on surrogate endpoints, such as amount of distal pointing in a contrived context to create the need for frequent JA acts. This allows more rapid demonstration of effects than is characteristic of later efficacy trials. The design of the current study will address feasibility and early efficacy questions within an experimental design. Its primary purpose is to investigate the appropriateness of the CATE intervention with children with autism in addressing JA deficits and to test modifications in the planned protocol that may be necessary to implement CATE with children with autism. This information is critical to develop one or more efficacy studies that could definitively address questions regarding the efficacy of CATE in teaching JA to children with autism. The secondary purposes of the study were (a) to determine whether a CATE protocol for teaching JA skills leads to measurable gains in the use of distal pointing for JA and (b) to determine whether gains in distal pointing are associated with spontaneous improvements in the use of earlier-developing forms of JA skill. Consequently, if the planned target selections, probes, prompting progression, and reinforcement schedules are tolerated by the participants and are appropriate with minimal modifications; then the study would produce initial evidence of efficacy and would pave the way for the testing of additional larger and better controlled investigations of CATE compared with traditional approaches to JA for children with communication impairments.

Given the importance of JA skills to both language and social development as well as the time intensive nature of teaching these skills to children with disorders such as ASD, it seems important to investigate the viability of the CATE model as applied to JA intervention. This current study addresses the following specific questions:

(1) Do children with ASD respond favorably to CATE treatment procedures that start with the highest level of nonverbal JA skill (distal pointing with gaze shift)?

(2) Do the children respond to the probes developed especially for this study to measure improvements in JA skills?

(3) Can children with ASD who demonstrate imperative but not declarative pointing learn to spontaneously produce a distal declarative point with gaze shift to the communication partner following intervention that only addresses this skill using the CATE model?

(4) Do children with ASD who acquire distal declarative pointing with gaze shift using the CATE model demonstrate use of simpler, earlier developing JA skills without direct intervention?

(5) What appear to be the key sources of variability that impact JA outcomes across children?

(6) Is there an observable progression of JA skills based on probe data for the following: respond to eye contact, follow a proximal point, follow a distal point, initiate coordinated gaze shift object/person, initiate a show/give to share object, initiate a proximal point with gaze shift, and initiate a distal point with gaze shift?

Method

Participants

Four participants with a diagnosis of autism were recruited for the study from a local early intervention preschool. The participants ranged in age from 2;10 to 4;9. Participants 1, 2, and 3 were enrolled in the same preschool classroom at the time of the study, while Participant 4 was on the wait list to start the preschool class the next term. All participants received speech-language services within the school or private settings. These services did not target joint attention goals in treatment. Table 3 (p. 79) presents the participant characteristics prior to intervention. Within 4 weeks prior to the start of the intervention, a licensed psychologist through the University of Kansas Medical Center confirmed the diagnosis of autism for each of the participants. The diagnosis and symptom severity ratings were based on the Autism Diagnostic Observation Schedule-2 (ADOS-2, Lord, et al., 2012) Modules 1 and 2. Each participant was given an ADOS-2 total score, with a cut-off score for an autism diagnosis, as well as an autism severity rating ranging from one to ten, with ten representing the greatest amount of symptoms. ADOS-2 scores for the participants ranged from 18-25, and the ratings ranged from 6 (moderate) to 10 (high). All of the participants were in good health, with no other medical conditions present. Hearing was confirmed to be within normal limits based on sound field testing completed through the University of Kansas Audiology Clinic. English was the primary language spoken in the home for all of the children. The participants all demonstrated an age equivalent of at least 12 months on four of the five subtests of the Mullen Scales of Early Learning (MSEL, Mullen, 1995): *Visual Reception, Fine Motor, Receptive Language, and Expressive Language*. The *Gross Motor* subtest was not administered.

Each child's communication skills were assessed through standardized measures as well as through a natural language sample. These measures included the Preschool Language Scale, Fifth Edition (PLS-5, Zimmerman, Steiner, & Pond, 2011), MacArthur Communicative Development Inventory (CDI, Fenson et al., 1993) number of expressive labels, and a natural language sample. The language sample was taken during the administration of the Early Social Communication Scales (ESCS, Mundy et al., 2003). Video tapes of the sample were transcribed and analyzed using the Systematic Analysis of Language Transcripts (SALT, Miller, Andriacchi, & Nockerts, 2011) for Mean Length of Utterance (MLU), total number of words, number of different words, and type-token ratio. The samples were also phonemically transcribed to provide a phonemic inventory for each participant as well as a Consonant-vowel word shape inventory. Lastly, the samples were categorized by phase (Preverbal Communication, First Words, Word Combinations, Sentences, Complex) according to the benchmarks presented in Tager-Flusberg et al. (2009). The ESCS was administered to evaluate the child's social communication through the measures of *Eye Contact, Alternate (Coordinated Gaze Shift), Point without Eye Contact, Point with Eye Contact, Show, Follow Point,* and *Follow Line of Regard*.

Each of the participants showed behavioral compliance to screening and testing procedures when provided with breaks and motivators. They also demonstrated adequate imitation skills by scoring at least 16 points total on the Motor Imitation Scale (MIS, Stone, Ousley, & Littleford, 1997). As a requirement for participation in the study, each child also used at least one imperative point (spontaneous or imitated) but no declarative point with eye contact on the Joint Attention Probe and on a 5-item behavior regulation probe. These probes were designed specifically for this study and will be described further later. See Appendix B. Use of an imperative point, but no declarative point, indicated that the participants used a gestural point for imperative purposes but not consistently for joint attention when communicating.

Measures

The following further describes the measures used within the study. The ADOS-2 was used to provide an autism diagnosis and symptom severity rating. The assessment was conducted by a psychologist trained to administer it. The ADOS-2 is a semi-structured play assessment that outlines play contexts and examiner presses. The protocol is designed to elicit typical language and play behavior by the child. These behaviors are then rated under the categories of language and communication, reciprocal social interaction, play, stereotyped behaviors and restricted interests, and other abnormal behaviors. The examiner selects the module that best fits the child's language use. Modules 1 and 2 were used in this study. A highly detailed coding system provides ratings for the outcome measures of Social Affect and Restricted and Repetitive Behavior. Each module has its own cut-off scores and conversion table for determining autism symptom ratings. The ADOS-2 evidences substantial to good reliability for inter-rater, test-retest, and item-total correlations. Sensitivity is high, and specificity varies across modules and replication studies, ranging from 50 to 100 (Lord et al., 2012).

The MSEL is a standard in cognitive assessment for young children. It has five subtests: *Gross Motor, Visual Reception, Fine Motor, Receptive Language,* and *Expressive Language*. The last four subtests were used within this study. Each subtest provides a variety of pictures, objects, and tasks to examine the child's understanding of concepts and motor skills. The assessment is normed on children age 0 to 68 months of age. The MSEL provides subtest *T* Scores, having a mean of 50 and standard deviation of 10, confidence intervals, percentile rankings, and age equivalents. The subtests can be combined into an Early Learning Composite, having a mean of 100 and standard deviation of 15. The MSEL demonstrates good split-half, test-retest, and inter-scorer reliability as well as substantial construct and concurrent validity.

The participants' receptive and expressive language skills were assessed using the PLS-5. It employs pictures and toys to elicit communication. Outcome measures are provided for Auditory Comprehension and Expressive Communication subtests as well as a Total Language Score. These measures include standard scores, confidence intervals, percentile ranks, and age equivalents. Standard scores are all based on a mean of 100 and a standard deviation of 15. The PLS-5 has a large body of normative data supporting its reliability and validity. It evidenced high test-retest, split-half, and inter-rater reliability. It also demonstrated high internal consistency, and showed substantial correlations with other language measures. The PLS-5 correctly identified a language disorder with a sensitivity of .83 and specificity of .80 (Zimmerman, Steiner, & Pond, 2011).

The ESCS is a structured play-based assessment. It provides social communication presses using toys and social interaction, such as songs, to elicit social communication from the child. The child's communicative acts are scored based on whether they are initiations or responses for the three main communicative functions of joint attention, behavior regulation, and social interaction. Normative data is based on longitudinal studies of typically developing children (Markus, Mundy, Morales, Delgado, & Yale, 2000; Mundy & Gomes, 1998).

The MIS provides sixteen motor imitation opportunities for the child. These include both meaningful and non-meaningful actions with objects. Meaningful movements are actions such as pushing a car across the table, and non-meaningful movements are actions such as placing a block on your head. The MIS also includes body movements, such as clapping hands and opening/closing the fist. The examiner provides three presentations of each item and up to three opportunities for the child to imitate the skill. Scoring is based on pass/emerge/fail. This allows points for partial imitation of items. Raw scores range from zero to 32. Means and standard deviations for typical performance are provided for children with autism (*n*=18), developmental delay (DD) (*n*=18) and typically developing (TD) children (*n*=18) (Stone, Ousley, Littleford, 1997).

Joint Attention and Behavior Regulation Probes were developed for this study. They provide structured play opportunities for 35 joint attention and 5 behavior regulation opportunities. The JA probe was designed to elicit the following skills: *Respond to Eye Contact*, *Coordinated Gaze Shift*, *Show or Give*, *Follow Proximal Point*, *Follow Distal Point*, *Initiate Proximal Poin*t with gaze shift to the adult, and *Initiate Distal Point* with gaze shift to the adult. Each skill has a range of zero to five points possible, for a total of 35 points across the seven JA behaviors. Following the 35 JA opportunities provided on the JA probe, five additional behavior regulation opportunities were provided to elicit imperative pointing. Three different probe sets were created and the sets were rotated at each probe date. See Appendix B for a detailed description of the probe and examples of items used. One of the purposes of the current study is to evaluate the JA Probe for its suitability as an outcome measure in studies designed to teach JA skills.

Procedures

Flyers describing the study were provided to local early intervention preschools and therapists. The schools distributed these flyers to families of children with autism. Those who were interested contacted the researcher by phone or email and set up an appointment to have their child screened for the study. The researcher met with the families to answer questions and to obtain informed consent prior to initiating the study. Parents completed a background questionnaire (see Appendix C) and filled out the CDI describing their child's communication skills. Each participant then attended several sessions to determine whether he met the qualifications for the study: diagnosis of autism, age equivalent on the MSEL of at least 12 months, motor imitation skills of at least 16 points on the MIS, hearing within normal limits, behavioral compliance, English as the primary language in the home, use of at least one imperative point ($\geq$ 1 point on the BR Probe), and lack of a declarative point (0 points on the JA Probe). Once it was determined that the child qualified, initial probe data was collected.

Probe Administration

The JA probe described earlier was used throughout baseline and treatment to track all seven skills listed in the JA hierarchy. The probe was administered to all the participants four days a week throughout the baseline and intervention phases until the final participant had received five days of treatment and had shown initial signs of progress. At that point in time, the probe frequency was decreased to once a week to monitor progress. The probe was administered by two examiners, the author as well as a certified speech-language pathology researcher who was blind to the order of treatment. The blind tester administered 56% of the probes (probe dates 1, 3, 5, 8, 12, 16, 18, and 22-32).

Research Design

To address the research questions in a way that would provide an initial test of the efficacy of the CATE approach, a single-subject multiple-baseline across participants design was used. In general, this study employed a single A-B phase change from baseline to intervention and was replicated across four participants, providing strength of generalization (Kazdin, 2011). This design was selected to longitudinally track changes in each of the seven JA skill in the complexity hierarchy during treatment. All of the participants started the baseline phase of the intervention at the same time. The JA Total score was used as the baseline measure. This was selected, since all seven skills were monitored during treatment. Once stability was observed for all of the participants, Participant 1 started the intervention phase of the design while the rest of the participants remained in baseline. A key feature of the design is the staggering of intervention, which continues to provide a control across all four participants. Stability of the baseline measures, for the participants not receiving intervention, provided evidence of a treatment effect for the participant that did receive intervention. Each successive participant who started intervention was given a minimum of three probe dates before the next participant started intervention. Slight modifications to the A-B design were employed to adjust for participant availability and learning needs.

Figure 1 (p. 81) illustrates the basic A-B design used for the study. It displays hypothetical data in order to illustrate the multiple baseline design and the statistical analysis used for this study. The statistical analysis will be described in greater detail later in this section. Each individual participant's data is presented separately in a bar graph. The four participant charts are then stacked on top of one another. In the figure, Participant 1 is shown first at the top, followed by Participants 2 through 4. Probes were administered on the same day for each participant and are listed along the bottom axis of each chart. The total number of JA probe points possible runs along the left axis. A solid line runs from the top of the graph, starting at Participant 1, to the bottom of the graph, ending at Participant 4. This solid line indicates the staggered start to intervention for each successive participant. Any changes to the type of intervention provided are shown with a dashed line. Each of these intervention adjustments is given a number in the graph and a description underneath the probe dates. For example, Intervention 1 represents *Initiate Distal Point* for each participant.

The total length of the bars in the graph represents each participant's total score on the JA probe, with 35 points possible. This total JA probe score was used to determine stability of baseline performance. Within each bar, the seven probe subtests were each given a distinct color. Each subtest allows a score of 0 to 5. This presentation of the data allows for analysis of the total JA probe score, while highlighting the contributions of the seven individual subtests. Each individual skill was later evaluated separately for impact of intervention.

Statistical Analysis

A combination of both visual analysis and statistical analysis is recommended by Kazdin (2011) to account for the strengths and weaknesses presented by either approach. Therefore, data in the current study were analyzed using this combination. First, visual analysis of each participant was employed to determine individual trends. Secondly, the data was analyzed statistically using Tau-U.

Visual inspection is the standard for single-case data evaluation. It presents data for the baseline and intervention phases over time in a graph. The primary question for visual analysis is whether the behavior changed relative to the point in time that the intervention was introduced. In a multiple-baseline across participants approach, the intervention is then replicated across participants. Kazdin (2011) recommended evaluating the data for (a) magnitude of change, according to variation in means and level across phase, (b) rate of change, including fluctuations in slope and latency of change, and (c) the overall pattern of data, such as nonoverlap between phases.

Figure 1 displays hypothetical data used to illustrate the visual analysis approach. Participant X shows a significant effect of treatment. He had a stable baseline with minimal variation. The change between phases showed little difference in level between probe 3 and probe 4; however, the overall mean differed greatly for baseline (M=6.3) compared to intervention (M=12.4). There was a slight latency before change was observed in the intervention phase. Then starting at probe 5, there was an upward trend in the data. Probes 5 through 8 did not overlap with probe values in the baseline phase. Participant Y did not show a significant change in performance from baseline to intervention. He exhibited a stable baseline, with slight variability. His baseline extended two probes past the baseline of Participant X, acting as a control for Participant X during intervention. Participant Y showed a slight increase in level for probe 6 immediately following the start of intervention; however, no positive trends was noted within the intervention phase. The means for baseline (M=6.3) and intervention (M=11.5) did not differ significantly in this case, and all the intervention data overlapped with the baseline data.

Despite the benefits of graphical displays for showing individual changes for single case data, it is recommended that statistical analysis be employed as well (Kazdin, 2011). Visual analysis can be subject to Type I error in which the viewer determines that there was a positive effect due to intervention when in fact there was no effect of treatment. This type of false positive error was found to be potentially high, ranging from 16 percent to 84 percent for single-case time-series studies (Matyas & Greenwood, 1990).

Tau-U was used for statistical analysis of the data. It is a summary effect size index of both between and within-phase trend that has been demonstrated to be effective in analyzing single-case research (Parker, Vannest, Davis, & Sauber, 2011). Tau-U is a form of non-overlap analysis that has several benefits for single-case time-series analysis. According to Parker, Vannest, Davis, & Sauber (2011), Tau-U is a non-parametric statistic, not requiring normal distribution, constant variance, or interval-level measurement. Their research using Tau-U on a sample of 176 data sets found no impact of autocorrelation on Tau-U standard error or significance level. Tau-U is essentially a combination of the Kendall's Tau (KRC), which is a rank correlation coefficient, and Mann-Whitney U (MW-U), which tests between group differences. The resulting Tau-U statistic is a non-overlap effect size measure that also takes into account trend in both baseline and intervention. Tau-U is calculated by comparing all possible scores with the equation $N(N\text{-}1)/2$, where N equals number of scores. The S distribution is the number of pairwise comparisons that increased over time minus the number of comparisons that decreased over time. This value of S is then divided by the total number of pairs. This is termed Tau and represents the percent of data that improved over time. When considering an A-B Phase design, Tau-U values are calculated for each phase of the design as well for the A versus B phase overlap. These Tau-U values are then weighted by the number of pairs used for the calculation and finally added together to yield a combined Tau-U summary index. Tau-U is interpreted as "the percent of data that improved over time considering both phase nonoverlap and Phase B trend, after control of Phase A trend" (Parker et al., 2011, p. 291).

In application to Phase A-B single case design, the Tau-U index allows for correction of baseline trend in the analysis of Phase A to B change while combining Phase AB non-overlap with phase B trend. Coefficient values range from -1 to +1. A score of zero would indicate no improvement of the observed behavior over time, while +1 would indicate 100% improvement of the behavior over time when considering phase nonoverlap and Phase B trend (Parker, et al., 2011).

Using the hypothetical data in Figure 1, Tau-U is calculated as follows. First score comparisons are made both within each phase (baseline vs baseline, intervention vs intervention) and between phases (baseline vs intervention). Participant X had baseline scores of 6, 7, 6 and intervention scores of 7, 10, 12, 16, 17. The total number of comparisons equals $N(N\text{-}1)/2$, which is 8(7)/2=28 for this data set. Therefore, 28 total pairs are compared in a "time-forward direction". The baseline trend comparison has three pairs (i.e., 3(2)/2=3), the intervention trend comparison has ten pairs (i.e., 5(4)/2), and the baseline versus intervention nonoverlap comparison has 15 comparison pairs (i.e., n_A x n_B = 3 x 5 = 15). Comparisons marked as "+" indicate that the comparison value was larger, "-" indicates a smaller comparison value, and "T" indicates a tie.

Baseline to baseline comparison

	6	7	5
6	NA	+	-
7	NA	NA	-
5	NA	NA	NA

Intervention to intervention comparison

	7	10	12	16	17
7	NA	+	+	+	+
10	NA	NA	+	+	+
12	NA	NA	NA	+	+
16	NA	NA	NA	NA	+
17	NA	NA	NA	NA	NA

Baseline to intervention comparison

	7	10	12	16	17
6	+	+	+	+	+
7	T	+	+	+	+
5	+	+	+	+	+

Next, a net improvement sum, *S*, is calculated by subtracting the number of negative comparisons from the number of positive comparisons (# pos - # neg). Baseline trend *S* = (1-2)= -1, Intervention trend *S* = (10-0) = 10, Baseline to intervention nonoverlap comparison *S* = (14-0)

= 14. Finally, these variables can be combined in an equation to answer the following question: What percent of the data improved over time considering both baseline to intervention phase nonoverlap and intervention trend, after controlling for baseline trend (Parker et al., 2011)? Tau-U = *S* (Baseline vs Intervention) + *S* (intervention trend) - *S* (baseline trend) / # pairs (Baseline vs Intervention) + # pairs (intervention trend) = [15 + 10 – (-1)]/25 = 1.0. This effect size indicates that 100% of the probe data improved over time after considering (a) phase nonoverlap, (b) the positive intervention trend, and (c) control for baseline trend.

Treatment for JA Distal Pointing

All participants received intervention at the same early intervention preschool within the community. They were seen one-on-one within a speech-language treatment room. The room contained minimal distractions. All materials were stored in cabinets and were not visible to the child unless they were being used within treatment. Each child was seen by the author four times a week for approximately 30 sessions. Each session lasted approximately 30 minutes (M=33 minutes).

Intervention followed a mixed behavioral and naturalistic approach similar to that of Kasari and colleagues (2006). Each session began with 5 to 10 minutes of discrete trial training (DTT) at the table. This section of the treatment was intended to provide at least ten practice opportunities for the targeted joint attention behavior at a higher intensity and with more structured materials. For this portion, pictures and posters were frequently used to elicit declarative pointing.

Following the DTT practices, a more play-based approach was employed, utilizing toys to elicit joint attentional skills. Twenty practice opportunities for the targeted JA skill were provided within this section of the intervention in approximately 15-25 minutes. As much as possible, materials were arranged to encourage communication similar to the Prelinguistic Milieu Teaching approach (PMT, Warren et al., 2006). During the more naturalistic portion of the session, toys were selected for the participants that would match their interests. The clinician also attempted to follow the child's lead. All of the children demonstrated limited play repertoires. Consequently, the clinician had to frequently lead the play, provide play models, or redirect the child back to play.

Two brief breaks were provided during the intervention. One break was given between the DTT and naturalistic portions, and one break was given half way through the naturalistic portion. During these breaks, the child played on his own with toys of interest while the therapist rotated the toys to be used in treatment.

Materials were selected that would likely elicit the targeted skills. Materials used to elicit distal point with eye contact included posters on the wall, pictures and decorations hung from the ceiling, music/sound starting in the background, toys with missing parts, picture projection on the walls using view master projectors, flashlights with picture covers, sticky toys that fell down the wall, pop up toys, ring toss (where the therapist missed the target), push-n-go vehicles, jumping ants, battery operated toys, spinning tops, musical light up toys, hidden item game, puzzles with hidden pictures, puppets, books, and a potato head toy with pieces that were in the incorrect location. Materials were selected that were expected to be interesting to the child, and yet they were presented in such a way as to encourage joint attention and not requesting behavior.

The author provided all intervention for the study. She attempted to alternate modeling the targeted JA skills with eliciting that same skill from the child. The mean number of child JA acts for the targeted skill, such as *Initiate Distal Point,* was 33.5 opportunities per session. This included spontaneous acts, prompted acts, and incomplete acts following adult prompting. The mean number of adult models for the targeted skills was 30.0. The type of prompting used to elicit the targeted JA skill varied from child to child. The initial aim was to primarily provide physical prompts to elicit the skill, such as shaping a hand point, together with an expectant lean in toward the child to gain eye contact. However, as the intervention started this approach was modified. Additional prompts were required to coordinate the point with eye contact. One child needed the therapist to block outside visual stimuli by holding her hands up in the space between their faces in order for him to look at her. In this case, the therapist would then verbally prompt the child to point to the item of interest. The opposite occurred as well, where the therapist would physically prompt a point and then verbally prompt the child to look back to the adult. Additionally, multiple types of prompts were often needed to elicit the targeted skill. For example, the therapist might have tried a physical prompt to get the child to point, then she might have leaned in toward the child to gain eye contact, and then eventually cued the child with a verbal cue to look. Physical prompts were also avoided when a participant showed a negative response. For example, at times participants would pull back their hand when given a physical prompt to point to an item.

When the child produced the correct response during intervention, the clinician (a) verbally praised the child, stating what the child did correctly, (b) put a sticker on a visual reinforcement card (Appendix D), and (c) provided additional reinforcing toys for those children who are not motivated by the verbal praise and visual reinforcement. A short play break with reinforcement was provided when the child filled up each reinforcement card, having approximately ten practice opportunities. As noted earlier, this provided one short play break in the middle of the session and one at the end. See Appendix E.

If the child exhibited negative behaviors (e.g., expressing frustration) in response to the treatment approach, then adjustments were quickly made to the rate/type of reinforcement, activities, rate of teaching, prompting, and/or target selection. If the child demonstrated eight episodes of negative behaviors in response to the teaching approach within a session, then the intervention was discontinued for that session. Only one episode of negative behavior was observed in the intervention samples. When negative behavior was observed, the child was given at least one simple task to complete in a positive manner before ending the session in order to avoid reinforcement of escape/avoid behaviors.

Reliability

To minimize bias, all coding of probe data, treatment data, and fidelity of treatment was completed by two graduate students in speech-language pathology who were blind to the status of the child in his treatment protocol. Each coder served as the primary coder for half of the files. Using a computerized random number generator, twenty percent of the files were selected for reliability. The other coder independently completed a reliability check on these files. Prior to reliability coding, coders achieved inter-rater agreement of at least 80% on two out of three consecutive practice files.

All of the JA Probes were coded for baseline and intervention phases. Coders recorded the number of examiner solicitations and the number of correct and incorrect responses for each of the seven JA skills (*Respond to Eye Contact, Coordinated Gaze Shift, Follow Proximal Point, Follow Distal Point, Show/Give, Initial Proximal Point, Initiate Distal Point).* Five opportunities were presented for each of the seven skills, for a total of 35 points possible. The coders completed reliability on 23.6% of the probe files. Inter-rater reliability was calculated by comparing the two coders using a two-way mixed effects model evaluating consistency between judges. The coders achieved an Intraclass Correlation Coefficient (ICC) of 0.993 across the probe files.

For the intervention files, 26% of the sessions were randomly selected to be coded for intervention data and for fidelity of treatment. These sessions were selected using the following method. All of the sessions were divided into eight sections. A computerized random number generator was used to select one session from each of these sections. The sessions 4, 8, 12, 15, 20, 24, 26, 29, 33, and 35 were selected. The primary coder watched a video of the session and marked each act that occurred according to the categorical variables listed below. These are listed in parentheses next to each general coding category. The following data intervention variables were coded: (a) use of each targeted JA skill (spontaneous/imitated/ prompted/no response to prompts), (b) type of prompts needed for each act (physical/verbal/lean with expectant wait/verbal cue "Show me"), (c) spontaneous use of three other JA acts when not targeted in the treatment session (show or give/proximal point/distal point), and (d) negative reaction to treatment. These same sessions were coded for fidelity of treatment. The sessions were divided into the DTT and play-based portions. Each portion was coded to identify: (a) location of treatment (table/floor), (b) materials used (pictures/toys), and (c) amount of time in treatment. Each individual act was then coded to reflect the conditions, prompting, and reinforcement provided for that act. These codes were (a) number of toys available for child to select for that play situation (one/two/three or more), (b) adult directiveness in play for that act (follow child's lead/model play/direct play), and (c) use of reinforcement (praise/icon/toy) following that act. Each adult model of the targeted act was also recorded. A description of the treatment fidelity is provided below. For the intervention sessions, 20.5% of the files were independently coded by a second judge using the process outlined above and then compared for reliability. The coders achieved an inter-rater ICC of 0.993 for consistency on the intervention files.

For the pre-post measures (ESCS and language samples), the author of the study served as the primary coder. The following items were coded based on the guidelines provided in the ESCS manual: initiate JA (IJA) eye contact, IJA coordinated gaze shift, IJA point with and with eye contact, IJA show, follow proximal point, follow distal point, initiate behavior regulation (IBR) eye contact, IBR reach with or without eye contact, IBR give with or without eye contact, IBR point with or without eye contact, response to behavior regulation with or without gesture, initiate social interaction, response to social interaction, maintain social interaction, and imitate a point. Each potential act was evaluated to determine the function of the act and whether the requirements were met for that specific act. For example, a point could be coded with or without eye contact. It could also be coded as joint attention, behavior regulation, or imitation.

After the ESCS and language sample files were coded by the primary coder, the files were then divided into 5-minute video segments. A computerized random number generator was again used to select 21% of these segments, with one segment per file coded for reliability purposes. Results of the primary coder were compared to the reliability coder. The inter-rater ICC for the ESCS was .922 for inter-rater consistency.

Lastly, the author coded the language samples for the following items: total number of words, total number of different words, MLU in morphemes, type-token ratio, number of consonants used, and number of syllable structures used. Again, a reliability coder then coded randomly selected segments from 21% of the language samples. Results between coders were compared. For this analysis, the inter-rater ICC was .994 for consistency.

As shown above, across all inter-rater reliability, the ICC values were high. For all of the coding, each coder completed the coding independently and then submitted the file for reliability comparisons. Any differences in coding were then discussed between the coders and the author. Any differences that were determined to be errors in the original coding were changed before the data were analyzed. Any disagreements not resolved through consultations with all coders were left to the primary judge to make the final decision

Fidelity of Treatment

Data from the intervention sessions was used to answer the following questions: (1) Did the interventionist provide an opportunity for 30 JA acts within a session, with approximately 30 minutes per session? The mean number of acts per session was 33.5 (range 30-44), and the average amount of time of the treatment sessions was 28 minutes (range 17-38 minutes). (2) Did the experimenter use DTT techniques for the first portion of the session? All of the participants received 100% of the Discrete Trial Training (DTT) portion of the intervention at the table using pictures for 91% of the DTT opportunities. (3) Did the interventionist use play-based techniques for the second portion of the intervention? For the play-based portion of the intervention, Participant 1 received 100% of the intervention at the table, Participant 2 received 100% of it on the floor, Participant 3 received 75% at the table and 25% on the floor, and Participant 4 received 100% of the play-based intervention at the table. The treatment location was adjusted to accommodate the participants' need for environmental structure. Three out of four of the children received the play-based portion of the intervention at a table setting, rather than the floor. Toys were used for 100% of this part of the intervention. For toy selection, the children were provided with a toy selection of two or more toys 47% of the time and were given one toy at a time for 53% of the play opportunities. Across the four participants, the interventionist followed the child's lead in play for 10% of the play opportunities, modeled play for 84% of the opportunities, and directed the play for 7% of the opportunities. (4) Did the interventionist provide a form of reinforcement for correct JA acts? The interventionist provided praise for 97% of the acts, provided an icon representing the correct response for 94% of the acts, and provided an alternate toy as reinforcement for 35% of the acts. (5) Did the interventionist provide 30 models per session? The average number of models per session was 33.0 (SD=6.4).

Results

Implementation of Design

The multiple baseline design across participants was implemented as described in the Methods section, with minor modifications made for Participants 1 and 2. See Figure 2 (p. 82) for graphical display. The baseline was established on the JA Probe Total Score. This measure was the combined total of all seven JA skills included on the probe. The bar graph stacks the individual skills (ranging from 0-5 points each) for a total of 35 points possible. Each color on the bar represents a different JA skill.

The baseline measure started simultaneously for the first three participants; however, Participant 4 was not identified to start treatment until after the seventh probe point. Participant 1 started treatment after probe point 10. He could have started after probe 4; however, Participants 2 and 3 showed a rise in baseline at probe 4. Therefore, baseline was continued for all participants until all four showed stability with minimal variability. By probe date 10, Participant 4 had three initial probe points showing a stable, slightly negative slope. Participants 2, 3, and 4 continued to show stable baselines, and treatment was initiated for Participant 2 after probe 13. At probe 14, Participant 4 began to demonstrate a positive trend. The trend had reversed by probe 16, at which point treatment was started for Participant 3. Participant 4 showed a slight upward trend again for probes 17 and 18, but then plateaued again for three points by probe 20. Probe 20 corresponded to his thirteenth probe given his late start in the study. Treatment was initiated for him at this point.

Response to Intervention

Each participant's response to the intervention will be described separately in terms of visual inspection and statistical analysis for the probe data, intervention data, and pre-post outcomes. See Figures 3 through 9 (pp. 83-89) for a graphical display of the seven individual JA skills assessed with the JA probe. As noted previously, Figure 2 (p. 82) combines the individual scores on the probe into one combined total score to assess baseline performance. The feasibility and effects of the intervention were also evaluated based on a random sample of intervention sessions, as noted in the Methods section. Figures 10 and 11 (pp. 90-91) display data from these sessions. Pre-Post intervention measures also evaluated change in social-communication skills. See Table 4 (p. 80).

Participant 1: Response to Treatment Approach

Although Participant 1 did not show any positive change for any of the individual JA skills, he did tolerate the CATE treatment approach based on emotional response. He demonstrated only one instance of negative reaction to treatment out of the eight randomly selected treatment sessions, even during sessions that targeted the highest level of skill. In fact, this one, brief episode occurred during treatment of the least complex skill, *Coordinated Gaze Shift*. Participant 1 did show a significant decrease in performance for the skill *Follow Proximal Point* across the four intervention phases (Tau=-.35, p=.01) (Figure 3, p. 83). This may have indicated a decrease in motivation to the task or a negative reaction to the treatment.

He received 100% of the DTT portion of the intervention at the table. He received the first 25% of the play-based portion of the intervention on the floor; however, he demonstrated limited attention to the examiner and the materials in this context. Participant 1 received the play-based portion of the intervention at the table for the remaining 75% of the sessions. During the play-based portion, he selected a toy from a choice of two or more for 51% of the opportunities and the interventionist selected a toy for 49% of the opportunities. Participant 1 led very little of the play (8% of play interactions). The adult either modeled the play (82% of the interactions) or led the play (10% of interactions). During the intervention, Participant 1 displayed a more limited play repertoire, with few play interests. He frequently sang to himself and visually focused on lights or musical toys. He appeared to be at a sensory-based level of interacting with his environment.

Participant 1: Probe Results

Intervention 1 targeted the skill that was initially selected for all four participants, *Initiate Distal Point* for twelve probe dates. He received thirteen intervention sessions targeting this skill. When considering the seven joint attentional skills separately, Participant 1 did begin to demonstrate *Initiate Distal Point* with and without gaze shift on six probe measures during Intervention 1 (Figure 4, p. 84). However, analysis of the seven JA skills individually showed no positive change in mean or level between phases for *Initiate Distal Point* or for any of the other six skills: *Respond to Eye Contact* (*Tau*=-.10, *p*=.56) (Figure 5, p. 85), *Follow Proximal Point* (*Tau*=-.18, *p*=.29) (Figure 3, p. 83), Follow *Distal Point* (*Tau*=-.08, *p*=.63) (Figure 6, p. 86), *Coordinated Gaze Shift* (*Tau*=.00, *p*=.99) (Figure 7, p. 87), *Show/Give* (*Tau*=-.02, *p*=.91) (Figure 8, p. 88) *Initiate Proximal Point* (0 observed) (Figure 9, p. 89), *Initiate Distal Point* (*Tau*=.13, *p*=.45) (Figure 4, p. 84). Intervention 2 was initiated after probe 22. During this phase, treatment was moved to the next skill listed on the JA complexity hierarchy, *Initiate Proximal Point*. It was targeted for four intervention sessions. The Intervention 2 mean rose slightly to 8.5, but no significant change in slope was noted. Intervention 3 was initiated after probe 24. During intervention 3, the therapist targeted the next skill lower on the hierarchy, *Show Items*.

Participant 1 did not demonstrate any immediate success after two sessions for any of the seven JA skills; therefore, and the next skill lower on the hierarchy, *Coordinated Gaze Shift*, was initiated. The mean during Intervention 3 dropped to 5.0, which was one of the lowest points in the intervention phase. Participant 1 did begin to show more success with the skill *Coordinated Gaze Shift* in treatment. Therefore, this skill was continued for ten intervention sessions. Since probes were conducted approximately once every four days at this point, this corresponded to probes 26 through 28.

Participant 1: Intervention Session Data

Participant 1 required the most prompts of the four participants to produce the targeted JA skills. The average number of prompts needed per act for *Distal Point* was 3.3, for *Proximal Point* was 5.0, and for *Coordinated Gaze Shift* was 2.3. This indicated that a high amount of prompts were required for each type of JA skill before the skill was produced within the treatment session.

Several JA skills were recorded during intervention to track spontaneous use of JA skills during treatment sessions, whether or not they were targeted in the session. These included the spontaneous use of *Show/Give, Proximal Point (with or without Gaze Shift), and Distal Point (with or without Gaze Shift).* Even though Participant 1 did not show a significant change on the probe measures, he produced spontaneous JA acts within the sessions. When the intervention targeted *Initiate Distal Point*, he exhibited two distal point acts but without a coordinated gaze shift at session 4, which was the first intervention session randomly sampled. Within the phase of treatment targeting *Initiate Distal Point*, he produced an average of two spontaneous distal points (with or without gaze shift) per session (range 0-4). Within the intervention phase targeting *Proximal Point,* he did not spontaneously use any distal pointing. Finally within the phase of *Coordinated Gaze Shift,* he spontaneously used an average of .5 distal points with or without gaze shift (range 0-2). It should be noted that he used spontaneous distal points the most during the *Initiate Distal Point* intervention.

When evaluating three JA acts (*Show/Give, Proximal Point, Distal Point)*, Participant 1 demonstrated the fewest number of spontaneous JA skills compared to the other participants. He exhibited an average of 2.3 spontaneous acts per session during the intervention targeting *Distal Point,* 0 acts during *Proximal Point,* and 0.5 acts during intervention targeting *Coordinated Gaze Shift.* The act used most often was spontaneous *Distal Point* without gaze shift, having a mean of 0.88 across the sessions. The only other act used was *Proximal Point* without gaze shift. This only occurred once for a mean of 0.1 across the eight sessions randomly sampled.

Participant 1: Additional Measures

On the spontaneous language sample, Participant 1 showed a slight improvement in number of total words, increasing from four to eleven across time points. He did not show an improvement on number of different words, MLU, number of phonemes, or number of CV word shapes. On the ESCS, he demonstrated slight improvement on a few skills. He increased on IJA eye contact from zero to two, IJA coordinated gaze shift from zero to two, initiate social interaction from zero to two, and respond to social interaction from three to five. He showed a decrease or no change for the remaining areas (IJA point, IJA show, follow proximal point, follow distal point, initiate behavior regulation, respond to behavior regulation, and point in imitation). On the global measure of language, the PLS-5, he obtained a standard score of 50 both pre- and post-treatment.

Participant 2: Response to Treatment Approach

Participant 2 appeared to tolerate the CATE approach to intervention well and showed no negative response. He participated in treatment as originally planned, with 100% of the DTT portion occurring at the table and 100% of the play-based portion on the floor with several toy options. He selected a toy option from a field of at least two 52% of the time, and the interventionist selected the toy 48% of the time. He led the play interaction 17% of the time. The adult modeled the play 82% of the time, and she directed the play 1% of the time. Participant 2 showed interest in toys such as bean bag toss, surprise music coming on, view master pictures on the wall, and flashlights on the wall. He demonstrated primarily cause-effect play at a non-symbolic level.

Participant 2: Probe Results

The probe results comparing Participant 2's distal pointing with the other participants are illustrated in Figure 4 (p. 84). Participant 2 exhibited a slight initial rise in baseline that leveled out by probe 8. His baseline was extended to probe 13 to act as a control for Participant 1. The specific skill of *Initiate Distal Point* increased from a mean of zero to a mean of .83 (*Tau*=0.52, *p*=.001), indicating that 52% of intervention data points exceeded baseline. Although this was not with great frequency, it did show a latent, low rise in trend within the intervention phase. Participant 1 also showed mastery of *Respond to Eye Contact* (Figure 5, p. 85) and *Follow a Proximal Point* (Figure 3, p. 83) on probe data, but these did not show significance since they reached the ceiling level during baseline (*Tau*=.16, *p*=.31 and *Tau*=.10, *p*=.54, respectively). *Coordinated Gaze Shift* (Figure 7, p. 87) showed a shift in level between phases with an overall positive trend. This was found to be statistically significant (*Tau*=.31, *p*=.05), indicating that 31% of intervention data points were above baseline, after accounting for intervention trend and controlling for baseline trend. *Follow Distal Point* (Figure 6, p. 86) did not show an increase from baseline to intervention (*Tau*=.15, *p*=.36). And while *Initiate Distal Point* showed a significant increase in probe points, *Initiate Proximal Point* (Figure 9, p. 89) did not (*Tau*-.08, *p*=.74). No shows or gives were noted during the probes.

Given the success in JA skills after twelve probe points, the treatment target was changed, acting as a modified reversal. This change in treatment was selected as an alternative to stopping treatment. For Intervention 2, the therapist only provided models of showing toys to the child. The models of shows were designed to provide exposure to the skill of *Show* without requiring any output. No other models, besides shows, were provided during this time and the child was not encouraged to produce any JA skills. Intervention 2, Show Models, lasted for twelve intervention sessions, corresponding to probe points 26-28. During Intervention 2, Participant 2 exhibited an immediate negative slope in the skills of *Initiate Distal Point. Coordinated Gaze Shift* dropped slightly during this time, from a mean of 2.08 to a mean of 1.67. A return to the initial intervention of *Initiate Distal Point* resulted in a low, latent increase for the individual skill of *Initiate Distal Point*. *Coordinated Gaze Shift* remained somewhat lower with a mean of 1.5 compared to 2.08.

Participant 2: Intervention Session Data

Of the four participants, Participant 2 required the least amount of prompts to produce *Initiate Distal Point* (Figure 10, p. 90). Participant 2 initially required 1.2 prompts per act, and this dropped to 0.4 prompts per act from intervention session 4 to intervention session 15. The mean number of prompts needed across Intervention 1 was 0.75.

For the first intervention sampled at session 4, Participant 2 spontaneously used *Initiate Distal Point* (Figure 11, p. 91) with gaze shift nine times and also used a distal point without gaze shift four times. This value rose steadily across treatment. During Intervention 1 targeting *Initiate Distal Point*, this skill (with or without gaze shift) had a mean of 25.5 (range 13-42), and *Initiate Proximal Point* (with or without gaze shift) was used only occasionally with a mean of 3.0 (range 1-5). During Intervention 2, Show Models, there was a slight mean increase of *Initiate Proximal Point* to 5.5 (range 2-9) and a large decrease of *Initiate Distal Point* to 1.25 (range 0-3). When treatment returned to the original target of *Initiate Distal Point*, the *Initiate Distal Point* frequency of spontaneous use returned to a mean of 21.0 (range 14-28) and *Initiate Proximal Point* dropped slightly to 1.5 (range 0-3). This change may have been affected by the location of the materials during intervention.

Participant 2: Additional Measures

Participant 1 exhibited growth on pre-post language sample measures. He used a larger number of different words, increasing from 56 to 94 different words and from 132 to 259 total words. His MLU increased from 1.43 to 1.99. He also increased somewhat in number of word shapes (15 to 19). Minimal change was noted for number of phonemes (18 to 20).

Social-communication skills on the ESCS improved pre-post, especially for pointing. He increased initiated JA pointing without eye contact from 2 to 13 and with eye contact from 0 to 9. Similarly, initiated behavior regulation pointing with eye contact rose from 4 to 13. Pointing in imitation grew from 1 to 6. Percent response to behavior regulation also rose from 75% to 100%. Minimal to no change was observed for initiated JA eye contact, coordinated gaze shift (0 to 2), percent follow proximal point, initiate behavior regulation point without eye contact, initiate social interaction, and respond to social interaction. No large changes were noted on the global language measure, the PLS-5. Receptive language rose from 81 to 84 and Expressive language rose from 76 to 79.

Participant 3: Response to Treatment Approach

Participant 3 also showed a positive response to the CATE approach to intervention. He demonstrated no negative behavior during the sampled intervention sessions. He received 100% of the DTT portion of the treatment at the table. When the play-based portion was attempted on the floor, he did not show attention to the examiner. Therefore, 100% of the play occurred at the table setting. Participant 3 selected 51% of the toy options from a field of at least two. The interventionist selected the toy 49% of the time. He led the play 10% of the time. The adult modeled the play 83% of the time, and she directed the play 7% of the time. Participant 3 showed limited play interests, primarily at the cause-effect level. These included balloons, simple puzzles, picture projections on the wall, and balls.

Participant 3: Probe Results

Participant 3 exhibited a stable performance in baseline from probe 4 through 16 (Figure 2, p. 82). This baseline period served as a control for Participants 1 and 2 during the start of their intervention phases. Intervention for Participant 3 started after probe 16. *Respond to Eye Contact* (Figure 5, p. 85) and *Follow a Proximal Point* (Figure 3, p. 83) reached ceiling level during the baseline phase and, therefore, did not show a significant change in intervention (*Tau*=-.03, *p*=.86 and *Tau*=.07, *p*=.61, respectively). *Coordinated Gaze Shift* (Figure 7, p. 87) showed a consistent steady rise in both baseline and treatment phases. Since the baseline phase showed a positive trend, it was corrected using Tau-U analysis. After correcting for baseline and accounting for intervention trend, *Coordinated Gaze Shift* used during treatment was found to be statistically significant (Tau=.49, p<.001), with 49% of intervention probe points above all baseline measures. Similarly, *Follow Distal Point* (Figure 6, p. 86) exhibited a positive but widely varied trend during baseline. The variability for *Follow Distal Point* decreased and remained consistently high, reaching ceiling for many probe points during intervention. This change from baseline to intervention, with a mean increase from 3.38 to 4.38, was not found to be statistically reliable (*Tau*=.16, *p*=.24). *Follow Proximal Point* (Figure 3, p. 83) reached the ceiling during baseline and did not show a significant change in intervention (*Tau*=.05, *p*=.74). *Initiate Proximal Point* (Figure 9, p. 89) was rarely used during baseline or intervention, and only one *Show/Give* (Figure 8, p. 88) was demonstrated in the baseline and treatment phases. Six *Initiate Distal Point* (Figure 4, p. 84) acts were used during the intervention phase, compared to two in the baseline phase. Although the mean was higher during intervention with a slight positive slope, this did not reach statistical significance (*Tau*=.01, *p*=.92).

Participant 3: Intervention Session Data

Participant 3 initiated treatment requiring an average of 2.5 prompts per act (Figure 10, p. 90). The amount of prompting needed decreased across the treatment sessions to 0.2 prompts per act. At treatment session four, Participant 3 used *Initiate Distal Point* spontaneously with gaze shift four times (Figure 11, p. 91), and he used an initiated distal point without gaze shift once. By treatment session 12, he used *Initiate Distal Point* with gaze shift spontaneously four times and without gaze shift five times. The amount of spontaneous uses of *Initiate Distal Point* with gaze shift rose steadily starting at intervention session 20 and peaked with 28 spontaneous acts at session 29. The overall mean number for *Initiate Distal Point* with or without gaze shift was 11.4 per session (range 5-28). *Initiate Proximal Point* was observed less often. He spontaneously used a proximal point with or without gaze shift an average of 2.1 times per session (range 0-5). Participant 3 did not use any shows or gives.

Participant 3: Additional Measures

Participant 3 showed little change pre-post on the language sample. The number of total words rose slightly (13 to 18) and MLU remained the same (1.0). Several values dropped slightly: number of different words (5 to 4), number of phonemes (8 to 7), and number of word shapes (4 to 2).

On the ESCS social-communicative ratings, Participant 3 showed improvement for most of the joint attentional skills. He increased in amount of IJA eye contact (11 to 21), IJA coordinated gaze shift (6 to 16), and point with eye contact (6 to 9). He followed more distal points (50% compared to 88%). Initiation of behavior regulation remained similar or dropped slightly: lower IBR changed from 20 to 22 and higher level IBR reduced from 10 to 2. Response to behavior regulation increased slightly from 48% to 63%. Initiation of social interaction dropped from four to one, although response to social interaction rose slightly from three to six. Participant 3 pointed more in imitation, increasing from 7 to 11.

Participant 3 did not demonstrate noticeable changes on the PLS-5. His receptive language standard score dropped from 57 to 50, and his expressive language standard score remained at 60 both times.

Participant 4: Response to Treatment Approach

Participant 4 also demonstrated an overall positive response to the CATE approach. He exhibited no negative emotional reaction to the intervention. He received 100% of the DTT portion of the intervention at the table, as the other participants did. He also demonstrated decreased compliance to the interventionist when the play-based portion was moved to the floor. He traced the brick outlines on the wall and did not show body orientation toward the interventionist. After initial attempts to participate in therapy on the floor, 100% of the remaining play-based portions of the intervention were completed at the table. Participant 4 selected a toy from a field of two or more 35% of the time. Otherwise, the interventionist tried to engage him with a toy for 65% of the other play opportunities. He led the play interaction only 6% of the time. The adult modeled the play 87% of the time, and directed him in play 7% of the time. Participant 4 displayed frequent hand posturing and visual inspection of objects. He had a high preference for alphabet letters and puzzles. His play interests were limited to object configurations, with no functional pretend play noted.

Participant 4: Probe Results

Participant 4 showed variability on the total JA probe score baseline measure (Figure 2, p. 82). It showed several rises and falls, with an overall significant positive trend within phase. The last three baseline points, 18 through 20, appeared to show stability. Intervention was initiated after probe 20. Participant 4 demonstrated change on several individual skills. After a short latency, the mean for *Initiate Distal Point* (Figure 4, p. 84) rose from .31 in baseline to 1.92 in intervention. This was found to be statistically reliable (*Tau*=.39, *p*=.01), with 39% of the intervention points above baseline, after correcting for baseline and accounting for intervention trend. Positive changes were also observed for other skills. *Respond to Eye Contact* (Figure 5, p. 85) improved from baseline to intervention, where it eventually reached a ceiling effect. Visual analysis of the baseline showed a consistent positive trend. Using Tau-U analysis, the rise in performance between baseline and intervention was significant (*Tau*=.57, *p*<.001), showing 57% of intervention values were above baseline, after correcting for baseline and accounting for intervention trend. Similarly, Participant 4 showed a positive trend in the skill *Follow Proximal Point* (Figure 3, p. 83) during baseline measures based on visual analysis. Again, using Tau-U analysis, the baseline to intervention phase difference was significant despite the rise in baseline based on Tau-U (*Tau*=.39, p=.01), indicating that 39% of the data points were above baseline, after correcting for baseline and accounting for intervention trend. Participant 4 showed no change in *Coordinated Gaze Shift* (*Tau*=-.04, *p*=.82) (Figure 4, p. 84), *Shows/Gives* (0 uses) (Figure 3, p. 83), *Follow Distal Point* (*Tau*=-.02, *p*.91) (Figure 6, p. 86), or *Initiate Proximal Point* (Tau=-.003, p=.99) (Figure 9, p. 89) following treatment.

Participant 4: Intervention Data

Participant 4 initiated treatment requiring an average of 3.3 prompts per act (Figure 10, p. 90). The amount of prompting steadily declined across the treatment sessions to 0.1 prompts per act. The overall mean number of prompts was 1.3 per act. At treatment session four, Participant 4 did not use *Initiate Distal Point* spontaneously with gaze shift (Figure 11, p. 91). He spontaneously used a distal point without gaze shift twice. At session 8 he used five *Initiate Distal Point* acts with gaze shift, and by treatment session 15, this amount began to rise steadily. By session 29, he used 27 distal points with or without gaze shift. Participant 4 did not spontaneously produce any proximal points with or without gaze shift during intervention, nor did he use any shows or gives.

Participant 4: Additional Measures

Participant 4 showed a slight drop on the language sample measures: number of different words (33 to 17), number of total words (72 to 47), MLU (1.33 to 1.15), number of phonemes (19 to 18), and number of word shapes (11 to 10). On the social-communicative measures of the ESCS, he did not show positive change pre-post for initiated joint attention. Initiated JA with eye contact dropped from one to zero, JA coordinated gaze shift and point without eye contact increased from zero to one. No examples of point with eye contact were observed pre- or post-intervention. Participant 4 did improve in following a proximal point (67% to 100%) and in following a distal point (50% to 100%). He also showed increases in initiated behavior regulation. He increased in lower level behavior regulation (3 to 11), in point with eye contact for behavior regulation (0 to 13), and for overall higher level initiated behavior regulation (8 to 18). He also responded to more behavior regulation acts (12% to 74%). He showed a slight increase in initiated social interaction (5 to 6) and a modest increase in response to social interaction (4 to 9). Participant 4 also pointed more in imitation (3 compared to 11). His scores on the global language measure, the PLS-5, did not show improvement pre-post for receptive language (67 to 60 standard score) or expressive language (72 to 74 standard score).

Progression of JA Skills

The four participants in this study demonstrated similar patterns of acquisition for the seven JA skills monitored during the intervention. Differences were noted in the emergence of the first three skills: *Follow Proximal Point*, *Follow Distal Point*, and *Respond to Eye Contact*. The pattern of the last four skills remained the same: *Coordinated Gaze Shift, Initiate Distal Point, Initiate Proximal Point,* and *Show/Give*. The pattern of acquisition was determined by evaluating the trend and means for each of the JA skills.

Participant 1 showed the following progression during intervention: *Follow Proximal Point* (mean=3.11), *Follow Distal Point* (mean=2.39), *Respond to Eye Contact* (mean=1.67), *Coordinated Gaze Shift* (mean=0.33), *Initiate Distal Point* (mean=0.17), *Initiate Proximal Point* (mean=0), and *Show/Give* (mean=0).

Participant 2 showed a similar progression of skills based on Intervention 1 data. However, Participant 2 showed a higher mean for *Respond to Eye Contact* than *Follow Distal Point*. Participant Two exhibited the following order of JA development: *Follow Proximal Point* (mean=5.0), *Respond to Eye Contact* (mean=4.92), *Follow Distal Point* (mean=3.17), *Coordinated Gaze Shift* (mean=2.08), *Initiate Distal Point* (mean=.83), *Initiate Proximal Point* (mean=.08), and *Show/Give* (mean=0).

Participant 3 exhibited a similar emergence of skills to Participant 2. He had the same mean JA scores for *Follow Proximal Point* and *Respond to Eye Contact*. *Follow Proximal Point* occurred prior to *Respond to Eye Contact* during the intervention phase, but no difference in slope was observed for the two skills. Participant 3 demonstrated the following order of JA development: *Follow Proximal Point* (mean=4.88), *Respond to Eye Contact* (mean=4.88), *Follow Distal Point* (mean=4.38), *Coordinated Gaze Shift* (mean=3.75), *Initiate Distal Point* (mean=0.38), *Initiate Proximal Point* (mean=0.31), and *Show/Give* (mean=.06).

Participant 4 also exhibited a comparable emergence of skills to Participants 2 and 3 with the exception that *Respond to Eye Contact* emerged slightly after *Follow Proximal Point* and *Follow Distal Point*. He had the same mean scores for *Follow Proximal Point* and *Follow Distal Point*. The difference in trend was negligible. Participant 4 demonstrated the following order of JA development: *Follow Proximal Point* (mean=4.46), *Follow Distal Point* (mean=4.46), *Respond to Eye Contact* (mean=4.08), *Coordinated Gaze Shift* (mean=0.23), *Initiate Distal Point* (mean=1.92), *Initiate Proximal Point* (mean=0), and *Show/Give* (mean=0).

Discussion

Question 1: Do children with ASD respond favorably to CATE treatment procedures that start with the highest level of nonverbal JA skill (distal pointing with gaze shift)?

This question focused on how well the children tolerated treatment that was focused on a challenging skill at the start of the study. The primary outcome for this question was the amount of negative behavior observed. Within the treatment sessions probed, only one negative response was noted across all the treatment sessions for the four participants. This occurred for Participant 1 during treatment of *Coordinated Gaze Shift,* the least complex skill targeted in treatment. This episode was resolved, and the child completed the intervention session. No instances of negative reaction were observed for the most complex skill, *Initiate Distal Point,* for any of the participants.

Questions three and four below describe the participants' performance on the JA skills monitored during treatment. Improvements in performance were seen on at least one JA skill for three out of four of the participants. Participant 1 did not show improvement for any of the JA skills following initiation of treatment. It may be that children with his developmental profile are not ideal candidates for the CATE approach. Participant 1 exhibited severe global developmental delays. He had a chronological age of 57 months; however, he scored between 13 and 20 months across the four *MSEL* subtests. He also exhibited the fewest number of total words (4) on the language sample. The other participants displayed moderate to severe developmental delays on the *MSEL*, but the gap between chronological and mental age was not as great for them.

Question 2: Do the children respond to the probes developed especially for this study to measure improvements in JA skills?

The JA probe designed for this study was sensitive enough to show changes in six out of the seven individual skills assessed. The most complex skill, *Initiate Distal Point,* was exhibited 50 times on the probes. Although this was not a high frequency overall, it did indicate that the probe was at least somewhat sensitive to the acquisition of the skill. In contrast, the skill *Show/Give* was only observed four times across the probes. This suggests that the opportunities for giving and showing were not sufficiently explicit to ensure use among children who were capable of producing these gestures.

The primary limitation of the JA probe was the number of opportunities available to demonstrate each skill. Only five elicitation opportunities were given for each skill on the probe in order to provide consistency between probe administrations. However, ceiling effects during baseline and/or intervention phases were observed on four JA subtests: *Respond with Eye Contact* (3 participants), *Coordinated Gaze Shift* (1 participant), *Follow Proximal Point* (4 participants), and *Follow Distal Point* (3 participants). This ceiling effect may have hidden any additional improvement that might have occurred within or between phases.

Another limitation to the probe may have been the materials or setting used to elicit *Show/Give* and *Initiate Proximal Point.* Very few instances of these skills were demonstrated on the probe. It is unclear whether this was due to an absence of this skill in their JA repertoire or if it was due to floor effects for the elicitation procedures. The *Show/Give* JA opportunities were modeled after an elicitation technique used on the Communication and Symbolic Behavior Scales Developmental Profile—First Edition (CSBS; Wetherby & Prizant, 2002). The child was given a bag with toys in it that might be unusual or visually interesting in some way, such as a ball with a spider floating inside. This was designed as an opportunity for the child to hold up the toy to show it to the examiner.

It may be that *Show/Give* was in fact absent from their JA repertoire, however. The skill *Show/Give* was also assessed using the ESCS pre-post treatment. No *Shows* were demonstrated on the ESCS by any of the children. Another possibility was that *Show/Gives* were not used because two of the children were already in the word combinations phase of language development. The showing gesture is used less frequently than the pointing gesture and decreases over time (Iverson, Capirci, & Caselli, 1994); therefore, words might be used in place of a show or give gesture for these children.

The probe item *Proximal Point* was also used infrequently. Proximal points were used only 16 times across the participants in the study. This was a relatively low number compared the total number of opportunities provided. Again, it may be that the materials did not encourage use of a JA proximal point. For example, one probe item was a toy with a missing wheel. The participants may not have been cognitively aware of the part-to-whole relationship of the wheel to the car. It could be, however, that this skill did not show improvement during the study. The skill *Proximal Point* was not taught to the participants, so there may not have been a change in this skill. The ESCS did not separate the use of proximal versus distal gestures. Therefore, a comparison cannot be made between outcomes of the ESCS and JA Probe.

A final limitation of the JA probe was the apparent practice effect. The probe was administered between 10 and 16 times for the participants during baseline. The participants began to anticipate when the examiner might look to them for *Respond to Eye Contact,* or when she might point for *Follow Proximal Point* and *Follow Distal Point.* This is reflected in a rise in baseline. Even though the presentation of items was alternated within the probe and three separate sets of materials were used, the participants appeared to become familiar with the routines. This is especially problematic for eliciting joint attention. Communication acts that do not regulate a partner's behavior generally arise because of the child's desire to share an unexpected object or event. Repeated probes that result in children's anticipation of events that have been designed to be unexpected are likely to be less effective and less sensitive to child change in use of joint attention over time.

Question 3: Can children with ASD who demonstrate imperative but not declarative pointing learn to spontaneously produce a distal declarative point with gaze shift to the adult following intervention using the CATE model that only addresses this skill?

On the probe measure, Participants 2 and 4 demonstrated a significant change in the complex JA skill of *Initiate Distal Point* which included gaze shift to the adult. Participant 3 also showed more distal points, but this was not found to be statistically reliable. Participant 1 did not show improvement in this skill.

When considering the intervention data, all of the participants showed use of *Initiate Distal Point* in the eight treatment sessions randomly sampled. Participant 1 only used one *Initiate Distal Point* act with gaze shift within the eight intervention session randomly sampled. However, he used seven distal points without gaze shift across the sessions.

Participants 2, 3, and 4 each showed a steady rise in *Initiate Distal Point* across intervention sessions. At session 4, the first session randomly sampled, Participant 1 spontaneously produced nine distal points with gaze shift and four without a gaze shift. On his last treatment session sampled, session 15, he spontaneously used 28 distal points with gaze shift and 14 distal points without gaze shift.

By session 4, Participant 3 spontaneously used *Initiate Distal Point* with gaze shift four times and without gaze shift once. He demonstrated similar levels of pointing until session 20, when his use of pointing began to rise steady. He spontaneously initiated a distal point with gaze shift 28 times during his last session sampled, session 29.

Participant 4 had almost an identical response to treatment as Participant 3. He used two distal points without gaze shift at session 4. By treatment session 15, he began to frequently use *Initiate Distal Point* with gaze shift. His last session sampled had 25 spontaneous distal points with gaze shift.

The results on the ESCS reflected the intervention data. Participant 1 did not show any declarative points pre or post-treatment. Participants 2 demonstrated a large increase in point with eye contact (0 to 9 points) and point without eye contact (2 to 13). Participant 3 increased in declarative point with eye contact (6 to 9), and Participant 4 only demonstrated minimal improvement on declarative point without eye contact (0 to 1).

Participants 2, 3, and 4 demonstrated that children with ASD can learn to use an initiated distal point with gaze shift when that is the only skill targeted in treatment. Participant 2 demonstrated *Initiate Distal Point* across all measures, while Participants 3 and 4 showed the skill less consistently on these measures. Five other studies investigated teaching a similar JA skill using a point with gaze shift (Jones, 2009; Jones, Carr, & Feeley, 2006; Jones & Feeley, 2007; MacDuff et al., 2007; Taylor & Hoch, 2008). With the exception of MacDuff et al. (2007), all of these studies first taught a response to joint attention skill, such as follow a distal point with gaze shift, prior to teaching initiate joint attention. The outcomes varied across studies. Three studies presented percent correct of opportunities when a remote controlled toy was activated, and two studies reported rate of spontaneous initiations.

MacDuff et al. reported a mean rate of spontaneous JA pointing with orientation toward person and repetition of a pre-recorded script during treatments of 4.0, 5.0, and 7.0 for toys and pictures placed in a hallway. The number of treatment sessions per participant based on visual analysis ranged from 45 to 90. Taylor and Hoch (2008) reported mean rates of spontaneous pointing with gaze shift and the word “look” of 2.8, 3.0, and 3.3 per session. The number of sessions per participant ranged from 38 to 76, including both goals of follow a point and initiate a point. The mean rates in the current study for initiated distal point with gaze shift were 0.33, 16.0, 11.3, and 12.9 across the four participants. Participants 2, 3, and 4 used at least 10 spontaneous distal points with gaze shift by sessions 8, 24, and 24 respectively. The participants in this study acquired a distal point with coordinated gaze shift much quicker and used it more often than the comparison treatments just noted. However, the current study did not include a verbal comment as the other two studies did. The study by MacDuff et al. included older children, ages 3 to 5, with comparable or higher language levels to the children in this study. Taylor and Hoch (2008) also included older children, ages 3 to 8, with word and sentence level language skills. These skills could not be compared directly, but appeared more advanced than the children in this study.

In a series of studies, Jones and colleagues reported the percent of opportunities that the child pointed to a remote controlled toy that lit up, played music, or moved. The initial study (Jones, Carr, Feeley, 2006) was implemented by a therapist and required a point with gaze shift. Each child first mastered follow a point with gaze shift at 80% accuracy, with number of sessions ranging from 19 to 78. Next they were taught to initiate a distal point with gaze shift, with number of session ranging from 26 to 157. The participants ranged from 2 to 3 years of age with mental ages 8-18 months and receptive language levels of 6-12 months. Jones and Feeley (2007) applied this same intervention approach but had parents implement it. The number of sessions required to teach follow a point with gaze shift ranged from 7 to 107, and initiate a point with gaze shift ranged from 24 to 117. The children were age 3 and 4 with moderate to severe cognitive and language impairment. The third study (Jones, 2009) again taught follow a point (5-15 sessions), followed by initiate a point with gaze shift (6-19 sessions), and lastly initiate a point with gaze shift and a one word verbalization (5-22 sessions). These children were 3 and 4 years of age with severe cognitive and language impairment. Although treatment intensity could not be compared between these studies and the current study, in general it appears the current study was at least as efficient, if not more efficient in teaching the skill of distal point with gaze shift.

Three additional studies treated distal pointing, but did not require a gaze shift (Ferraioli & Harris, 2011; Kasari, Freeman, & Paparella, 2006; Whalen & Schreibman, 2003). Overall the children in these studies had a higher chronological age than the participants in the current study with language and cognitive abilities at or above those of the children in the current study. The amount of treatment varied across the studies: 8.0-9.25 hours (Ferraioli & Harris, 2011), 12.5-15.0 hours (Kasari et al., 2006), and 42.0-49.5 (Whalen & Schreibman, 2003). The pointing outcomes evidenced minimal changed pre-post treatment. The amount of time in treatment prior to spontaneous use of at least 10 points in the current investigation ranged from 4.0 to 12.0 hours across the three participants that acquired a distal point with gaze shift in the treatment sessions.

In summary, the CATE approach appears to be successful at teaching a complex skill, initiated joint attentional distal pointing with gaze shift for some children. These children used an imperative point at baseline but did not use a distal point to solicit joint attention. The two children who benefited the most (Participants 2 and 4) were at the word combinations language phase of development. Another child (Participant 3) at the first words level showed improvement in treatment data and pre/post data. It may be that he needed a greater treatment intensity to generalize these effects to the probe data. Participant 1 did not show a change in JA behavior. He, too, was at the first words language phase. He may have needed a greater intensity of treatment to show effects, or alternately, he may not have been a good candidate for treatment.

In comparison to the studies reported earlier, the CATE approach appears to be potentially more efficient in terms of number of session and in terms of total number of hours until mastery, at least for children who are fairly young (2;10 to 3;1 in the current study) and at the first words and early word combinations language phases. The comparison groups described in the literature were typically this age or older with similar or more advanced language and cognitive abilities.

Question 4: Do children with ASD who acquire distal declarative pointing with gaze shift using the CATE model demonstrate use of simpler, earlier developing JA skills without direct intervention?

Participants 2, 3, and 4, each showed acquisition of *Initiate Distal Point,* through probe and/or intervention data. These participants also evidenced generalization to lower level JA eye contact skills that are part of the more complex skill, *Initiate Distal Point.* Participant 4 generalized to *Respond to Eye Contact.* Participants 2 and 3 obtained a ceiling effect for that skill during baseline; therefore, improvement could not be monitored during treatment. Participants 2 and 3 generalized to *Coordinated Gaze Shift*, while Participant 4 did not.

Generalization was also seen for following a point. Participant 4 evidenced a change in *Follow Proximal Point.* Unfortunately, Participants 2 and 3 reached ceiling for this skill during baseline. Participant 2 displayed inconsistent results for *Follow Distal Point,* and Participants 3 and 4 reached a ceiling effect for that skill during baseline. Improvements in point following could be an outcome of the treatment targeting *Initiate Distal Point.* Point models were used frequently, with an average of 33 distal point models provided in each intervention session. None of the Participants exhibited generalization to *Initiate Proximal Point* or *Show/Give.*

Participant 1 did not demonstrate a significant improvement for any of the JA skills, even though treatment was adjusted for four different intervention phases. His treatment targets progressed from the highest level of skill, *Initiate Distal Point*, down through each skill on the hierarchy and ended with *Coordinated Gaze Shift*, one of the least complex skills in the hierarchy.

Results on the ESCS support generalization of JA skills for Participants 2, 3, and 4. Participant 3 evidenced an increase in initiated eye contact (11 to 21) acts pre to post-treatment as well as in increase in coordinated gaze shift (6 to 16). The other participants exhibited minimal increases in coordinated gaze shift. Participant 2 increased in initiated JA point without eye contact (2 to 13) and in initiated point with eye contact (0 to 9). Participant 3 also increased in JA point with eye contact (6 to 9). Participant 4 improved in following a proximal point (67% to 100%). All three participants displayed increases in following a distal point (Participant 1 0% to 100%, Participant 2 50% to 88%, Participant 3 50% to 100%). Again, no improvements were demonstrated for the showing gesture.

The limited improvement observed for *Initiate Proximal Point* and *Show/Give* may be a result of probe design or it may reflect a lack of association within the designed JA hierarchy, in that these individual skills are not actually related communicatively. It could reflect general deficits in generalization of skills for children with ASD. It could also reflect lack of motivation to share interest about the materials used to elicit *Initiate Proximal Point* and *Show/Give*. That is, the underlying social basis for joint attention acts may not have been affected directly.

In comparison to the treatment literature, six of the studies followed an intervention progression from response to JA to initiated JA (Ferraioli & Harris, 2011; Jones, 2009; Jones, Carr, & Feeley, 2006; Jones & Feeley, 2007; Taylor & Hoch, 2008; Whalen & Schreibman, 2003). None of these studies reported improvements for untreated skills as they progressed through the skill hierarchy from least complex to most complex skills in treatment. Given the generalization observed in the current study, further investigation of the CATE approach to treating JA is warranted.

Initiating treatment with the advanced JA form of *Initiate Distal Point* may have a long-term impact on a child's language development. A meta-analysis by Colonessi et al. (2010) identified declarative pointing as strongly related to language development (r=.35, p<.001), whereas imperative pointing was not correlated. This underscores the role of JA pointing in social-communicative interactions. As Colonessi et al. noted, the use of declarative pointing likely highlights the individual traits of the child as a stronger communicator from an early age, even from 10 months of age, as well as the environmental impact of pointing on the child's communication partners. The more frequently a child points, the more often conversational partners can respond to the child in ways that further promote language development. In fact, a longitudinal study by Beuker et al. (2013) demonstrated that children who directed attention with gaze shift (an IJA behavior) prior in development to following the attention of others (an RJA behavior) showed greater vocabulary growth for both receptive language (between 10 and 15 months) and expressive language (between 14 and 18 months) in comparison to children who demonstrated the reverse emergence of skills (following the attention of others prior to directing attention with gaze shift). Again, this supports a transactional model of language development in which the child's communication acts influence the behavior of the communication partner which in turn influences the child's development.

Questions 5: What appear to be the key sources of variability that impact JA outcomes across children?

The current study demonstrated a treatment effect on *Initiate Distal Point* with gaze shift for Participants 2 and 4. Participant 3 showed development of pointing in treatment and on the ESCS. Participant 1 did not evidence improvement in therapy. The CATE approach to treating JA skills may be more effective with some children over others. Specifically, the evidence in this study suggests that language development and severity of developmental delay may indicate those children who might or might not respond well to this JA Treatment approach. In contrast, autism severity ratings and motor imitation skills may not indicate suitability for the intervention.

Those children who are in the Word Combinations phase of language development (Tager-Flusberg, et al., 2009) may be the best candidates for this approach. In looking at the participant characteristics, the two participants who showed a significant increase in initiated distal point were in the Word Combinations phase. The caregivers reported use of at least 100 expressive words on the CDI, and the children exhibited moderate to severe receptive/expressive language delays on the PLS-5 (range=67-81 SS). In contrast, the two participants who did not show improvement in initiated distal pointing were at the First Words language development phase. Their caregivers reported that they used less than 100 words on the CDI, and the children exhibited severe receptive/expressive language delays on the PLS-5 (range=50-60 SS).

The speculation that gestural development may be impacted by language status is supported by other studies of typically developing children (Brooks & Meltzoff, 2008) and those with Down syndrome (Zampani & D'Odorico, 2009). The ability of a child to engage socially in communication with others, through words or gestures, appears to be affected by his or her joint attentional development. Distal declarative pointing emerges around 12 months of age in TD children (Carpenter, Nagell, & Tomasello, 1998). The participant who did not show any significant gains in JA skills (Participant 1) exhibited a baseline age equivalent of 8 months on the PLS-5 Total Language Score and 13 months on the MSEL Receptive and Expressive Language Subtests. The age equivalents of the other participants on the PLS-5 ranged from 17 to 27 months. A baseline measure of 15 months on the PLS-5 might indicate social-communicative development prerequisites to success in acquiring the pointing gesture.

The overall severity of DD may have influenced the effects as well. Participant 1 exhibited the greatest amount of DD compared to the other participants, having a chronological age of 57 months and language age equivalents of 8 to 13 months on PLS-5 and MSEL assessments. He did not show any JA skill development during the intervention. In contrast, the autism severity ratings on the ADOS-2 did not indicate those candidates that might respond to the intervention. Participant 2 had the highest autism severity rating of 10, and yet he demonstrated some of the greatest gains in intervention.

The baseline motor imitation scores from the MIS also did not suggest those children who would respond best to the intervention. Participant 1 and Participant 2 had the highest MIS scores of 22 and 29 points respectively; however, Participant 1 did not acquire any of the JA skills whereas Participant 2 did. In contrast, Participant 4 had a lower MIS score of 18 points, and yet he showed development in initiated distal pointing. Participant 3 also had a lower score of 16 points, just making the cut-off for inclusion. He did not show a significant improvement on *Initiate Distal Point*, but he did show development in *Coordinated Gaze Shift* and *Follow Distal Point*, neither of which required a motor component. Although motor imitation skills may not provide an indication of who might be a good fit for this approach, they might be essential for the child to benefit from the treatment. That is, imitation ability may be necessary but not sufficient for CATE joint attention intervention to be effective.

Questions 6: Is there an observable progression of JA skills based on probe data for the following: respond to eye contact, follow a proximal point, follow a distal point, initiate coordinated gaze shift object/person, initiate a show/give to share object, initiate a proximal point with eye contact, and initiate a distal point with eye contact?

The probe results also demonstrated a consistent pattern of acquisition in JA skills for those children receiving the CATE intervention. In general, the JA skills progressed in the following order: *Follow Proximal Point*, *Respond to Eye Contact, Follow Distal Point*, *Coordinated Gaze Shift*, *Initiate Distal Point*, *Initiate Proximal Point*, and *Show/Give*. This order of progression is consistent with the intervention literature in that responses to joint attention (e.g., following a point and response to eye contact) preceded initiation of joint attention (e.g., initiated point and initiated show/give). This order was not consistent with the hierarchy of skills developed based on a review of the intervention literature in which eye contact preceded following a point (Ferraioli & Harris, 2011; Whalen & Schreibman, 2003). The order was consistent with the longitudinal study conducted by Carpenter, Pennington, and Rogers (2002). The progression of skills seen in this study could have been affected by the therapy targets selected for intervention. For example, *Initiate Distal Point* emerged before *Initiate Proximal Point* or *Show/Give*. The results may also have been influenced by the means of data collection via treatment probes rather than play-based longitudinal samples. Additionally, it may be beneficial to change the method in which the observations are made on the JA probe so that there is no limit to the number of opportunities that the JA skill can be demonstrated on that task. This could allow for better monitoring of skill growth over time.

Strengths/Limitations

The current study indicates viability of a new JA treatment approach for children with ASD and provides an early test of efficacy for this approach. Three out of four of the children came from the same early intervention preschool classroom, providing homogeneous treatment backgrounds. Three of the children were similar in age, ranging from 2;10 to 3;1. One participant was 4;9 with more severely affected cognitive and language skills. The study employed a multiple baseline design across participants, providing a form of research control to monitor impact of intervention. Blind judges were used to code all probe and intervention sessions. A blind evaluator was used to administer over half of the probe measures.

There were several limitations to this study that affect the generalizability to other children and settings. First, only four children were included in the current study from similar intervention backgrounds. This small sample size limits generalization. The current study used a previously untested probe measure. The results of the probe may not have provided a valid representation of each child's joint attentional skills. In the current study, the participants appeared to become acclimated to the probe and began to predict the examiner during the initial portion of the baseline phase. Additionally, for several of the items, the participants showed a ceiling effect, limiting the distribution of scores possible.

Although three of the children in the study showed gains in JA skills, with performance at or above that shown in comparable studies, it is not clear that the CATE approach to intervention is more efficacious than the traditional developmental approach. The current study only investigated whether this approach could be a viable treatment approach for this population with this skill deficit. This investigation provided initial evidence that this approach can produce positive outcomes. It does not show that those outcomes are better than the traditional approach to treatment. Lastly, there was no measure of social validity to indicate the impact that the JA intervention may have had on daily interactions for the child.

Future Considerations

Given that the current study indicated feasibility with some evidence of efficacy for three of the participants, future studies are warranted to further investigate the application of the CATE approach. The next phase of research could focus primarily on early efficacy level questions (Fey & Finestack, 2008). This phase of research investigates the cause-effect relationship of an intervention on a specific behavior within a laboratory context. It will also be important to compare the intervention to other approaches. The most meaningful clinical hypothesis postulated in this dissertation is not simply that selection of complex joint attention goals can work, which is what has been shown. Rather, the more interesting hypothesis is that using the CATE approach yields more generalized joint attention acts as well as more frequent use of later developing gestures such as distal pointing with coordinated eye gaze. Using the CATE perspective should yield higher level abilities. Due to the feasibility level of investigation of this study, very little can be said about this hypothesis at this time. Several questions could be considered in future research.

1) Do children at the Word Combinations language phase of development show greater acquisition of JA skills when taught starting with the most complex form or with the least complex form?

2 Do children at the Word Combinations language phase of development show an overall improvement in communication based on social-communicative ratings of language samples when JA acts are taught with words included?

3) What means of assessment best tracks the development of joint attentional skills and how does it correlate with standard measures such as the ESCS?

A future study could be designed as a small group experimental study comparing two interventions, one intervention that starts with the most complex form, and one that starts with the earliest developing skills. The impact of intervention could be determined by the total improvement in JA skills as well as time needed to treat these skills.

Given that the development of distal pointing in the current study did not show generalization across all the JA skills, it could be useful to target each skill individually that is not acquired through generalization. Participant 2 received a second baseline phase that only provided models of showing behaviors. His use of distal points dropped during this time and he did not exhibit an increase in the number of shows. It appears that direct teaching may be needed and generalization should not be assumed for skills such as *Show/Give* that have a different topography than the point gesture. It is unknown if this lack of generalization is a reflection of the population of children with ASD or a disassociation of items within the JA hierarchy.

When teaching each JA skill, the specific skill could also be generalized across materials and contexts. For example, distal pointing could be mastered for posters, unexpected sounds, broken items, missing toys, and sticky items that fall down the wall. Treatment context could also rotate to include a variety of locations, such as the therapy room, a hallway, a classroom, and items outside. Providing additional examples of the same skill in various contexts may increase the understanding of the skill. Materials could also be monitored to match the cognitive level of the participants. In the current study, the participants did not respond to broken toys or pictures of common objects with missing parts, such as a face without an eye. It may have been that they did not identify the part-to-whole relationship.

Within the treatment, it may be useful to include another adult or peer to act as a communication partner. The experimenter could provide models and prompt the participant to engage in JA acts with another person. This could highlight the role of sharing information with others. For verbal children, nonverbal joint attentional acts could be paired with commenting using words.

Summary

The focus of intervention for the current study is on a core deficit for children with ASD: the development of initiated JA pointing with gaze shift to an adult. This is a complex joint attentional skill often lacking in children with ASD. As described previously, using or following a pointing gesture involves multiple social and communicative skills. A child must first understand the social context in which the communication act is occurring, then show awareness of the communication partner's perspective and knowledge, next produce a pointing gesture that references the object or event of interest, and finally shift attention back to the communication partner through eye gaze. Amazingly, this gesture begins to emerge as early as 9 months in children who have TD.

Children with ASD exhibit pointing deficits well beyond typical developmental expectations. These deficits in gestural pointing set children with ASD apart from other children with DD, even from a young age. The ability to use a declarative point is related to long-term communicative success (Colonnesi, Stams, Koster, & Noom, 2010). Three of the children in the current study evidenced a favorable response to the CATE approach in terms of outcomes on the probe results, intervention data, and ESCS measures pre and post-treatment. The children appeared to tolerate the challenging nature of the task and showed some generalization to JA skills that were related components of the complex skill. The amount of time needed in treatment to see an effect was less compared to similar treatments in the literature. Such findings suggest that future studies are warranted to test the efficacy and effectiveness of the CATE approach compared to typical treatment approaches. If greater treatment efficiency can be shown by targeting more complex skills in therapy, then this approach could have broad effects for children with ASD and other DD.

List of Tables

Table 1. *Order of Emergence for Non-verbal Joint Attentional Skills*

	Typically Dev		ASD			DD
Study	**A**	**D**	**B**	**C**	**E**	**E**
RESPONDS TO JOINT ATTN						
Adult places child hand on object						
Adult hand on object						
Adult helps child tap object						
Adult taps object						
Adult shows object						
Eye contact	1					
Follow look / gaze	6	3			4	1
Follow point (general)	3	3	1	1	2	2
Follow proximal point						
Follow distal point						
Alt gaze object-adult						
INITIATES JOINT ATTN						
Eye contact	1					
Look to object						
Coordinated gaze shift object-person	2	1			1	1
Show/Give to share object	4	2				
Show/Give to share object w/gaze shift	8					
Reach		4				
Declarative gestures (general)					3	2
Contact point						
Proximal Point						
Declarative point w/o gaze shift	5	4	1	2		
Declarative point with gaze shift	7					

Note. When studies show the same number for more than one skill, this indicates that the skill emerged at the same time or had the same mean frequency as another skill.

A. Beuker, Rommelse, Donders, & Buitelaar (2013). *n*=23 TD, age= 8 months, longitudinal

B. Camaioni, Perucchini, Muratori, & Milone (1997). *n*=3 with autism, ages=2;1, 2;8, and 4;6. Single-case longitudinal study.

C. Camaioni, Perucchini, Muratori, Parrini, & Cesari (2003). n=5 with autism, ages= 3;3 to 4;10. Single-case longitudinal study.

D. Carpenter, Nagell, & Tomasello (1998). *n*= 24 TD, range=9-15 mo, longitudinal study

E. Carpenter, Pennington, & Rogers (2002). Group with ASD: n= 12, mean age=50 mo, age range=40-57; Group with DD: *n*=11, mean age=46 mo, age range=31-60. Controls: Matched for CA, VMA, NVMA. Assessed at a single point in time. Order based on JA skill mean frequency.

Table 2. *Order of JA Intervention Targets for Children with ASD*

Study	A	B	C	D	E	F	G	H
RESPONDS TO JOINT ATTN								
Adult places child hand on object	1							1
Adult hand on object								
Adult helps child tap object	2							2
Adult taps object								
Adult shows object	3							3
Eye contact	4							4
Follow look / gaze	6							6
Follow point (general)	5						1	5
Follow proximal point					X			
Follow distal point			1	1	X			
Alternate gaze object-adult		1	1	1			1	
INITIATES JOINT ATTN								
Eye contact								
Look to object								
Coordinated gaze shift object-person	7				X		2	7
Show object					X			
Give to share (not request)					X			
Reach								
Declarative gestures (general)								
Contact point								
Proximal Point					X			
Declarative point w/o gaze shift	8				X			8
Declarative point with gaze shift		2	2	2		1	2	

Note. When the same number is given for more than one skill, this indicates that the skill was targeted at the same time as another skill. "X"= skills not targeted in a specified sequence.

A. Ferraioli & Harris (2011). *n*= 4, age range=3;7-5;4, Multiple baseline design across participants.

B. Jones (2009). *n*=2, age range=3;8-5;4. Multiple-baseline across skills.

C. Jones, Carr, & Feeley (2006). *n*=5, age range=2-3 yrs, Multiple baseline across skills.

D. Jones & Feeley (2007). *n*=3, mean ages=3;0-4;0, Multiple baseline across skills.

E. Kasari, Freeman, & Paparella (2006). Subjects: ASD JA Group (*n*=20, mean age=43 mo), ASD play (*n*=21, mean age=43 mo), ASD Control (*n*=17, mean age=42 mo). Randomized controlled trial.

F. MacDuff, Ledo, McClannahan, & Krantz (2007). *n*=3, age range=3-5 yrs, Multiple baseline across participants.

G. Taylor & Hoch (2008). n=3, age range=3-8 yrs. Multiple baseline across participants.

H. Whalen & Schreibman (2003). *n*=5, age range=4;0-4;4), TD use for comparison (n=6). Multiple baseline across participants.

Table 3. *Participant characteristics prior to intervention*

Measures	Participant 1	Participant 2	Participant 3	Participant 4
Age/gender	4;9 male	3;0 male	3;1 male	2;10 male
ADOS-2 score	25 (module 1)	22 (module 2)	22 (module 1)	18 (module 1)
ADOS-2 severity (1=minimal, 10=high)	9	10	7	6
Mullen: Visual Reception AE	19	39	26	25
Mullen: Fine Motor AE	20	27	22	26
Mullen: Receptive language AE	13	39	18	19
Mullen: Expressive language AE	13	28	15	23
Mullen: Composite SS	49	84	50	57
PLS-5 Receptive language SS	50	81	57	67
PLS-5 Expressive language SS	50	76	60	72
PLS-5 Total language AE	8	27	17	19
CDI (# words spoken)	62	273	13	133
Lang Sample: MLU in morphemes	1.0	1.43	1.0	1.33
Lang Sample: # words total	4	132	13	72
Lang Sample: # different words	4	56	5	33
Lang Sample: Type-token ratio	1.0	.42	.38	.46
Lang Sample: # CV word shapes	4	15	4	11
Lang Sample: # phonemes	14	18	8	19
Lang Sample: Phase	First Words	Word Combinations	First Words	Word Combinations
Motor Imitation Scale (raw score)	22/32 points	29/32 points	16/32 points	18/32 points
Mother's education	Graduate degree	High School	2 years college	Graduate degree

Note. All age equivalents are given in months. AE=Age Equivalent in months. SS=Standard Score (typical range=85-115).

Table 4. *Pre-Post Treatment Measures*

Measures	Participant 1		Participant 2		Participant 3		Participant 4	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Language Sample								
# Different words	4	3	56	94	5	4	33	17
# Total words	4	11	132	259	13	18	72	47
Type-Token ratio	1.0	0.27	0.42	0.36	0.38	0.22	0.46	0.36
MLU in morphemes	1.0	1.0	1.43	1.99	1.0	1.0	1.33	1.15
# Phonemes	14	11	18	20	8	7	19	18
# CV Word shapes	4	3	15	19	4	2	11	10
ESCS Assessment								
IJA Eye Contact	0	2	1	1	11	21	1	0
IJA Coord Gaze Shift	0	2	0	2	6	16	0	1
IJA Point w/out EC	0	0	2	13	4	0	0	1
IJA Point with EC	0	0	0	9	6	9	0	0
IJA Show	0	0	0	0	1	0	0	0
% Follow Prox Point	.83	.67	.83	.83	1.0	1.0	.67	1.0
% Follow Distal Point	.75	.25	0	1.0	0.5	0.88	0.5	1.0
Lower level IBR	8	7	16	10	20	22	3	11
IBR Point w/out EC	0	0	3	0	0	0	1	0
IBR Point w/ EC	2	0	4	13	0	0	0	13
Higher level IBR	4	3	14	23	10	2	8	18
% RBR	.32	.13	.75	1.0	.48	.63	.12	.74
ISI	0	2	1	3	4	1	5	6
RSI	3	5	9	10	3	6	4	9
Point in Imitation	9	5	1	6	7	11	3	11
PLS-5								
Rec Language SS	50	50	81	84	57	50	67	60
Exp Language SS	50	50	76	79	60	60	72	74

EC=Eye Contact, IJA=Initiated Joint Attention, IBR=Initiated Behavior Regulation, RBR=Response to Behavior Regulation, ISI=Initiated Social Interaction, RSI=Response to Social Interaction

List of Figures

Figure 1. Hypothetical probe data

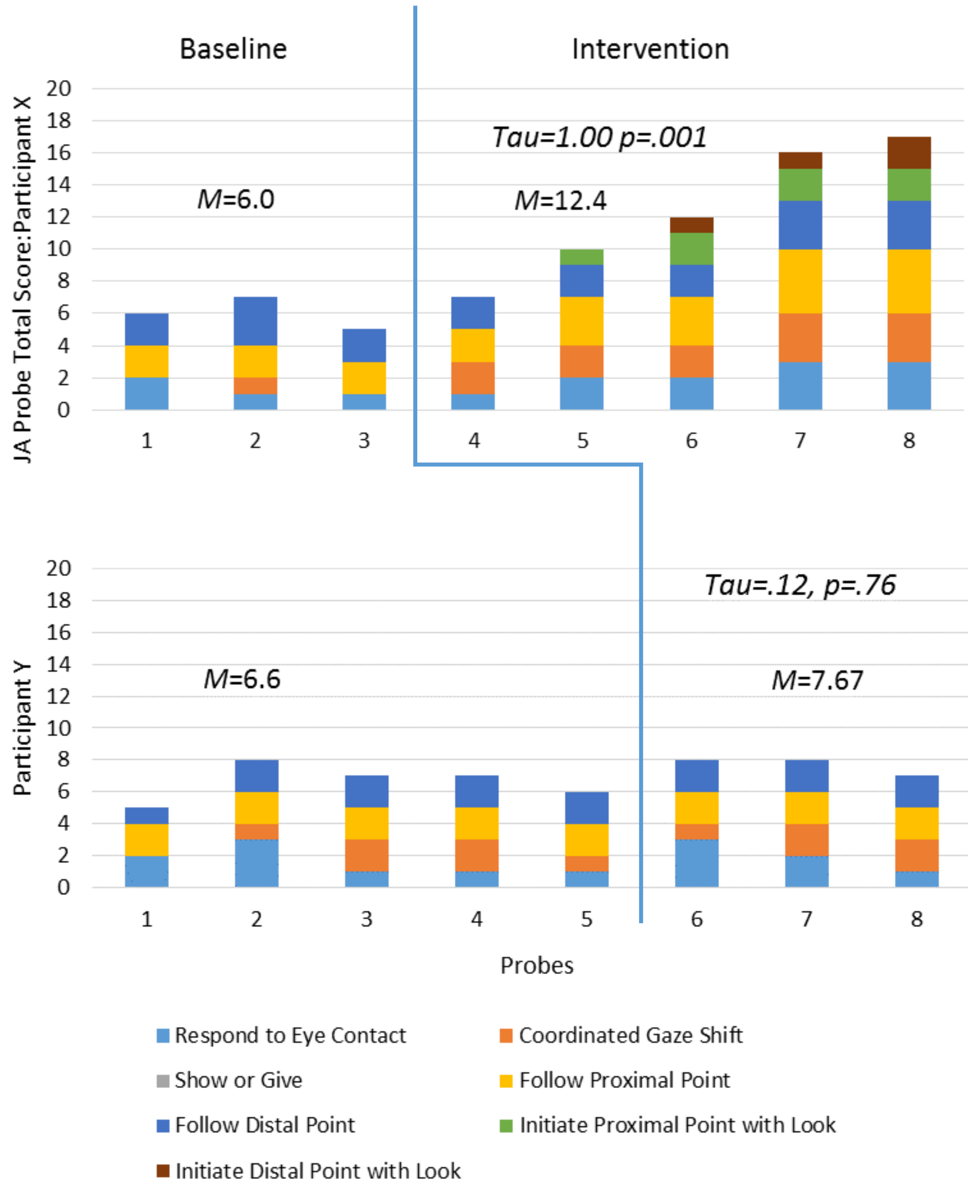


Figure 2. Probe Results (JA Probe Total Score—Baseline Measure)

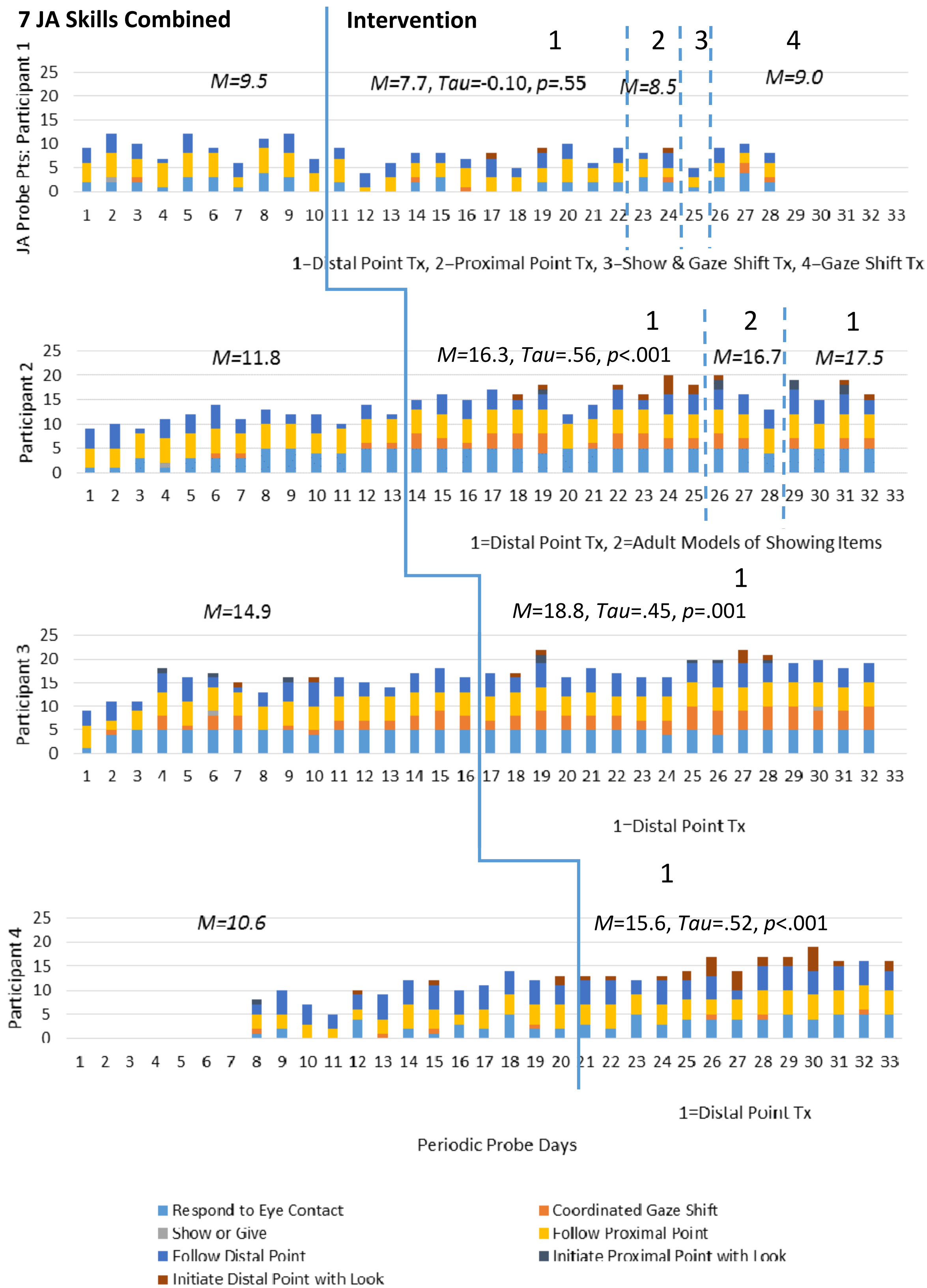


Figure 3. Probe Results (Follow Proximal Point)

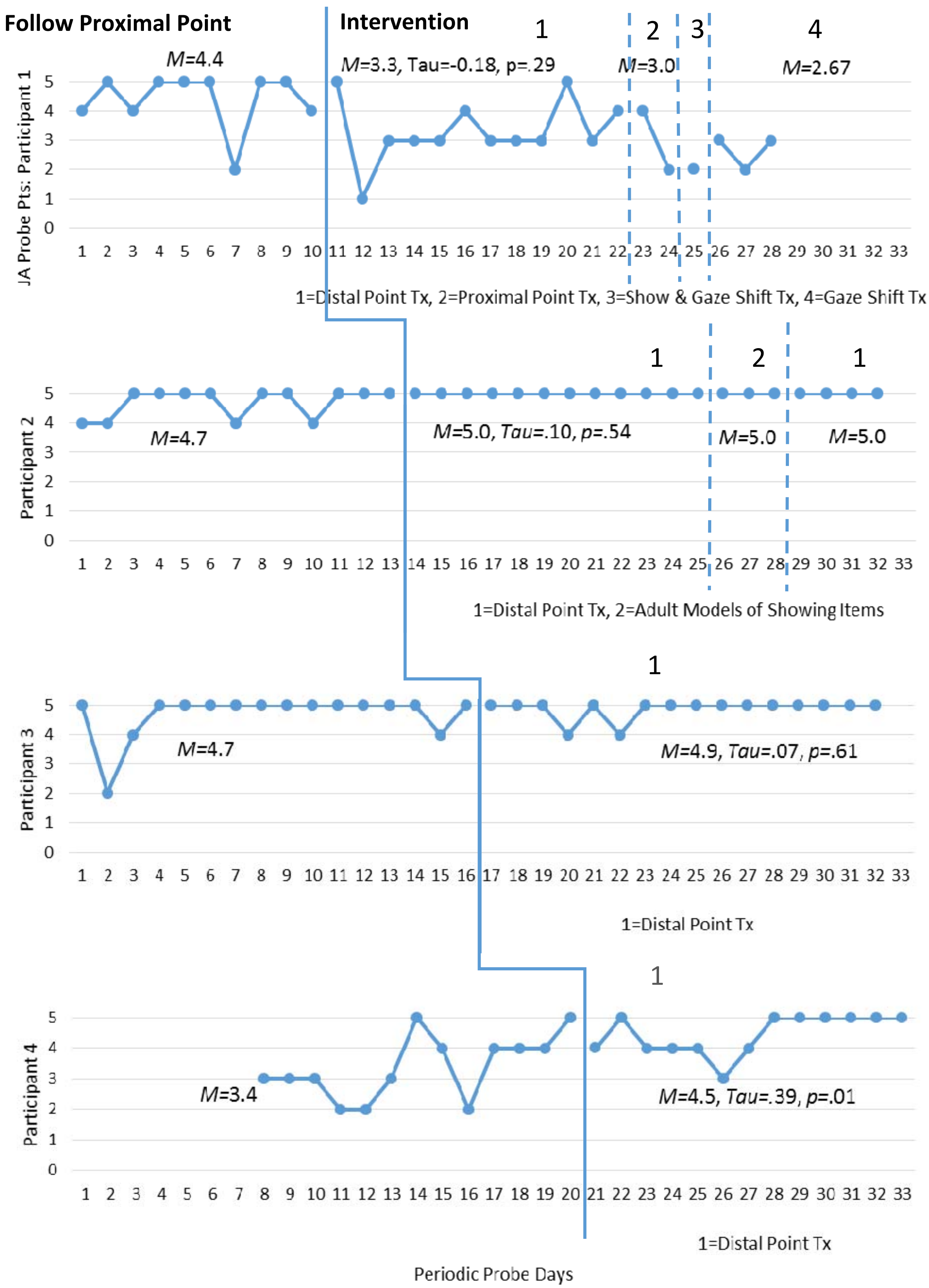


Figure 4. Probe Results (Initiate Distal Point)

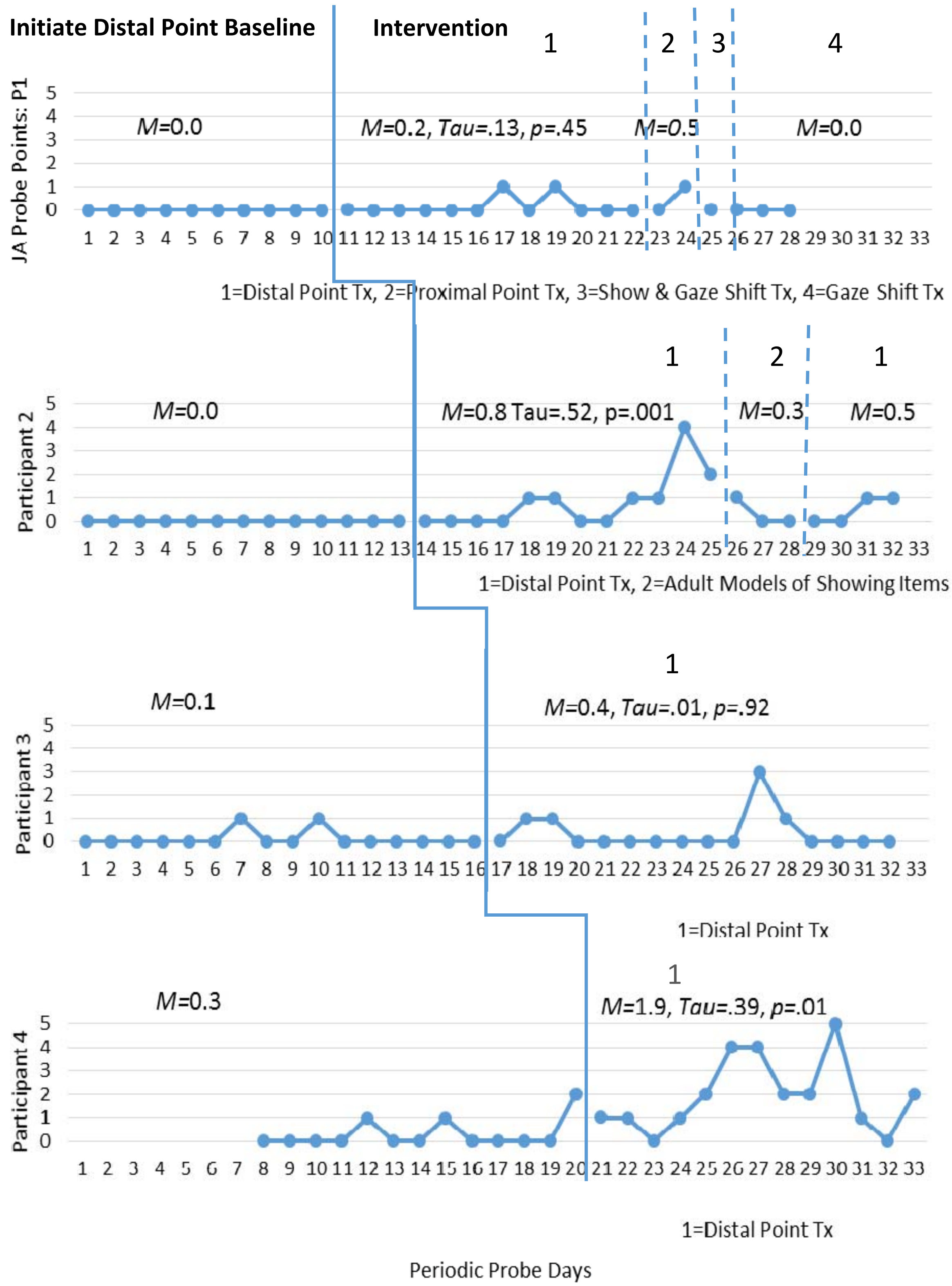


Figure 5. Probe Results (Respond to Eye Contact)

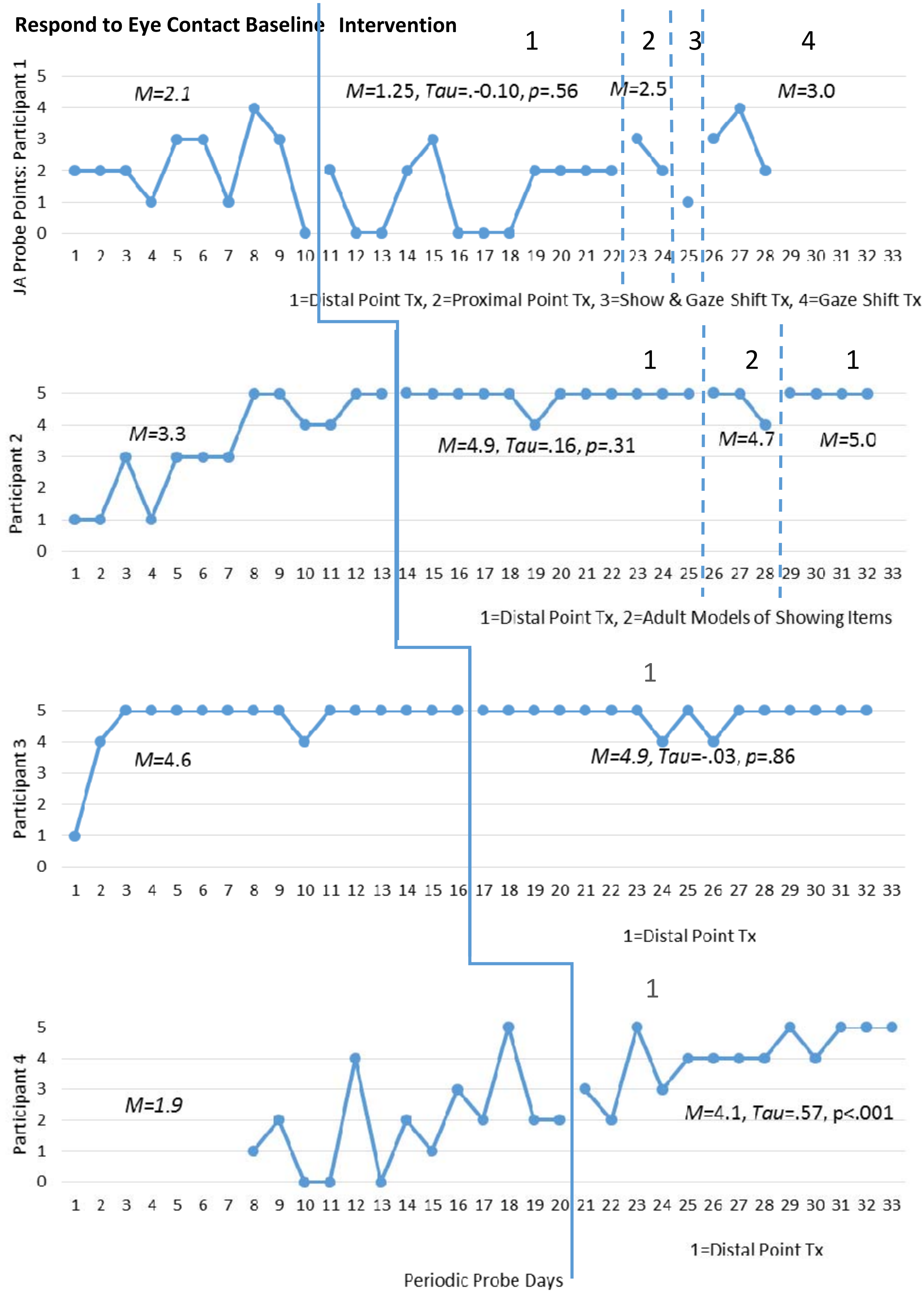


Figure 6. Probe Results (Follow Distal Point)

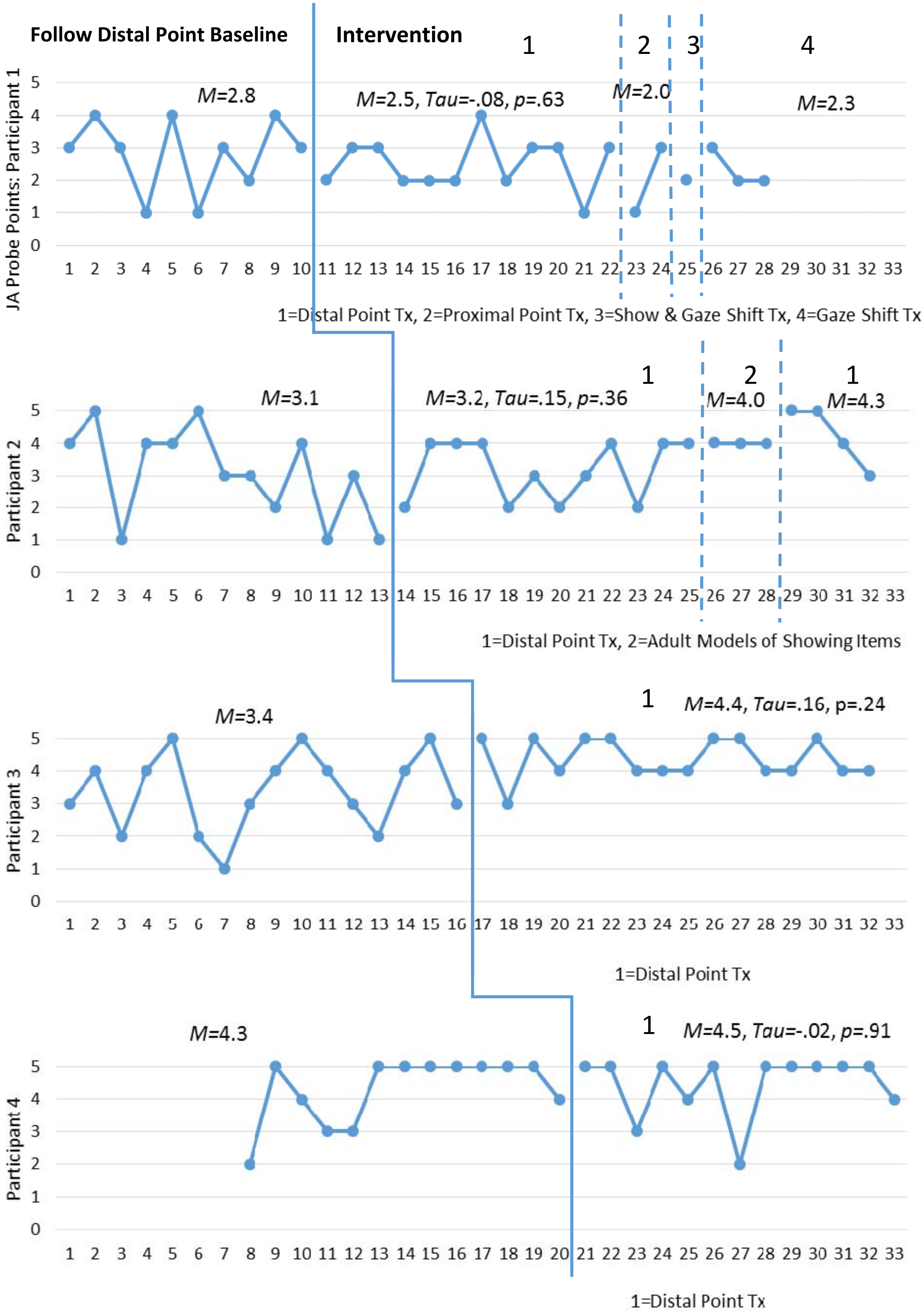


Figure 7. Probe Results (Coordinated Gaze Shift)

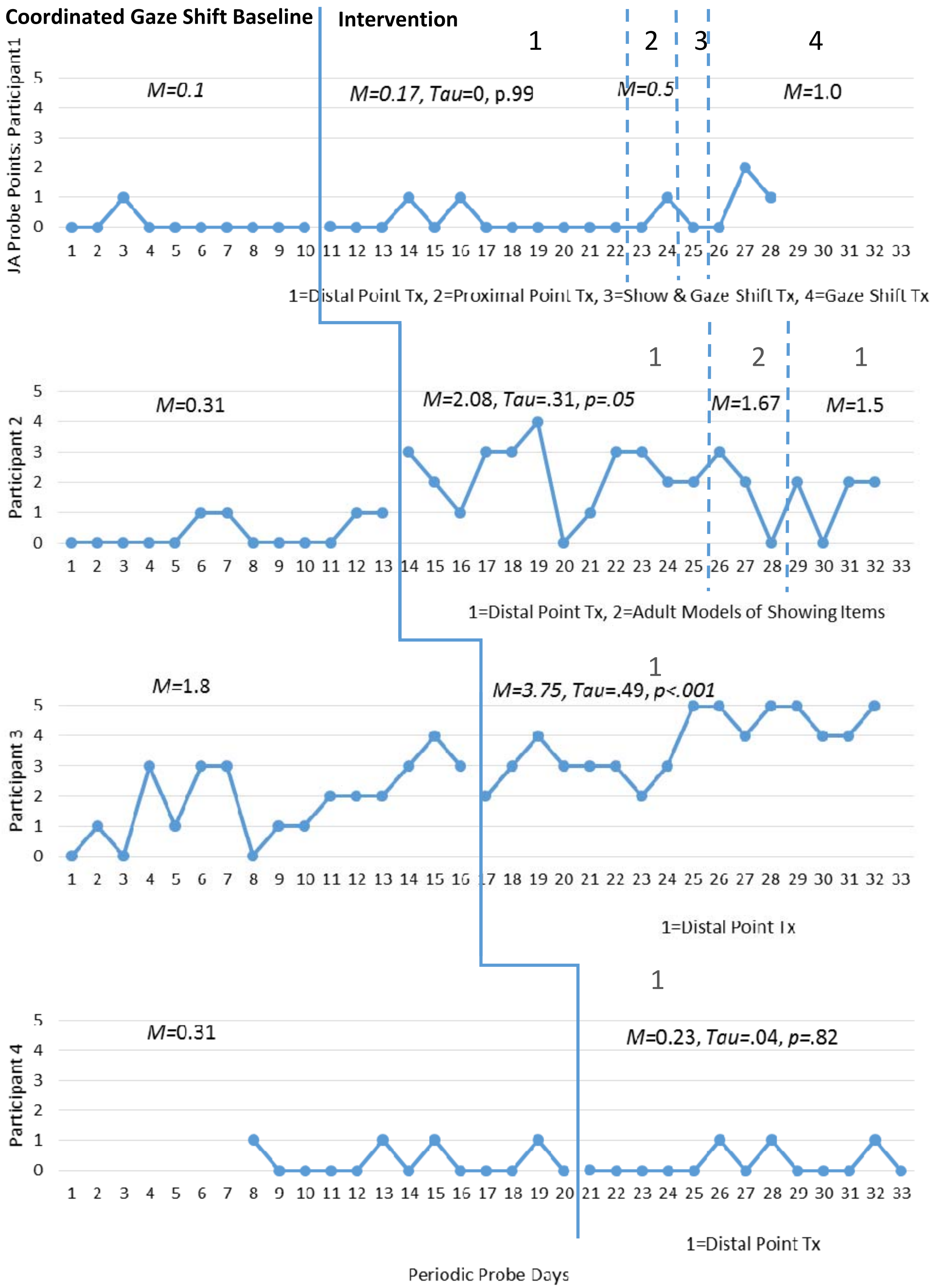


Figure 8. Probe Results (Show/Give)

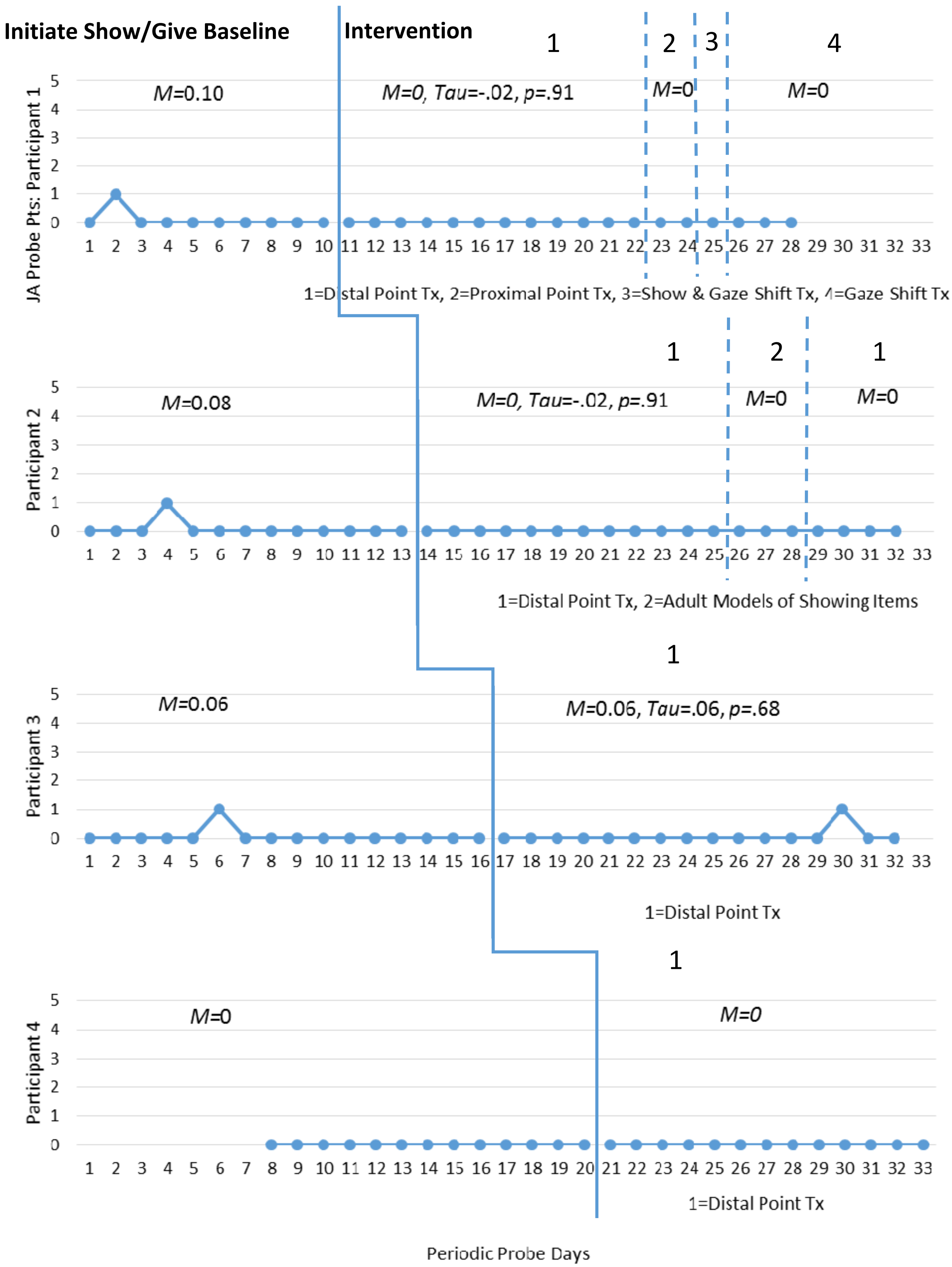


Figure 9. Probe Results (Initiate Proximal Point)

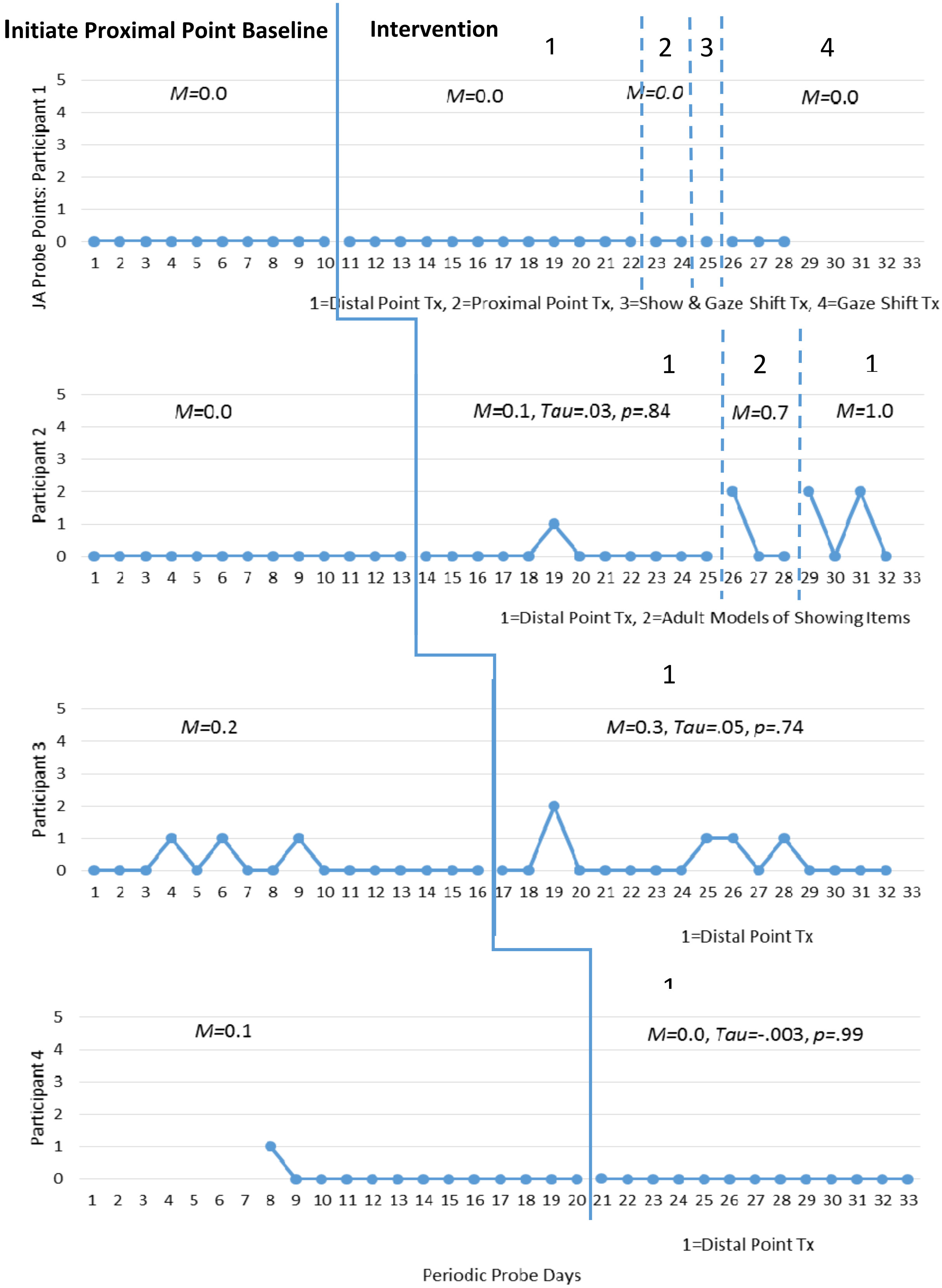


Figure 10. Treatment Data (Number of Prompts During Intervention Sessions)

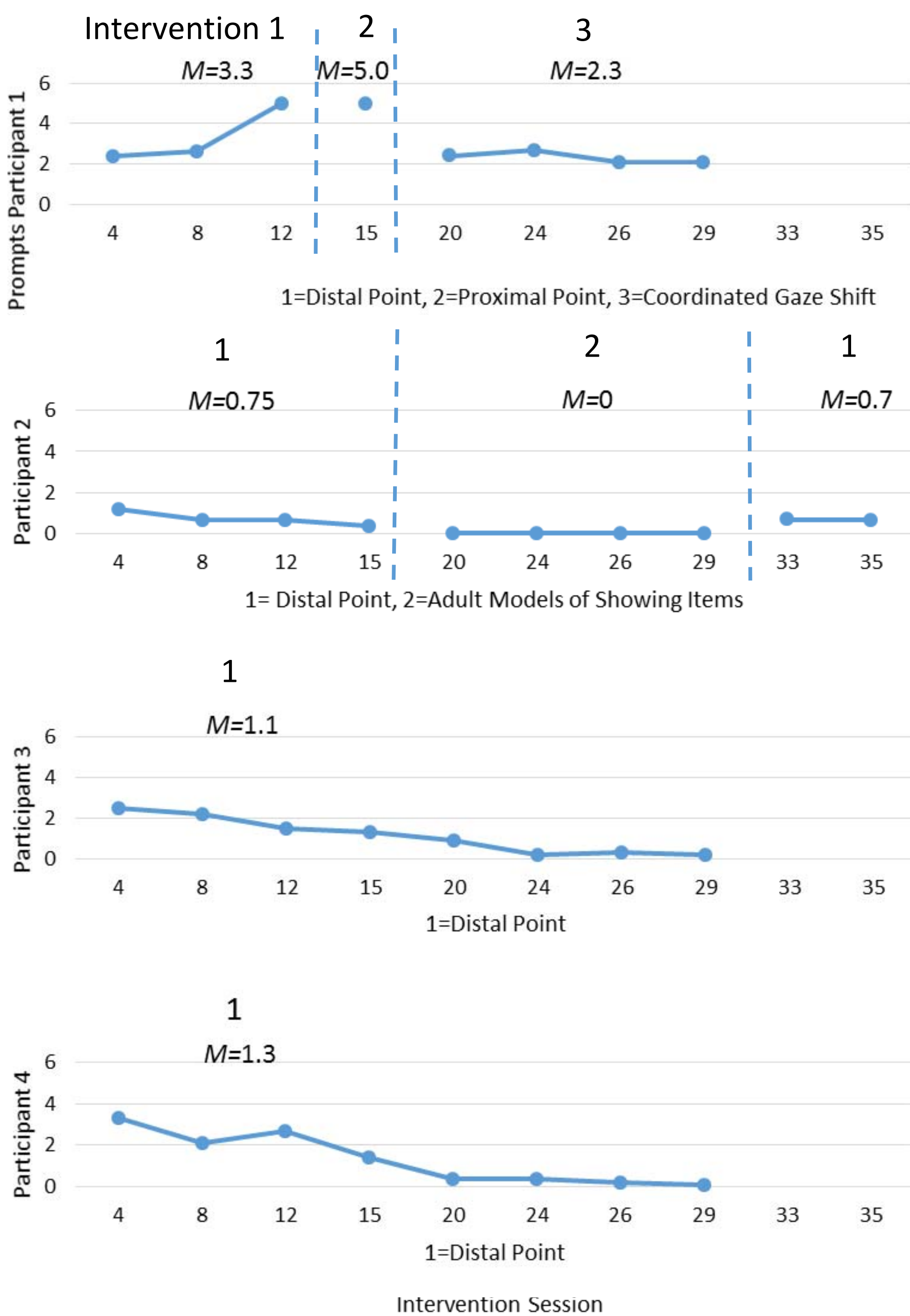
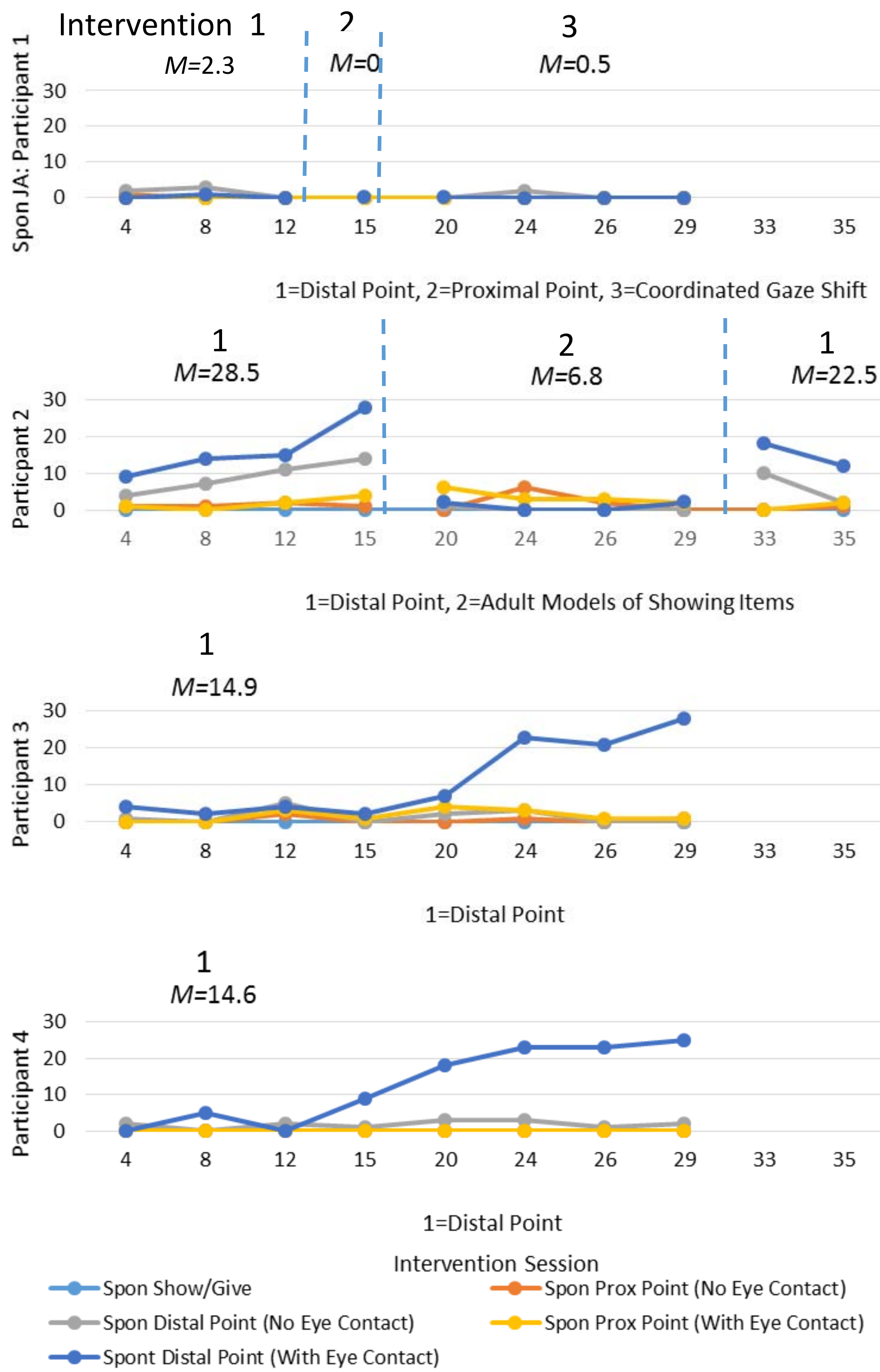


Figure 11. Treatment Data (Spontaneous JA Acts)



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Appendix A

Definitions of joint attention skills based on Kasari, Freeman, & Paparella (2006)

RESPONSE TO JOINT ATTENTION BID	
Respond to eye contact*	Child will look at the adult's eyes within 3 seconds of the adult moving into the child's line of sight and attempting to make eye contact.*
Follow proximal point	After adult points (to object within 6 inches of pointing finger), child responds with an attentional focus. The child's eye-gaze shifts to focus on the object that the adult is pointing to.**
Follow distal point	Child follows adult distal point (more than 6 inches away from object). The child's eye-gaze shifts to focus on the object that the adult is pointing to.**
INITIATION OF JOINT ATTENTION	
Coordinated Joint Look	Child looks between adult and a toy to share attention. No more than 3 seconds must separate the look between the toy and the adult.
Show	Child has object in hand and holds it towards adult to share attention. Child does not give toy to adult.
Give to share	Child gives toy to adult. The child must make a clear attempt to give the toy to the adult. Just a general thrust or throw in the direction of the adult is not acceptable. Child does not want adult help. Child gives purely to share, e.g. for adult to look at a toy or for adult to take a turn with a toy.
Proximal Point	Child points to an object within 6 inches of object purely to share interest with the adult. Child's finger does not need to be touching object.**
Distal Point	Child points to an object which is more than 6 inches away from pointing finger purely to share interest with the adult. Child does not want adult to act on the toy.**

*Addition to Kasari, Freeman, & Paparella (2006) **Distance was increased from 4 inches to 6 inches for the purposes of this study

Appendix B

Joint Attention Probe Description

Targeted JA skill	**Probe items**
Respond to eye contact	Adult moves within child's line of sight. After the child either looks at the adult or there is a 7 second pause, the adult presents a toy that was hiding behind her back (repeat five times)
Follow proximal point	Place picture on the table. Call child's name and make sure that child shows attending through body orientation or eye contact. Then point to each item in random order drawing child's attention in a different direction each time. Wait 7 seconds to see if the child responds. Obtain the child's attention prior to each new presentation.
Follow distal point	Call child's name and make sure that child shows attending through body orientation or eye contact. Then point to posters on the wall (one on left, one on right, two in front towards the right/left, and an item hanging from the ceiling). Wait 7 seconds to see if the child responds.
Initiate coordinated gaze shift object/person	Hold up novel toy within reach of child that would not promote requesting behavior and look at child with expectant pause. Wait 7 seconds for child response. (five times)
Initiate a show/give to share object, Initiate a proximal point with eye contact	Hand bag that contains 2-3 silly novel toys to the child. Allow about 7 seconds per item presented for child to respond. (5 items presented) Present items and pictures that are unusual, missing a part, or used in a silly way (e.g., messed up book, car with missing wheel, animated book, puzzle with missing piece) (five items). Items should be within reach of child. Wait 7 seconds for response.
Initiate a distal point with eye contact	Present items and pictures that are unusual, missing a part, or used in a silly way (e.g., messed up book, car with missing wheel, animated book, puzzle with missing piece) (five items). Items should be approximately three feet away (out of child's reach). Hold up item and provide approximately a 7 second pause. When finished, put toy away and do not give to child.
Behavior Regulation Probe	
Imperative Point	Hold up two potentially preferred items out of the child's reach. Ask "which one do you want?" Wait 3 seconds to see if the child initiates an imperative point. If child does not point, say "show me." Wait 3 seconds. If the child does not point, hold up the item that the child seems most interested in and model a point. Wait 3 seconds. If the child does not respond, say "point to it". If child does not use a point but shows other requesting behavior, then present child with the object.

Probe Set 1: Order of item presentation

Avoid using any pointing models during the JA probe. For each item, typically allow a 7 second opportunity to respond.

- **Repeat the following sequence twice (puzzle: adult helps put pieces in, book page):**
  - **Respond to eye contact**: Move within line of sight to present novel toy. Wait 7 seconds.
  - **Initiate coord gaze shift object/person**: Hold up toy and look at child with expectant pause. Wait 7 sec.
  - **Initiate a proximal point**: Present item within reach of child. Wait 7 seconds
- **Initiate a show/give to share**: Hand bag that contains 2 silly/novel toys to the child. Give 14 seconds.
- **Initiate a distal point (doll with glasses that fall down, potato head piece falls off):** Present item approximately three feet away from child. Wait 7 seconds. Do not give item to child when done. (Two times)
- **Repeat the following sequence three times (doll without leg, car without wheel, picture)**:
  - **Respond to eye contact**: Move within line of sight to present novel toy. Wait 7 seconds.
  - **Initiate coor gaze shift object/person**: Hold up toy and look at child with expectant pause. Wait 7 sec.
  - **Initiate a proximal point**: Present item within reach of child. Wait 7 seconds.
- **Initiate a show/give to share**: Hand bag that contains 3 silly/novel toys to the child. Wait 21 seconds.

- **Initiate a distal point (grasshopper jumps then falls on back, magnet dog loses leg, bunny pops out of puppet)**: Present item approximately 3 feet away from child. Wait 7 seconds. Do not give item to child when finished. (three times)
- **Follow distal point (1 side poster, 1 front):** Call child's name and secure attention. Point to item at a distance. Wait 7 seconds. (two times)
- **Follow proximal point**: Place picture on the table. Call child's name and secure attention, then point to item on the page. Allow 7 seconds for child to respond. Repeat for remaining items, pointing to items in a different direction each time (five times).
- **Follow distal point (one side, ceiling, one front):** Call child's name and point to item at a distance (three times).
- **Imperative Point no model/model**: Allow 3 seconds before moving on to the next prompt level. (1) Hold up two potentially preferred item out of the child's reach. Ask "which one do you want?" (2) Say "show me." (3) Hold up item and model point. (4) Say "point to it". If child still does not use point, but uses other requesting behavior, then give toy to child. (5 toy choices)

Appendix C

PARENT QUESTIONNAIRE

Date:

Child's name:

Parents' names:

Address:

Phone: (home) (mobile)______________________

Child's Birthdate:

What is your child's primary Language?___________________________

Did you adopt your child from another country? Yes No

Does your child currently receive speech/language services? Yes No

If yes, who is your child's SLP? How many hours of service per week?____

Does your child attend services at an early intervention or childcare center? Yes No

If yes, who is your child's teacher and what school do they attend?

Has your child ever worked on eye contact in therapy? Yes No

Has your child ever worked on pointing in therapy? Yes No

How many hours of therapy do they receive each week addressing these skills?_____

How many hours of therapy have they received in the past addressing these skills?___

Does your child have a visual impairment? Yes No

If yes, is his or her vision corrected with lenses? Yes No

Does your child have a hearing impairment? Yes No

If yes, is his or her hearing corrected with hearing aids? Yes No

Does your child have any specific diagnosis? Yes No

If yes, what is the diagnosis?________________________________

Was your child born premature? Yes No   If yes, at how many weeks?______

Has your child ever had a seizure? Yes No

Does your child have any other medical conditions? Yes No

Are you willing to have your child participate in 2-4 sessions per week each lasting approximately 45-minute for up to 50 sessions (20 data collection sessions and 30 treatment sessions)? Yes No

What is the Mother's highest level of education?__________Father?____________

How did you find out about this study?__________________________________

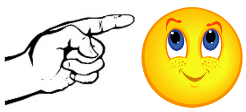
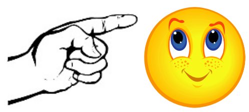
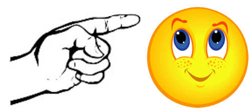
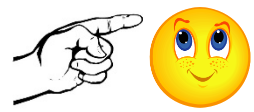
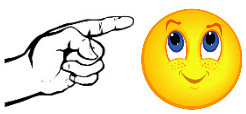
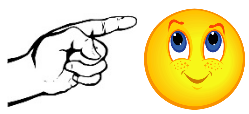
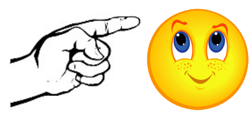
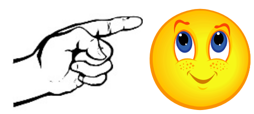
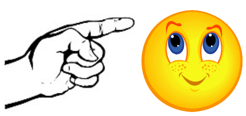
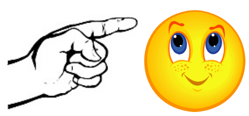
What is your child interested in and what motivates him/her?___________________________

____

Appendix D

Visual reinforcement chart for the skill *Initiate Distal Point with Gaze Shift*

I point at something and look at my friends to show them what I see.

 Point and look	 Point and look	 Point and look	 Point and look
 Point and look	 Point and look	 Point and look	 Point and look
 Point and look	 Point and look		

Appendix E

Hypothetical Intervention Session (Targeting *Initiate Distal Point)*

DTT Portion (5-10 minutes)

- Setting: The interventionist places pictures on the walls and ceiling around the table prior to the child entering the room.

- Prompting: When the child comes into the work area, the interventionist waits to see if the child will initiate a point to one of the pictures. If he does not, the interventionist models a distal point with coordinated gaze shift to the child and makes a comment about the picture "a truck!" She then waits to see if he will respond. If he does not respond, she then prompts with a verbal instruction such as "point at the pictures and look at me" or "you point". The amount of verbal instruction used varies by the child's level of language comprehension. If the child still does not respond, then the adult uses a slight physical prompt to the elbow to encourage the child to prompt. If the child does not respond, the adult next prompts a point by shaping the child's hand. Once a point to the item is established, the adult leans in toward the child to make eye contact.

- Reinforcement: Once the coordinated point with gaze shift is achieved, the interventionist provides specific praise "You pointed at the truck and looked at me! Great job! Here is a pointing sticker. Nice work!" If the child does not respond to the verbal praise and "sticker" (icon showing a point and look), then the adult will provide a quick break with an alternate toy such as a small light up ball.

- Intensity: Practice opportunities are provided in quick succession with approximately two acts per minute. After the child has been given 10 practice opportunities, the child is provided with a two-minute break to play with a toy at the table while the interventionist sets up toys for the play-based portion of the intervention.

Play-based Portion (20-25 minutes)

- Setting: The interventionist places several toy options on the floor. The items include toys that would encourage distal pointing. For example, a bean bag toss, push and go trucks, and projector flashlights could be set out. The child transitions to the floor and makes a toy selection. The adult follows the child's lead in play and models play that encourages distal pointing.

- Prompting and reinforcement: Same as the DTT portion.

- Intensity: The adult shapes or prompts the child to use a distal point with coordinated gaze shift approximately once per minutes for a total of twenty opportunities.