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Improving accuracy of joint attention assessment by extending the observation period after toy activation

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Improving Accuracy of Joint Attention Assessment by Extending the Observation Period After Toy Activation

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Abstract

The purpose of this study was to examine IJA [Initiating Joint Attention] scores of 34 children with autism [CWA] and 34 typically developing children [TDC] during and after toy activation. Composite scores summarized performance of three behaviors (gestures, eye contact, and vocalizations) across toys. Performance was evaluated during toy activation only, and two seconds and five seconds after activation. Results of the analysis indicated that for 13 out of 34 CWA and 13 out of 34 TDC, joint attention occurred within two seconds after the activation period. When observations included five seconds after the toy stopped, joint attention occurred for 22 of 34 CWA and 19 of 34 TDC. Extending the observation period after toy activation from 2-s to 5-s resulted in the number of joint attention initiations increasing. To obtain the most accurate assessment of joint attention behavior, observation and scoring should continue until five seconds after the activation period.

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According to the DSM-IV, autism is a pervasive developmental disorder characterized by impairments in social interaction, communication, and stereotypical behavior (APA, 1994). With respect to social deficits, the literature indicates that impairments in joint attention skills may be an early, reliable diagnostic characteristic of autism (Osterling & Dawson, 1994; Zwaigenbaum et al., 2005). Joint attention is the ability to "coordinate attention between interactive social partners in order to share an awareness of objects or events" (Mundy, Sigman, & Kasari, 1990, p. 115). Joint attention has been classified into two types of behavior: responding to a bid for joint attention (RJA) refers to appropriately following a gaze shift or gesture of another person, while initiating joint attention (IJA) refers to engagement in a gaze shift or gesture to direct the attention of another person to an interesting event (Jones & Carr, 2004). In addition, research suggests that joint attention may be correlated with later language development (Charman, 2003; Mundy et al., 1990).

This paper will outline the typical development of joint attention and the deficits present in children with autism. Of specific interest is the difficulty these children exhibit in orienting to social vs. nonsocial stimuli. Additionally, children with autism may display impairments in disengaging attention from one stimulus, in order to orient to a second stimulus. This relates to the initiation of joint attention, as attention must be shifted away from a salient, nonsocial environmental stimulus, and directed towards a social partner, which may be less salient. Further topics of discussion include the importance of joint attention in its contribution to later outcomes, a behavioral analysis of the subject, and the need for early intervention. Finally, a

comparison of assessment tools will indicate the need for procedural revisions to ensure accurate assessment of joint attention.

Development of Joint Attention

During typical development, joint attention emerges between 9 and 18 months of age (Bakeman & Adamson, 1984). The first of these responses to emerge is eye gaze shifts from an object in the environment to a familiar adult. Next, children begin to gesture, including reaching, pointing, showing, and giving. Gestures then occur in combination with combined with gaze shifts, and finally, vocalizations occur in combination with gestures and gaze shifts. Over time, these behaviors increase in frequency (MacDonald et al., 2006). As joint attention develops, responding becomes more complex. As children age, they engage more interactively with others (i.e., coordinated joint engagement) and spend more time attending to and engaging in verbal behavior (i.e., symbol-infused engagement; Adamson, Bakeman, Deckner, & Romski, 2009).

Deficits in Joint Attention

As noted above joint attention is one of the earliest noted deficits among children with autism. Osterling and Dawson (1994) retrospectively studied home videos of first birthdays and found that children later diagnosed with autism pointed, showed objects to another, oriented to their name, and looked at others less than typically developing children. Zwaigenbaum et al. (2005) prospectively examined behavioral risk markers in high-risk infants (i.e., older sibling diagnosed with autism). These indicators included eye contact, orienting to name, and social interest, or a sustained attending to social stimuli (Bryson, Zwaigenbaum, McDermott, Rombough, & Brian, 2008). When compared to the low-risk infant control group, differences were not seen at 6 months of age, but were apparent at 12 months. Additionally, the presence of

multiple risk markers at 12 months identified the majority of the infants that received an autism diagnosis at 24 months.

There is increasing literature on the specific nature of joint attention deficits in children with autism. Mundy, Sigman, and Kasari (1990, 1994) have found that developmental status affects the level of impairment. When compared to mental age (MA)-matched control groups of typically developing children and children with mental retardation, for the children with autism, the low-MA group demonstrated fewer joint attention behaviors than the high-MA group. Specifically, for high MA, the deficit was only evident in higher-level behavior (i.e., gesturing), while the deficit for the low-MA group was also apparent in lower-level behavior (i.e., eye contact). This trend was also obtained for IQ. For the children with autism, the lower-IQ group exhibited a greater deficit in lower-level behavior than the higher-IQ group, yet all children displayed deficits in higher-level behavior. Also, children with autism demonstrated fewer higher-level joint attention behaviors, when compared to language-matched and MA-matched control groups of children with mental retardation.

This research indicates that level of impairment is also dependent on the behavioral repertoire of interest (e.g., eye contact vs. gestures). Further studies supporting this finding have shown that children with autism had more severe deficits in IJA then RJA (Whalen & Schreibman, 2003). This greater impairment in IJA was particularly evident in children with autism when compared to typically developing children (MacDonald et al., 2006). Additionally, in contrast to previous literature, MacDonald and colleagues did not identify a consistent hierarchy for topographies of behavior. For both groups of children, some age groups demonstrated higher levels of gaze shifts, while other age groups demonstrated higher levels of

gestures. Though for all groups, both gaze shifts and gestures occurred more frequently than vocalizations, with the exception of the 4-year-old typically developing children.

One critical component in the development of joint attention is orienting towards and attending to multiple stimuli in the environment. However, previous research has shown that children with autism have more difficulty orienting to stimuli. Compared to typically developing children, those with autism were less likely to respond (e.g., look around, look at adult, vocalization) to a loud, animal-like sound or simulated distress of an adult (Bacon, Fein, Morris, Waterhouse, & Allen, 1998). Dawson and colleagues (1998, 2004) found that children with autism were also less likely to orient their attention to environmental stimuli, and this impairment was more pronounced for social vs. nonsocial stimuli. Specifically, when a nonsocial stimulus was presented (e.g., rattle, jack-in-the-box, timer beeping, phone ringing), children with autism were less likely to turn their head or eyes toward the stimulus, compared to typically developing or developmentally delayed children. Furthermore, this deficit was greater for social stimuli (e.g., name called, clapping, humming, whistle). In addition to being less likely to respond to bids for attention, children with autism were also less likely to follow a human head turn cue (Leekam, Lopez, & Moore, 2000). Other research found that this impairment of following a head turn was related to mental age (Leekam, Hunnissett, & Moore, 1998).

Difficulties in Orienting and Disengagement

These studies indicate that children with autism orient to stimuli differently than typically developing children or children with developmental disabilities other than autism. Past research has shown that this impairment may be due to overselectivity and difficulty responding to simultaneous multiple cues; however, this may be remedied through training (Schreibman, Charlop, & Koegel, 1982). More recent research suggests that difficulty orienting to social and

nonsocial stimuli may be related to interest. Adamson, Deckner, and Bakeman (2010) found that children with autism favored familiar objects over people and unfamiliar objects, when compared to typically developing children. Furthermore, this lower interest in people and unfamiliar objects was associated with greater deficits in joint attention.

One noteworthy study by Klin, Lin, Gorrindo, Ramsay, and Jones (2009) provides additional evidence of an impairment in orienting to stimuli of a biological nature. Compared to toddlers with autism, matched control groups of typically developing and developmentally delayed toddlers were more likely to demonstrate a preference to look at a visual display of typical human biological motion (i.e., a point-light animation of a live actor playing a game, such as peek-a-boo, versus an inverted orientation of the same animation played in the reverse sequence; each presented on half of the screen and accompanied by the same audio soundtrack). Instead, for the toddlers with autism, viewing of the animations was random. However, preferential viewing was correlated with and could be predicted by the level of audiovisual synchrony, "the synchronous occurrence of change in motion and change in sound" (p. 259). Thus, for an animation consisting of a pat-a-cake game, in which a clapping motion occurs simultaneously with sound, toddlers with autism did display preferential viewing for the upright animation. This research indicates that children with autism do not orient to biological stimuli in the same way as typically developing children.

Recent findings have also shown that difficulty orienting to stimuli may be due to an impairment in disengaging attention. When presented with a nonsocial stimulus (i.e., brightly colored geometric pattern) on a central computer screen, then a different stimulus was presented on a peripheral screen, children with autism took significantly longer to disengage attention from the central stimulus, compared to matched control groups of typically developing children and

children with Down syndrome (Landry & Bryson, 2004). Furthermore, the children with autism were more likely to completely fail to disengage from the central stimulus during the 8-s opportunity; however, if the central stimulus was turned off, their performance of shifting attention to the peripheral stimulus matched the control groups.

The ability to disengage attention typically develops by 3-4 months of age (Hood & Atkinson, 1993), so this may be one of the earliest indicators of autism. This is supported by the results of a longitudinal study of high-risk infants (i.e., older sibling diagnosed with autism), using the same visual orienting task to measure disengagement of attention (Zwaigenbaum et al., 2005). When compared to the low-risk infant control group, differences were not seen at 6 months of age, but were apparent at 12 months. Additionally, each of the infants that demonstrated decreased performance at 12 months received an autism diagnosis at 24 months. Collectively, this research indicates that disengaging attention and orienting to multiple stimuli—a central component to the development of joint attention—is a significant deficit in children with autism.

Joint Attention as a Predictor

Longitudinal studies have shown that joint attention may be a significant predictor of language development. Mundy et al. (1990) found that for children with autism, joint attention scores (though not initial language scores, age, MA or IQ) were correlated with later language scores. Additionally, Charman (2003) found that joint attention behaviors were positively correlated with later scores in receptive and expressive language, and negatively correlated with later measures of the severity of social and communication symptoms.

More recently, studies have shown that a specific form of joint attention contributes to language outcomes. Although a thorough description of states of engagement is beyond the

scope of the current research question, in brief, symbol-infused supported joint engagement is a state in which a child and partner are attending to a shared object, while the child is actively attending to language, but not explicitly to the partner. In typically developing toddlers, as well as children with autism and Down syndrome, the amount of time spent in this particular state of engagement predicts later differences in receptive and expressive language (Adamson, Bakeman, & Deckner, 2004; Adamson et al., 2009). This research provides evidence that the development of joint attention is critical to later outcomes of children with autism, and emphasizes the need for early intervention.

Analysis and Intervention

In working towards a behavioral analysis of joint attention in order to develop effective interventions, Dube, MacDonald, Mansfield, Holcomb, and Ahearn (2004) proposed a contingency analysis of gaze shift in IJA. The presence of a familiar adult may serve as a motivating operation under which the discriminative stimulus of an interesting object or event increases the reinforcing value of adult-attending stimuli, or indicators that the adult is aware of the event. These stimuli then serve as conditioned reinforcers for gaze shifting, and as discriminative stimuli for adult-mediated reinforcement. According to this analysis, deficits in IJA could be due to a failure to discriminate adult-attending stimuli, or to a lack of effectiveness of adult-mediated consequences. The latter is partially supported by data from a concurrent choice procedure which indicated preference for adult interaction was greater for typically developing children, and varied among children with autism. Holth (2005) extends this operant analysis to other joint attention skills (e.g., social referencing, protoimperative and protodeclarative gestures, and monitoring), provides examples of interventions based on this analysis, and calls for future experimental analyses of such interventions.

Although there is substantial literature on the nature of joint attention impairment in children with autism, studies of effective interventions are limited. RJA, in the form of following an adult's gaze shift, has been trained using a hierarchy of tasks and prompting procedures (Whalen & Schreibman, 2003). Gaze following was also trained using progressive delay of remote controlled toy activation as prompts and consequences (Klein, MacDonald, Vaillancourt, Ahearn, & Dube, 2009). Children with autism who received an intervention of a combination of discrete trial training and milieu teaching were more likely to respond to and initiate joint attention in a structured assessment, compared to children who had not received the intervention (Kasari, Freeman, & Paparella, 2006). For the children who received this intervention, a follow-up study reported significant language gains over the control group, supporting previous research linking joint attention to language skills (Kasari, Paparella, Freeman, & Jahromi, 2008). Taylor and Hoch (2008) used an intervention consisting of physical, verbal, and echoic prompts in a prompt delay procedure with social engagement as a consequence. RJA (follow a point, comment, and look back) was trained successfully; however, results for IJA (point and comment) were mixed. Finally, Isaksen and Holth (2009) also focused on social engagement, by establishing adult social responses of smiling and nodding as conditioned reinforcers. In addition, they used prompt fading and modeling to teach RJA and IJA in the context of turn-taking.

Assessment

Empirical studies examining joint attention have varied methods of assessment. Osterling and Dawson (1994) developed a behavioral coding system to score videos for the presence of developmentally appropriate behaviors, such as looking at another's face and pointing, and "specific autistic behaviors," such as stereotypical behavior and failing to orient to

name. For Charman's (2003) toy activation task, based on procedures described in previous research, the dependent measure was a gaze switch between the toy and the adult. Zwaigenbaum and colleagues (2005) developed the *Autism Observation Scale for Infants*, which examines the hypothesized risk markers in a standardized procedure.

One measure frequently used to assess joint attention is the Early Social Communication Scales (ESCS; Mundy et al., 1990; Whalen & Schreibman, 2003; Dawson et al., 2004). This is a tool designed to evaluate children's response to and initiation of joint attention behaviors, as well as to assess behavioral requests and social interaction behaviors (Mundy et al., 2003). Recently, the New England Center for Children (NECC) has adapted the ESCS to develop a behavioral assessment of joint attention (MacDonald et al., 2006).

For both assessment tools, the response definitions of the target behaviors are similar. For RJA, the target response is following the examiner's point. For IJA, there are three target responses: gaze shifts, gestures, and verbalizations. Both measures are also similar in content, though there are some differences in implementation. The RJA subtests include following the examiner's point to pictures in a book and to items in the room. The IJA subtests include looking at a book and toy activation.

One key difference between these two measures is the classification of a particular response as joint attention or manding. During the toy activation subtest, a toy is activated by the examiner in order to provide an opportunity for the child to initiate joint attention. When scoring the ESCS, if a child engages in a target behavior while the toy is active or up to 2 s after, the response is coded as IJA. However if the child engages in a target behavior more than 2 s after the toy has ceased, the response is coded as initiating a behavioral request (IBR), because it is suggested that "the function of these behaviors is to elicit supportive action or aid from the

partner in obtaining objects or events" (Mundy et al., 2003, p. 18). In contrast, when scoring the NECC assessment, if the child engages in the target behavior anytime during the activation of the toy, or up to 5 s afterwards, it is coded as IJA (MacDonald et al., 2006).

The literature indicates that children with autism have a deficit in disengaging their attention and orienting to multiple stimuli, particularly social stimuli, leading to the hypothesis that this impairment may inhibit the initiation of joint attention during the activation of the toy, but then this behavior may be exhibited several seconds after the toy has ceased. The purpose of the current study was to examine the responses, specifically vocalizations, that occur after the activation period of a toy during a behavioral assessment of joint attention. We propose that increasing the interval during which responses are recorded will reflect a more accurate IJA score. Additionally, we intend to identify the function of vocalizations as either a tact (i.e., comment or label) or a mand (i.e., request) for the toy. We hypothesize that children will be more likely to exhibit a tact than a mand for the toy. That is, children will be more likely to coordinate their attention with the examiner for the purpose of sharing the event, thus engaging in IJA, and less likely to seek assistance in gaining access to it, thereby requesting.

Method

Participants

Participants for this study included 34 children diagnosed with autism (30 male, 4 female) and 34 typically developing children (20 male, 14 female). The mean chronological age for the children with autism was 58 months (range, 26 to 93 months). The mean chronological age for the typically developing children was 46.5 months (range, 23 to 68 months). Participant characteristics, and developmental evaluation scores when available, are shown in Table 1 for children diagnosed with autism and Table 2 for typically developing children.

The children with autism were enrolled in the preschool component (24 male, 4 female) or home-based component (6 male) of the NECC's Intensive Instruction Program, an intensive behavioral analytic treatment program. All children were diagnosed independently by professionals not associated with the treatment program. The typically developing children were enrolled in a daycare preschool classroom onsite at NECC. Consent was obtained for all participants.

Setting and Materials

Assessments of joint attention were conducted in a testing room (approximately 3 m x 5 m) near the children's classrooms. For the six children in the home-based program, assessments took place in the area of their home where they received 1:1 instruction. There were two small chairs, a small table, and a shelf with various toys and books. During the assessment, the child and the examiner sat facing one another diagonally across a corner of the table. A video camera, which captured the front image of the child and the profile of the examiner, was operated from behind a curtain in the room to record all sessions. A curtain was not present for home-based assessments.

Materials for the assessment included four items, one for each subtest. The first subtest included either a toy fish or a toy bunny. The life-size fish was mounted to a board. When activated by a switch, music played, while the head, mouth, and tail of the fish moved, and it appeared to sing (i.e., Big Mouth Billy Bass™). The bunny stood upright with a drum fastened to its neck, and held drumsticks in its paws. When activated by a switch, the paws moved to play a rhythmic beat on the drum. The second subtest included a book with large, clear pictures of common household items, such as socks and a cat, common farm animals, such as a horse and a pig, or common zoo animals, such as a zebra and a lion. The third subtest included a small,

handheld, wind-up toy, either a crab, grasshopper, caterpillar, or bird. When wound up and set down on the table, the toy either moved across the table (i.e., caterpillar walked, grasshopper jumped), and/or parts of the toy moved (i.e., bird pecked in place, crab walked and moved pincers). The fourth subtest included either a toy robot or a toy one-man band. When activated by a switch, both toys played music, moved in circular patterns, and flashed bright lights. Additionally, parts of the one-man band moved, so he appeared to play the attached instruments (i.e., drum and cymbals).

Measurement and Data Collection

Three dependent variables were measured during each of the four subtests: (a) gaze shift, (b) pointing, and (c) vocalizations. For the three activation toys—subtests 1, 3, and 4—data were collected for the entire activation period, which was defined as the duration that the toy was active (M = 16 s; range, 6-33 s), and for five seconds after it had stopped. For the book—subtest 2—data were collected for the duration that the book was presented on the table, until it was removed.

A *gaze shift* was recorded if the child looked at the target object, then looked directly from the object to the examiner. Subsequent gaze shifts were recorded if the child then looked from the examiner directly back to the object. A gaze shift sequence consisted of consecutive gaze shifts back and forth between the toy and the examiner. A gaze shift sequence ended if the child looked away from either the object or the examiner. If the child again looked at the object, then directly at the examiner, a new gaze shift was recorded.

Pointing was recorded if the child gestured in the direction of the toy, or a picture in the book, with an isolated finger, though not necessarily the index finger. The occurrence of a point was recorded for each gaze shift sequence during the activation period.

A *vocalization* was recorded if the child made an intelligible comment or question about the toy or book. All vocalizations were transcribed during the activation period. Additionally, vocalizations that functioned as requests for the toy were differentiated from other vocalizations, including commenting and asking for information. *Requesting* was defined as a mand for an object or action. Examples included asking for a turn ("I want to play with that," "Can I try?"), asking for more ("Again"), and requesting the experimenter to engage in an action ("Press that button," "Let go"). *Commenting* was defined as a tact or a mand for information. Examples included labeling an item or its features ("Fishy," "He has sharp claws"), labeling an action or event ("The fish is singing," "It turn off"), exclamations ("Cool," "Hooray"), joint referencing ("Look, a robot," "Hey, look at that guy"), and asking questions to obtain information ("Wow, what is it?," "Where is he going?).

Interobserver Agreement

An independent observer scored 22 samples (32%) for comparison with the scoring of the primary data collector. An agreement was defined as identification by both observers of the occurrence or nonoccurrence of a target response, for each of the three dependent variables during each of the four subtests. Interobserver agreement (IOA) was calculated by dividing the number of agreements by the number of agreements + disagreements, and multiplying by 100%.

For the samples of joint attention behavior of children with autism, overall mean IOA was 93% (range, 75-100%). For the first subtest, IOA was 100% for gaze shifts, 100% for pointing, and 90% for vocalizations. For the second subtest, IOA was 90% for gaze shifts, 90% for pointing, and 80% for vocalizations. For the third subtest, IOA was 90% for gaze shifts, 90% for pointing, and 100% for vocalizations. For the fourth subtest, IOA was 90% for gaze shifts, 100% for pointing, and 100% for vocalizations.

For the samples of behavior of the typically developing children, overall mean IOA was 98% (range, 83-100%). For the first subtest, IOA was 100% for gaze shifts, 100% for pointing, and 92% for vocalizations. For the second subtest, IOA was 100% for gaze shifts, 92% for pointing, and 100% for vocalizations. For the third subtest, IOA was 100% for gaze shifts, 100% for pointing, and 100% for vocalizations. For the fourth subtest, IOA was 100% for gaze shifts, 92% for pointing, and 100% for vocalizations.

Procedure

The assessment used to evaluate the initiation of joint attention during toy activation included four subtests, taken from the NECC joint attention assessment. The present assessment took approximately 5 min to administer. Examiners were supervisors or teachers in the treatment program, but were not involved in the participants' treatment on a daily basis.

Prior to the assessment, the examiner brought the child into the room and allowed them to play with some toys on the floor or on a shelf near the door, for approximately 2 min. Then the examiner instructed the child to sit at the table. If the child asked for more time playing with the toys, this request was honored, and the examiner allowed an additional minute of free play before presenting the instruction again. If the child did not comply with the instruction, least-to-most prompting was used to guide the child to the table, progressing from gestures to vocal prompts to a light physical touch on the shoulder.

When the child was seated at the table, the examiner conducted a brief stimulus preference assessment of either edibles or toys to identify one preferred item (DeLeon & Iwata, 1996). This item was delivered between subtests, independent of the child's responding, and was presented in conjunction with praise for sitting nicely.

After the stimulus preference assessment, the examiner conducted the assessment to evaluate initiation of joint attention, which consisted of four subtests. If the child attempted to stand up or leave the table at any time during the assessment, the examiner prompted the child to stay in the chair by using vocal instructions, and if necessary, physically blocking escape or physically guiding the child's chair back under the table.

For the *first subtest*, the toy fish or bunny was located on the table, in front of the child but out of reach, approximately 1 m from the child. When the examiner determined that the child was not looking directly at the toy, she activated the toy using her foot to operate a switch located on the floor under the table. When the toy had been active for approximately 15 s, the examiner removed her foot from the switch to discontinue activation, and continued to observe the child for 5 s. At this time, the examiner removed the toy from the table.

For the *second subtest*, the examiner presented an open book on the table directly in front of the child and within the child's reach, approximately 10 cm from the edge of the table. Upon presentation, the examiner said, "What do you see?" or "Let's look at the book." The examiner allowed the child to turn the pages or touch the book, but did not allow the child to close the book. If this was attempted, the examiner held the book open with her hand. After approximately 20 s, the examiner removed the book from the table.

For the *third subtest*, the examiner held the hand-operated toy under the table while she wound it up. When it was completely wound up, she set it down on the table, in front of the child but out of reach, approximately 1 m from the child. When the toy stopped moving on its own, after approximately 15 s, the examiner continued to observe the child for 5 s. At this time, the examiner removed the toy from the table.

For the *fourth subtest*, the examiner discreetly removed a blanket that had covered either the robot or the one-man band, which was located to the right side of the child, either on the floor or on a stool, approximately 1 m from the child. This toy had been placed on an inverted frisbee, in order to restrict the circular movements to that location. The blanket was not present for home-based assessments. When the examiner determined that the child was not looking directly at the toy, she activated the toy using her foot to operate a switch located on the floor under the table. When the toy had been active for approximately 15 s, the examiner removed her foot from the switch to discontinue activation, and continued to observe the child for 5 s.

For the duration that the toys were active and for 5 s after (and for the entire presentation of the book), if the child engaged in any of the target responses (i.e., gaze shift, point, or vocalization), the examiner acknowledged the child with positive affect, a brief verbal comment (e.g., “It’s a fish” or “He’s singing”), and shifted eye gaze from child to toy. If no target behavior occurred, the examiner remained silent.

At the conclusion of the assessment, the child was allowed access to toys if requested, either the toys from the assessment or the toys on the shelf from the free play period. Then the examiner escorted the child back to the classroom.

Results

For the purposes of summarizing the data, a composite score was calculated for each child. One point was given for each target response performed on each subtest, so for each subtest there was a total of three possible points (MacDonald et al., 2006). Since there were four subtests, the total possible score was 12.

For this study, three composite scores were created for each child: one that consisted of responding during activation of the toy; one that included responding within 2 s after the toy had

stopped; and, one that included responding within 5 s after the toy had stopped. It should be noted that if the child engaged in a response both during and after activation, the score would remain unchanged. Only in instances when a response occurred after, but not during, the activation of the toy, would the score increase. For example, if a child said, “It’s a robot” during the activation period, then said, “Cool” afterwards, the score would remain 1 for that subtest. However, if a child stayed silent during the activation period, then said, “Did you see that?” afterwards, the score would increase from 0 to 1 for that subtest. It should also be noted that although the book subtest was included in the assessment, there was no activation period. Therefore, all scores for the book subtest remained unchanged.

Figure 1 depicts the average scores (median scores are in parentheses) for the children with autism, ranging from 0 to 9. During activation, scores averaged 3.4 (*Mdn* = 3), scores including 2 s after activation averaged 4 (*Mdn* = 4), and scores including 5 s after activation averaged 4.6 (*Mdn* = 4).

Figure 2 depicts the individual composite scores for the children with autism. By including behavior that occurred 2 s after the activation period, the composite score increased for 13 children. By including behavior that occurred 5 s after the activation period, the composite score increased further for 6 of those children, and also increased for an additional 9 children. In total, the composite score increased for 22 of 34 children by including 5 s after activation. Four of the scores that changed were due to a vocal request for the toy, with two occurring within 2 s and the remaining two occurring within 5 s. Six additional children made requests after the toy had stopped, two within 2 s and four within 5 s; however it did not change their composite scores because commenting also occurred during this period.

Figure 1 also depicts the average scores (median scores are in parentheses) for the typically developing children, ranging from 2 to 11. During activation, scores averaged 6 (*Mdn* = 6), scores including 2 s after activation averaged 6.5 (*Mdn* = 6) and scores including 5 s after activation averaged 6.8 (*Mdn* = 7).

Figure 3 depicts the individual composite scores for the typically developing children. By including behavior that occurred 2 s after the activation period, the composite score changed for 13 children. By including behavior that occurred 5 s after the activation period, the composite score increased further for 3 of those children, and also increased for an additional 6 children. In total, the composite score increased for 19 of 34 children by including 5 s after activation. Only one of the scores changed due to a vocal request for the toy, and this occurred within 2 s. Two additional children made a request after the toy stopped, one within 2 s and one within 5 s; however it did not change their composite scores because commenting also occurred during this period.

A paired t-test was performed to determine the effect of increasing the interval for observation from 2 to 5 s. For the children with autism, the mean increase in IJA score (M = .59, SD = .78, N = 34) was significantly greater than zero, t(33) = -4.38, two-tail p = .0001, providing evidence that increasing the observation interval produces greater IJA scores. A 95% C.I. about mean score increase is (3.73, 4.27). For the typically developing children, the mean increase in IJA score (M = .29, SD = .52, N =34) was significantly greater than zero, t(33) = -3.27, two-tail p = .002, providing additional evidence that increasing the observation interval produces greater IJA scores. A 95% C.I. about mean score increase is (6.29, 6.65).

We also compared the scores for the children with autism at 5 s to the scores for the typically developing children at 5 s, to test for statistical significance. A test for the equality of

variances indicated that the variances of the two groups were significantly different, $F = 2.05$, $p = .02$. Therefore, a two-sample t-test was performed that does not assume equal variances. The mean score for children with autism ($M = 4.59$, $SD = 2.71$, $N = 34$) was significantly less than the mean score for typically developing children ($M = 6.76$, $SD = 1.89$, $N = 34$) using the two-sample t-test for unequal variances, $t(59) = -3.84$, $p = .0003$.

We examined the scores that increased during the extended observation period (i.e., from 2 to 5 s) to identify the topographies of behavior responsible for this change. Figure 4 depicts changed scores for the children with autism. 67% were defined as IJA consisting of gaze shifts and pointing. 33% included a mand. Figure 5 depicts changed scores for the typically developing children. 100% were defined as IJA consisting of gaze shifts and commenting. When scores were graphed according to age, an increasing trend was observed among the typically developing children (See Figure 6). This trend was also present, but less apparent, for the children with autism (See Figure 7).

Finally, we analyzed scores by topography, depicted in Figure 8. As shown on the left, for the children with autism during toy activation, 76% engaged in gaze shifts, 47% engaged in pointing, and 65% engaged in vocalizations. By 2 s after toy activation, 79% engaged in gaze shifts, 47% engaged in pointing, and 68% engaged in vocalizations. By 5 s after toy activation, 79% engaged in gaze shifts, 56% engaged in pointing, and 68% engaged in vocalizations. As shown on the right in Figure 8, for the typically developing children during toy activation, 100% engaged in gaze shifts, 91% engaged in pointing, and 85% engaged in vocalizations. By 2 s after toy activation, 100% engaged in gaze shifts, 91% engaged in pointing, and 85% engaged in vocalizations. By 5 s after toy activation, 100% engaged in gaze shifts, 91% engaged in pointing, and 85% engaged in vocalizations.

Discussion

Results of this study support previous literature regarding an impairment in joint attention of children with autism (Osterling & Dawson, 1994; Zwaigenbaum et al., 2005). Composite scores for an assessment of initiating joint attention indicate a deficit in children with autism, as compared to typically developing children. Target behaviors included in the assessment were similar to those assessed in past research (i.e., eye contact, pointing).

In addition, the previous research on children with autism regarding difficulties disengaging attention from a central stimulus and orienting to multiple stimuli (Klin et al., 2009; Landry & Bryson, 2004) led to the hypothesis that this impairment may inhibit the initiation of joint attention during the activation of the toy, but then this behavior may be exhibited after the toy has ceased. Results of the present study support this hypothesis. By including data from after the activation period of the toy, the composite scores increased for 22 out of 34 children with autism. More specifically, only four of these changes were due to a vocal request for the toy. For the typically developing children, fewer composite scores changed, and only one of the changes was due to a request for the toy.

These results suggest that to obtain the most accurate assessment of joint attention behavior, observation and scoring should continue until 5 s after the activation period. Additionally, the data indicate that behavior occurring after the activation period of the toy is primarily joint attention, rather than manding for the object. However, manding did occur on occasion, so assessments of joint attention should continue to differentiate between vocalizations that function as commenting and those that function as requests for the toy.

For the purposes of this study, only vocalizations were scored as requests. It could be argued that gaze shifts and pointing occurring after the activation period also functioned as

requests for the toy. However, the low percentage of vocal requests from both groups of children suggests that is not the case. According to the ESCS, responding occurring more than 2 s after the activation period serves as a behavioral request, because it is assumed that the function is to seek assistance in obtaining the object (Mundy et al., 2003). In contrast, results of the present study indicate that these delayed responses frequently function as joint attention. Particularly for the typically developing children, we believe it is reasonable to assume that if children wanted assistance in gaining access to the toy, they would emit a vocal request, and this speculation may be generalized to vocal children with autism. We theorize that gaze shifts and pointing in this context, when not paired with a vocal request, function primarily as joint attention. That is, adult attention is the reinforcing consequence of the behavior, rather than access to the toy. However, this is beyond the scope of the current study.

Our analysis of scores by age supports previous research indicating increased responding across age groups (MacDonald et al., 2006). An increasing trend for IJA scores was observed among both groups of children; however, this was less apparent for the children with autism. Our analysis of scores by dependent variables of topography both does and does not support previous literature. Results for typically developing children corroborate research regarding the development of joint attention from gaze shifts to gestures to vocalizations (Bakeman & Adamson, 1984). In the present study, the highest percentage of children engaged in gaze shifts, followed by pointing, followed by vocalizations. Regarding children with autism, previous studies have been mixed with some research reporting a greater impairment in higher-level gesturing vs. lower-level eye contact (Mundy et al., 1994), while other research does not indicate such a hierarchy (MacDonald et al., 2006). In the present study, for the children with autism, the highest percentage of children engaged in gaze shifts, following by vocalizations, followed by

pointing. This finding provides further evidence of an impairment in joint attention for children with autism, and indicates how the skills demonstrated may differ from typically developing children.

The main findings of the current study lead to practical implications, both in the domains of assessment and intervention. In our field, accurate assessment is imperative to effective intervention. The current study provides evidence that allowing more time to initiate joint attention may partially overcome the deficit demonstrated by previous research of children with autism in disengaging from stimuli and orienting to stimuli, particularly social stimuli. That is not to say that extending the observation period will lead to typical responding; yet, accounting for this impairment may lead to responding that is more similar to typical levels. Thus, if assessments of joint attention are to be accurate, the scoring interval after activation must be increased. However, it will not be sufficient to merely increase the observation period. Assessments must place greater emphasis on identifying the function of behavior during this interval. It is necessary to confirm that observed responses are instances of joint attention, rather than manding for the toy.

Additionally, if interventions are to be as effective as possible, strategies for teaching joint attention may need revision. In order to account for the impairment in disengaging and orienting to stimuli, programming may be modified to allow adequate time for independent responding. This is relevant both before teaching—when probing the presence of a skill—and during teaching. For example, during baseline, if a skill is not demonstrated at 2 s but is demonstrated at 5 s, it may not be deemed necessary to teach. Additionally, if baseline indicates a skill is not present, the teaching procedures used must account for this impairment when delivering prompts. For example, if using a time-delay prompt procedure, it may not be

developmentally appropriate to prompt immediately. Conversely, one goal for intervention may be to decrease this deficit by improving reaction time. That is, decreasing the time it takes to disengage from and orient to stimuli may lead to levels of responding more similar to typical levels; however, that is an area for future research.

Limitations of this study include participant selection and procedural concerns. In future research, stronger validity will be achieved by matching the participants based on chronological age or developmental status. Additionally, greater reliability could be obtained by improving the consistency of the procedure, including the use of a single toy for each subtest (a variety of toys and books were used across children for each subtest) and the placement of toys in a single location (the toy in the final subtest was either on the floor or on a stool). Finally, in terms of the vocal instruction when presenting the book, two forms were used. By asking, "What do you see?" the examiner may have inadvertently prompted target responses that may not have occurred otherwise. This could be avoided by consistently using the phrase, "Let's look at the book," or possibly by not presenting any vocal response from the examiner upon presentation. In summary, this research provides evidence that behavior occurring after the toy activation period in a joint attention assessment functions primarily as joint attention, rather than manding for the toy. That is, behavior occurring after toy activation is generally maintained by the consequences of adult attention rather than gaining access to the toy, and should therefore be included in an accurate assessment. By extending the time that behavior is scored to 5 s, a more precise representation of a child's joint attention repertoire may be obtained.

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Table 1

Participant characteristics of children with autism

Participant	Gender	Chronological age (year: months)	PPVT MA	Mullens MA	Mullens DQ
JPS	M	2:02			
TPS	M	2:02			
BLN	M	2:09			
JCY	M	2:10			
JSA	M	2:10			
JNS	M	2:11			
RIS	M	3:06		11	28
ZZO	M	3:06		8	19
RBX	M	3:07		59	118
SEE	M	3:11	67	61	124
EBN	F	4:01	53	48	96
PIE	M	4:02		28	58
SRA	F	4:06		54	89
ALT	F	4:07		65	105
AND	M	4:08	31	33	55
JBK	M	4:09	25	22	29
PRO	M	4:10		49	75
JET	M	4:11		18	31
SAL	M	5:00	<24	19	31
CTC	M	5:02	42	43	72
LLO	M	5:07	27	25	36
WLG	M	5:08	55	40	65
JAG	M	5:10	48	50	70
CGU	M	6:01	77	62	86
KNE	F	6:01	74	50	69
MED	M	6:01	39	42	56
NNZ	M	6:02	38	41	55
SNE	M	6:02	51	44	59
MHF	M	6:03		47	57
TYX	M	6:05		28	34
MCF	M	6:08	32	32	39
TMO	M	7:09	48	43	84
KOL	M	6:10		27	31
OLY	M	6:11		41	47

Table 2

Participant characteristics of typically developing children

Participant	Gender	Chronological age (year: months)
JSY	M	1:11
ADE	F	2:00
CMH	M	2:00
JKS	M	2:05
NAM	M	2:06
SRO	F	2:06
SSE	F	2:06
OPS	M	2:07
EMN	F	2:11
AKR	F	3:00
JMO	M	3:00
DCN	M	3:03
RRY	M	3:06
DES	M	3:07
HMN	F	3:07
JCN	M	3:07
RMN	M	3:10
FIS	M	4:00
AMS	M	4:04
IVI	M	4:04
NOL	M	4:05
ABR	F	4:06
AML	F	4:07
JKA	M	4:08
LTH	F	4:10
ARE	F	5:00
KAD	F	5:01
OFD	M	5:01
MLB	F	5:02
AJW	F	5:03
TKH	M	5:03
BJM	M	5:05
CCN	F	5:07
CGA	M	5:08

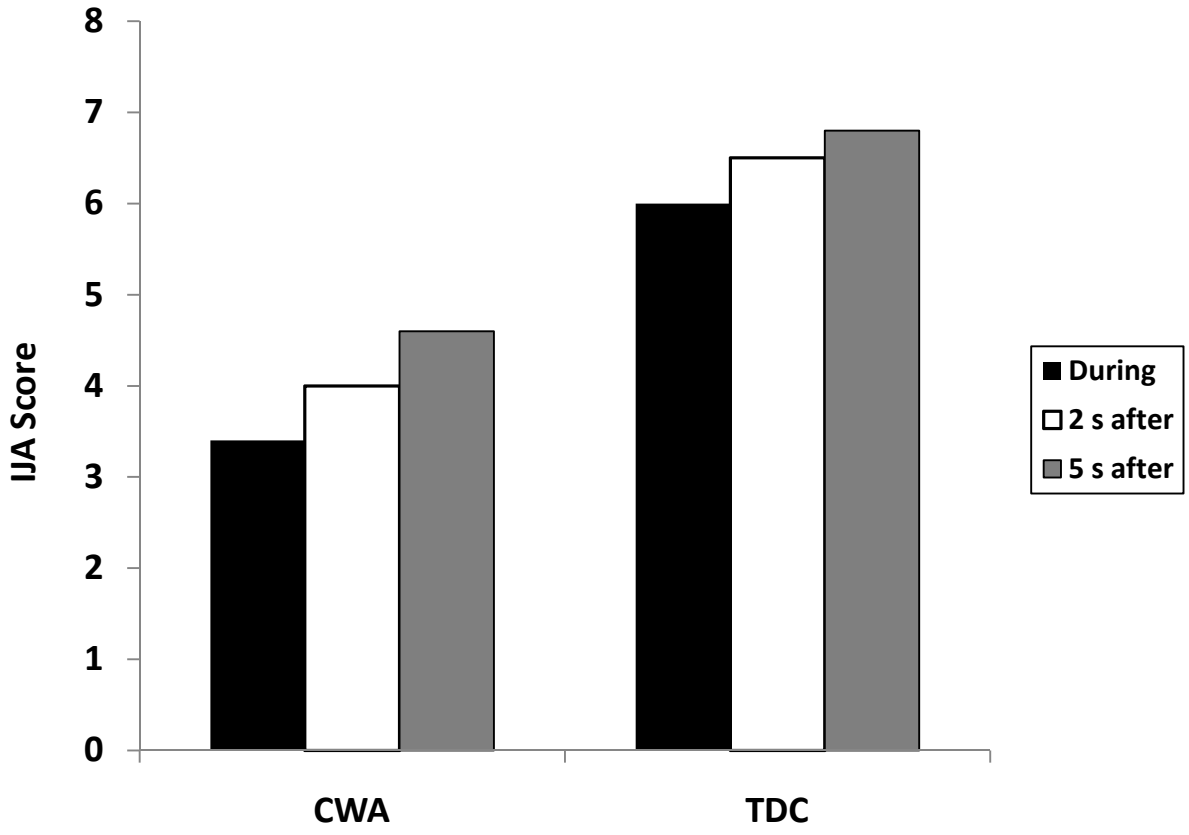

Figure 1. Average composite scores of joint attention assessment during toy activation (black bars), 2 s after (white bars), and 5 s after (gray bars), for children with autism (left portion of graph) and typically developing children (right portion of graph).

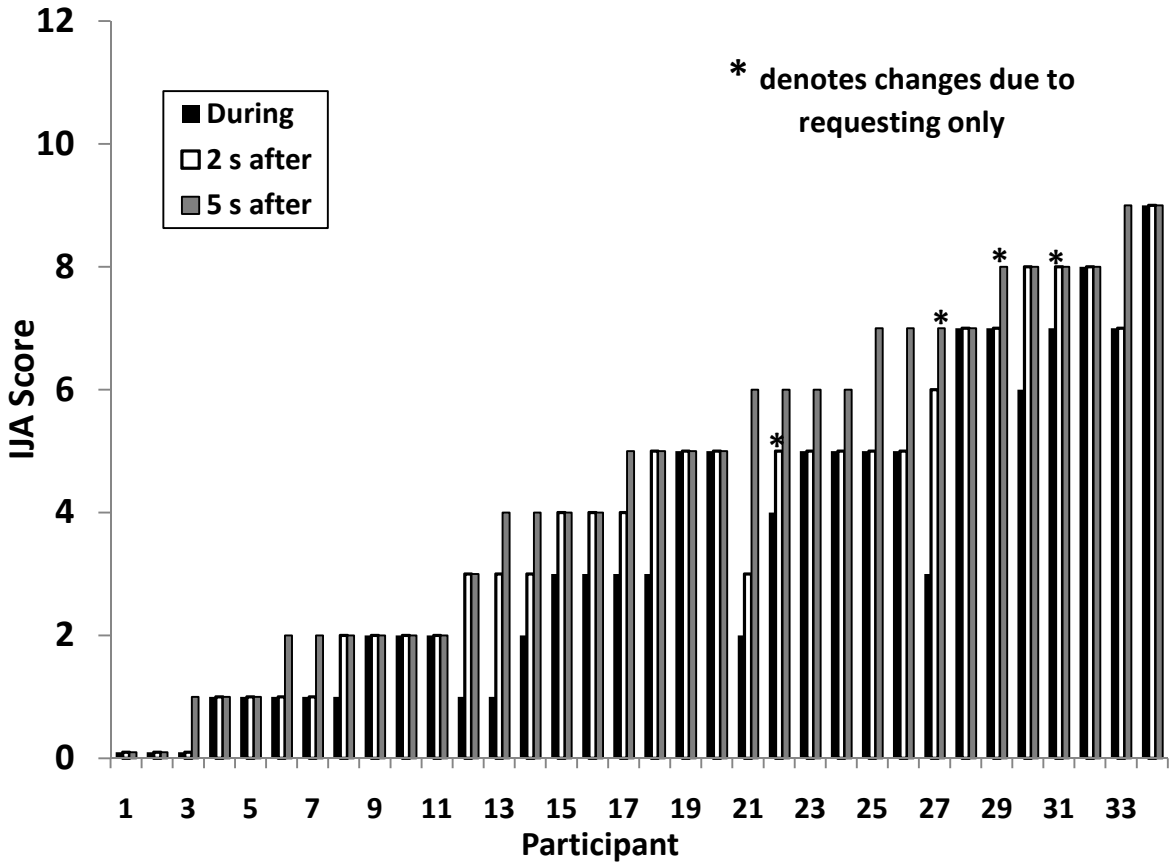

Figure 2. Individual composite scores of joint attention assessment for children with autism during toy activation (black bars), 2 s after (white bars), and 5 s after (gray bars).

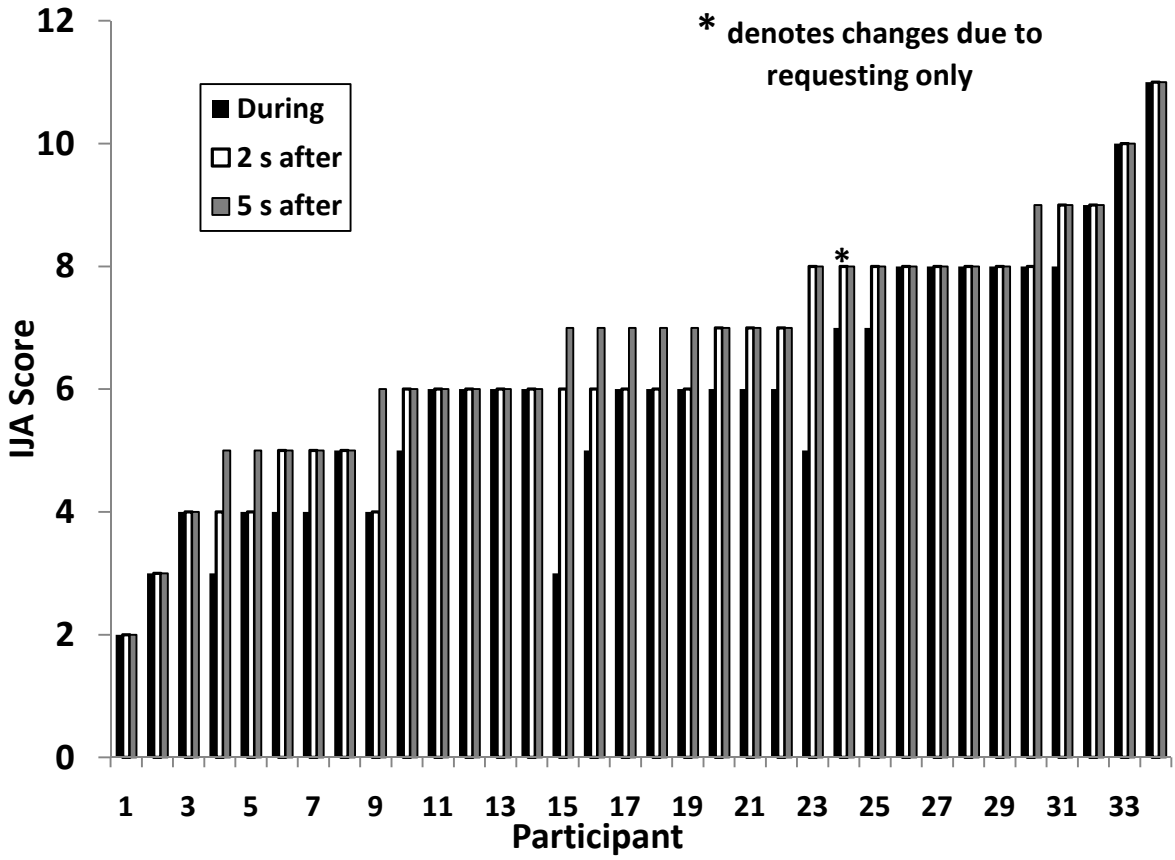

Figure 3. Individual composites scores of joint attention assessment for typically developing children during toy activation (black bars), 2 s after (white bars), and 5 s after (gray bars).

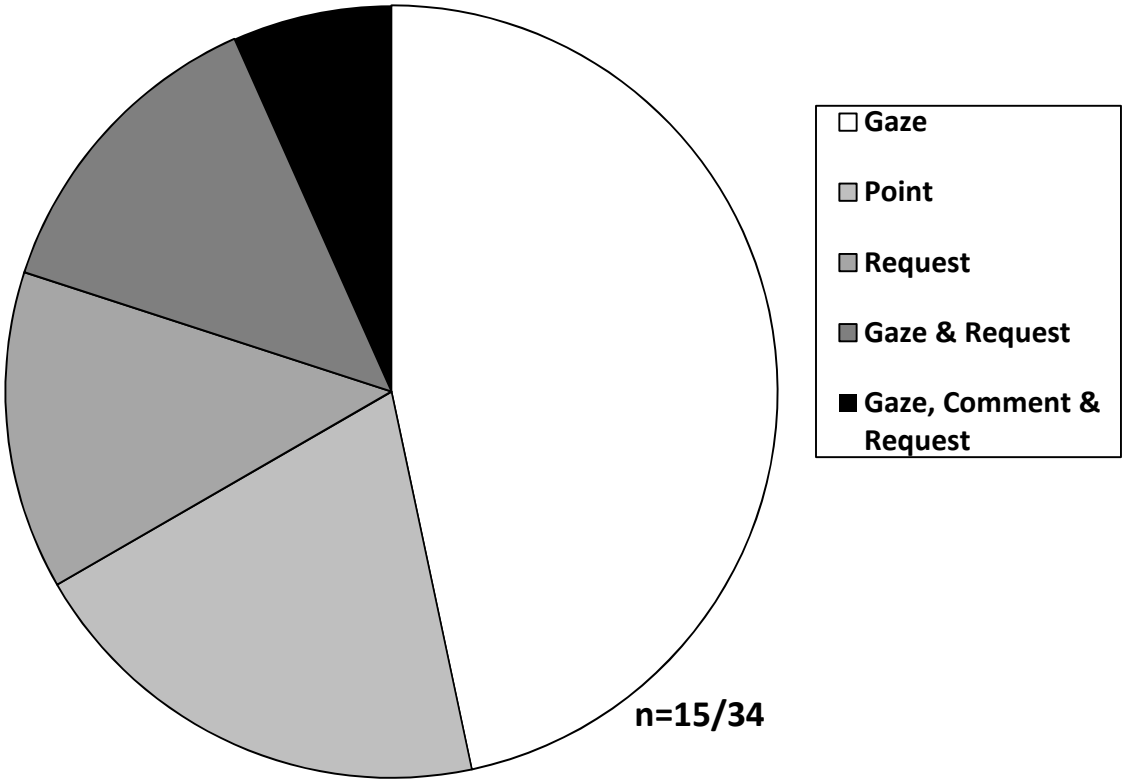

Figure 4. Percentage of response topographies that changed composite scores for children with autism, including gaze shifts (white segment), pointing (gray segment), requesting (light gray segment), a combination of gaze shifts and requesting (dark gray segment), and a combination of gaze shifts, commenting, and requesting (black segment).

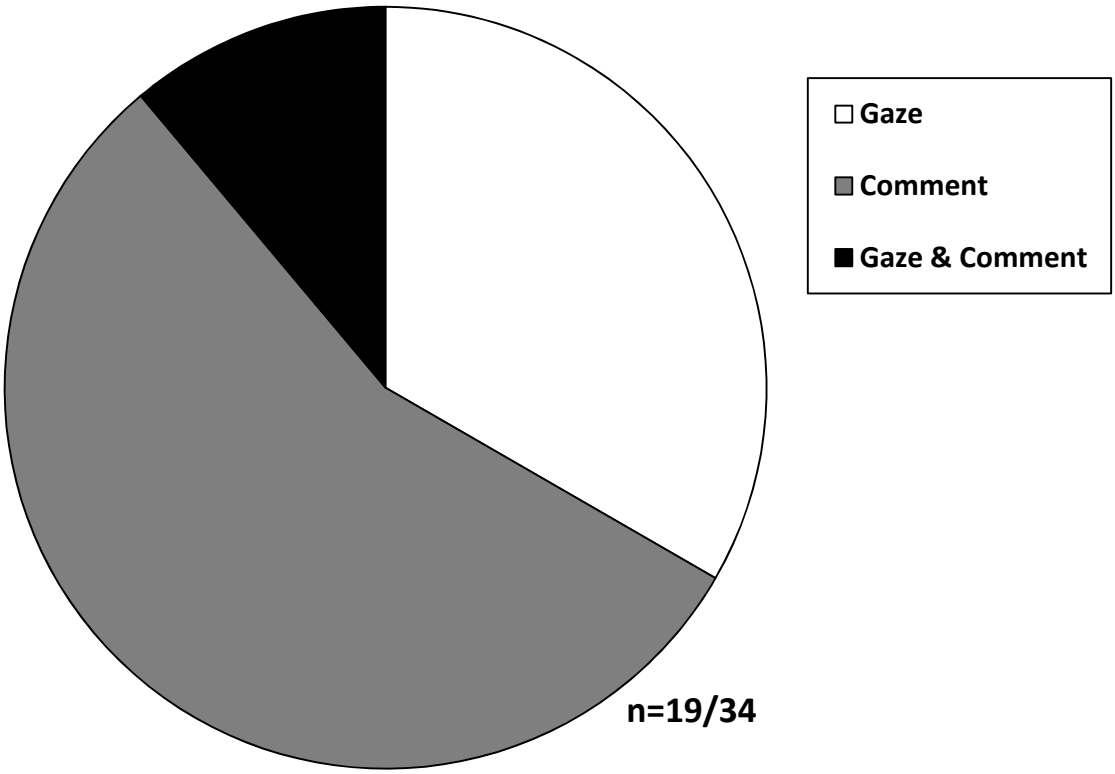

Figure 5. Percentage of response topographies that changed composite scores for typically developing children, including gaze shifts (white segment), commenting (gray segment), and a combination of gaze shifts and commenting (black segment).

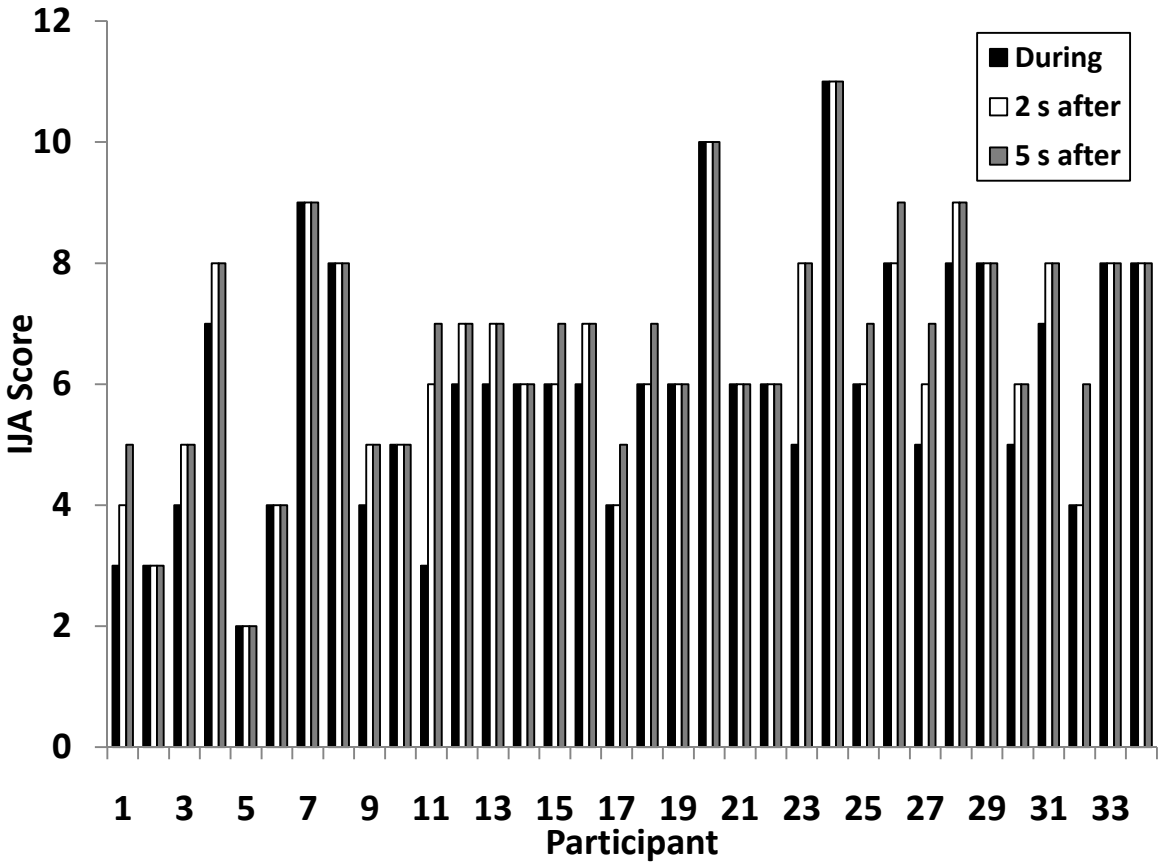

Figure 6. Individual composites scores for typically developing children according to age, of joint attention assessment during toy activation (black bars), 2 s after (white bars), and 5 s after (gray bars).

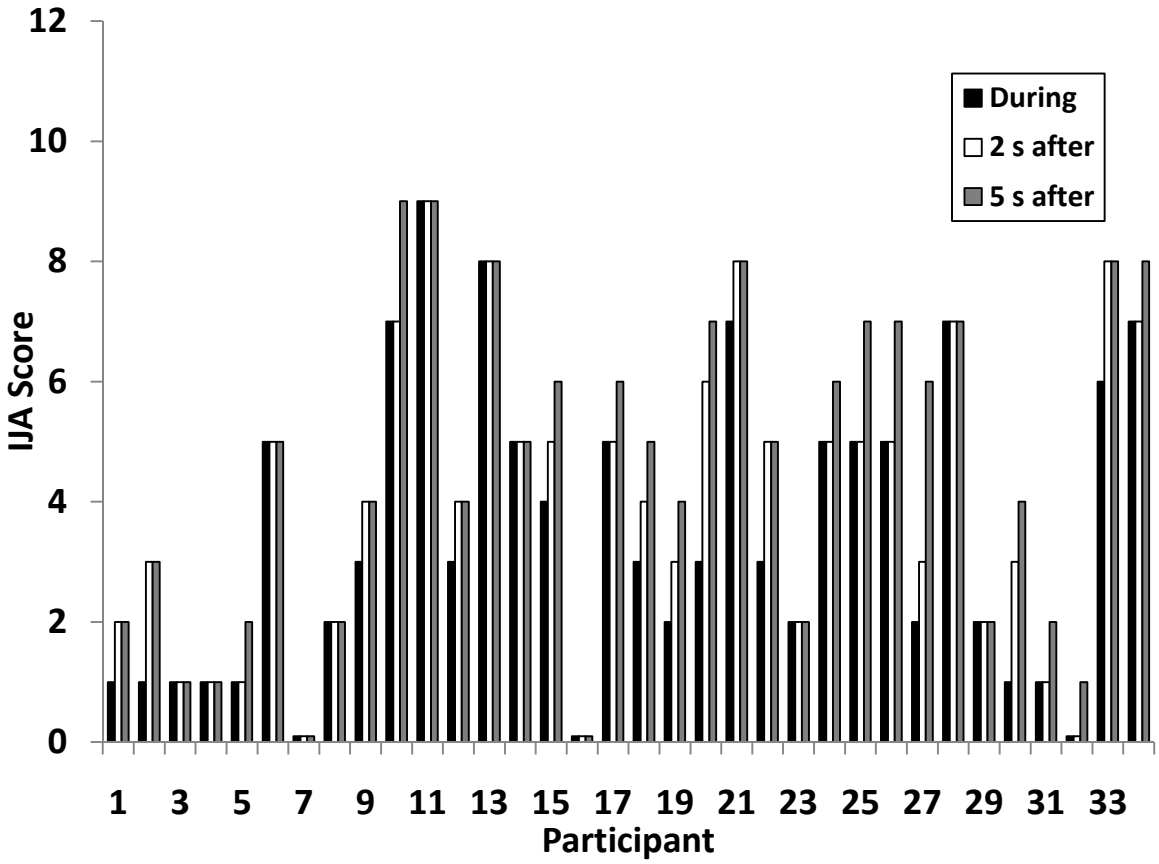

Figure 7. Individual composites scores for children with autism according to age, of joint attention assessment during toy activation (black bars), 2 s after (white bars), and 5 s after (gray bars).

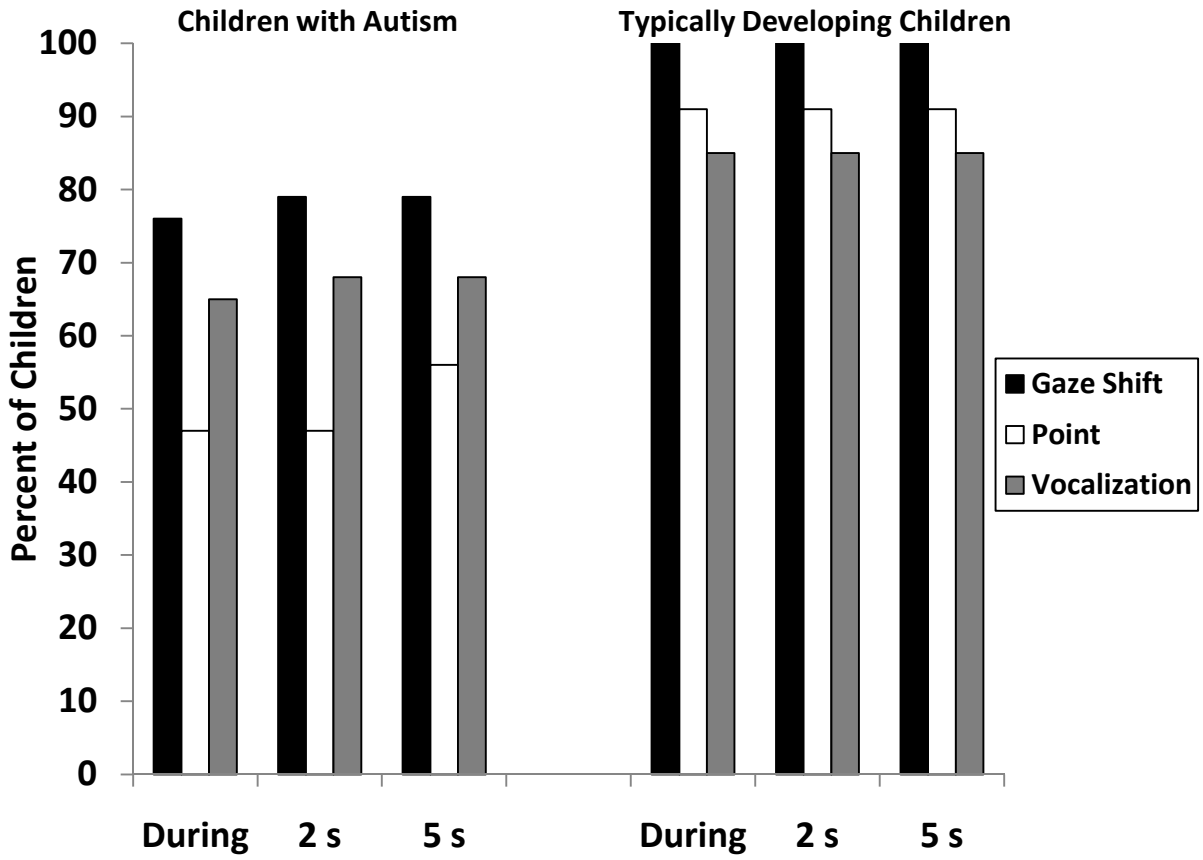

Figure 8. Percent of children demonstrating gaze shifts (black bars), pointing (white bars), and vocalizations (gray bars) during toy activation, by 2 s after, and by 5 s after, for children with autism (left portion of graph) and typically developing children (right portion of graph).