The Effect of Pairing Adult Eye Gaze With a Communication Device on the Frequency
and Duration of Joint Attention Episodes in Typically Developing Infants

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Julia L. Smith
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The Effect of Pairing Adult Eye Gaze With a Communication Device on the Frequency
and Duration of Joint Attention Episodes in Typically Developing Infants

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ABSTRACT

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The Effect of Pairing Adult Eye Gaze With a Communication Device on the Frequency and Duration of Joint Attention Episodes in Typically Developing Infants (83 pp.)

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Joint attention is critical for language development in children. Children with severe communication impairments requiring assistive technology have additional challenges in managing their joint attention and there is minimal information on how to reduce these demands. A within-subjects design was used to determine the effect of communication device placement, in relation to eye gaze, on the overall, as well as AAC device specific, frequency and duration of coordinated and passive joint attention episodes. Sixteen, typically developing infant-parent dyads participated in the study consisting of 2 storybook reading interactions. Device placement aligned with adult eye gaze resulted in significantly greater frequency and duration of coordinated joint attention than passive joint attention with the device. Younger infants engaged in more passive joint attention when the device was not aligned with gaze while older infants engaged in more coordinated joint attention when the device was aligned. Future directions and clinical implications are discussed.
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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

Introduction

More than 3.5 million Americans with disabilities have communication impairments so severe that their natural speech does not adequately meet their daily communication needs (Beukelman & Mirenda, 2005). Augmentative and alternative communication (AAC) options such as gestures, picture communication systems, and computer-based systems with synthesized voice output are available to help serve these individuals. The number of children requiring AAC is substantial. According to Binger and Light (2006), the prevalence of preschool children requiring AAC has increased over the past two decades. This survey study indicated that 24% of the children on a speech language pathologist’s (SLP) preschooler caseload in Pennsylvania required AAC (Binger & Light, 2006).

When implementing AAC methods, the attentional demands provide a significant challenge for beginning communicators (Light & Drager, 2006). Beginning communicators must not only monitor their communication attempts but also must attend to multiple foci (i.e., partner, AAC system, and shared activity) (Light, Parsons, & Drager, 2002). Minimizing the demands of AAC for infants and young children is essential because further advances in cognitive, social, and literacy skills are rooted in children’s early speech and language development (Light, 1997; Light & Drager, 2006).

Efficiently introducing AAC to beginning communicators and maximizing their early language development requires understanding of infants’ ability to engage in joint attention (JA). JA, which is the ability to share attention with persons and objects, is one
of the earliest forms of social communication that emerges between 9-15 months of age (Bakeman & Adamson, 1984; Carpenter, Nagell, & Tomasello, 1998). JA is important because it is significantly related to early language development, such as vocabulary size (Tomasello & Farrar, 1986). However, for some children and adults, the emergence of social communication and language skills does not follow the typical developmental trajectory. Therefore, early provision of speech and language services, including effective introduction of AAC, must take into account the JA abilities of the individuals. Only then can the intervention benefit the acquisition of language skills for such children (Light & Drager, 2006).

Literature Review

To understand the role of JA in AAC, it is important to review the history and theory of the related research. This review is divided into three sections: an overview of JA, beginning communicators and AAC, and JA and the position of an AAC device.

Joint Attention

Around one year of age, infants attain several social communication milestones such as following adults’ eye gaze, social referencing, which is the ability to monitor another’s reaction to an object or event before determining one’s own course of action, and the ability to imitate adults’ actions on objects. These skills represent the early stages of human social cognition and cultural learning (Tomasello, 1999). The common skill underlying each of these milestones is the ability to coordinate attention between an adult and an object or other person (Bakeman & Adamson, 1984; Tomasello, 1999). The frequency, duration, and percentage of time infants spend jointly engaged with other
people and objects, increases between 6 to 18 months (Bakeman & Adamson, 1984; Carpenter et al., 1998).

Bakeman and Adamson (1984) define JA as the ability to attend to an object of common interest at the same time another individual is attending to the same object. Carpenter, Nagell, and Tomasello (1998) assert that JA reflects early social cognitive skills. In order to engage in JA, the child must understand that others are intentional beings who are able to control their own behavior and make choices to help them attain and pursue desired outcomes. Infants comprehend new language by understanding the adult’s focus of attention within the environment (Carpenter et al., 1998).

Although variations exist in the terminology researchers adopt in the JA literatures, the types of JA discussed are conceptually similar. Carpenter and colleagues (1998) discuss three forms of JA including sharing attention, following attention, and directing attention. These three types of JA overlap with Mundy and Gomes’ (1998) discussion of two types of JA skills: responding to joint attention (RJA) and initiating joint attention (IJA). RJA refers to the child’s ability to follow a line of regard and gestures (Mundy et al., 2003). IJA refers to the frequency with which the child uses eye contact or gestures to initiate an interaction of shared attention (Mundy et al., 2003). Carpenter et al.’s (1998) types of JA, including sharing, following, and directing, are closely related to Mundy et al.’s (2003) concepts of RJA and IJA. As defined, RJA includes sharing and following attention abilities, whereas IJA includes directing attention skills.
Carpenter and colleagues’ (1998) investigation of the emergence of three forms of JA, including sharing attention, following attention, and directing attention, revealed that social cognition and communication skills developed in close synchrony between the ages of 9-15 months. Five specific social-cognitive skills were identified as representations of the three types of JA including joint engagement (sharing attention), attention-following and imitating learning (following attention), and communicative gestures and referential learning (directing attention). Further, a general order of the mean age of emergence (AOE) of these developing skills was established, From joint engagement (mean AOE = 9.0 months), communicative gestures emerged (mean AOE = 10.3 months); from attention-following (mean AOE = 11.5 months), imitative learning emerged (mean AOE = 11.9 months), and thereafter, referential language (AOE = after 15 months) emerged. The skills emerged rapidly and were only measured monthly, yielding low variability in the AOE of each skill. Despite low variability, intercorrelations among these skills were identified.

As stated, JA skills, including sharing, following, and directing attention emerge predictably during the first two years. Specifically, Bakeman and Adamson (1984) identified two types of developing JA: passive and coordinated. Passive joint attention (PJA) is the ability to attend to an object at the same time another individual is attending to the object but without any attempts to interact with the other individual or provide evidence he/she is aware the other person is also engaged. Coordinated joint attention (CJA) is characterized by shifts in an individual’s attention between an object of common interest and another individual who is also attending to that object. The individual
demonstrates awareness of the other person’s presence by alternating his or her eye gaze between the communication partner and the object, or by talking about the object or event of joint interest. Bakeman and Adamson (1984) illustrated the awareness involved in coordinated JA in the following example: “the baby pushes the truck the mother has been pushing and then looks back and forth between the mother’s face and the truck” (p. 1281). The authors reported that of the two types of JA, PJA is the least demanding of the child and clearly emerges before CJA (Bakeman & Adamson, 1984).

The importance of both types of JA for language development is well documented. Tomasello and Todd (1983) found that variations in JA abilities from 12 to 18 months were related to differences in later language growth as indexed by the infants’ vocabulary development at 19 months. This relationship was further investigated by Tomasello and Farrar (1986) who found that the frequency of follow-in references (the maternal references to objects of their children’s current interest) at 15 months was positively correlated to the child’s vocabulary at 21 months of age. In contrast, the frequency of references made outside their child’s focus (directive references) was negatively correlated with later vocabulary measures (Tomasello & Farrar, 1986). Similarly, Carpenter et al. (1998) discovered that during the middle months of their study, particularly the 12-month session, the infants’ comprehension and production of language was strongly related to the use of maternal language that followed into the infants’ already established attentional focus.

Further investigations attempted to clarify the relations between specific joint attentional skills and later language development. To illustrate, using the Reynell
Developmental Language Scales (Reynell & Graber, 1990), Mundy and Gomes (1998) reported that RJA was significantly related to receptive language skills, whereas IJA was significantly related to expressive language skills. Carpenter et al. (1998) also found that language comprehension skills from 9 to 15 months were positively correlated with joint engagement abilities (sharing attention). In contrast to prior investigations, they did not find that joint engagement abilities were significantly correlated with language production.

Markus, Mundy, Morales, Delgado, and Yale (2000) found that measures of RJA at 12 months of age were related to child/caregiver interactions, including frequency of JA episodes at 18 months of age, both of which were positively related to later expressive and receptive language development (as reported using the MacArthur Communication Development Inventory, Fenson et al., 1991) at 21 and 24 months of age. Taken together, these key studies suggest that child/caregiver engagement in JA interactions significantly affects language development during the toddler years.

In summary, the literature on JA in typically developing populations of children demonstrates three key findings. First, the frequency and duration of JA during caregiver-child interactions emerges reliably during the first two years of life. Second, these skills in responding to and initiating JA within experimental contexts and caregiver-child interactions relates to early language development. Finally, parental follow-in behaviors (e.g., caregiver behaviors which follow into their child’s present attentional focus) are positively related to language outcomes as opposed to directive behaviors (e.g., caregiver behaviors directing their child’s attentional focus away from current objects of interest).
Implementing AAC systems with beginning communicators is challenging, yet not an effort that should be abandoned. The positive effects of implementing AAC for speech production are well supported (Millar, Light, & Schlosser, 2006). In a systematic review of 27 methodologically-sound cases published, AAC interventions did not result in decreases in speech production for any of those individuals. In contrast, AAC interventions resulted in speech production increases for the majority of the individuals (Millar et al., 2006). Based on these results, implementing AAC with beginning communicators and finding the most effective means to introduce these interventions is of utmost importance.

Many of the children requiring AAC face additional challenges beyond communication impairments such as impaired motor skills. As a result, the social interaction experiences, including JA routines, of many children using AAC may be different from the experiences of typically developing infants. Light and Kelford Smith (1993) revealed that these children spend a greater amount of time in daily care routines, such as feeding, when compared to their non-disabled peers. Therefore, the children requiring AAC have less time for play interactions and fewer opportunities to interact and achieve social closeness. These children may have more limited access to their environment and reduced opportunities for communicating and establishing relationships (Light & Drager, 2006). Consequently, the quality of the time spent in these types of play interactions must be maximized.
There are few data available on JA abilities of children with severe communication impairments requiring AAC. However, it is known that communicating via AAC creates additional demands on JA particularly when an aided (i.e., external) system, rather than a gestural system, is added to interactions to assist with communication (Cress, 2002).

For beginning communicators, the demands of typical language development are compounded by demands requiring the coordination of attention to multiple foci, including the object of interest, the adult, and the AAC system (Light et al., 2002). Implementing AAC devices with beginning communicators requires more than the standard coordinated, triadic JA. Due to the current design of devices, the demands for using AAC during play are quadratic. This type of interaction requires a joint episode attempt among the child, the communication partner, the device, and the target object, such as a toy or book. The interaction also frequently involves directive references by the adult communication partner to guide the child to use the communication system despite literature findings that directive references are negatively related to vocabulary development (Tomasello & Farrar, 1986).

In addition to the direct attentional demands, the asymmetry of the receptive and expressive language systems when using AAC exacerbates the challenges for beginning communicators (Smith & Grove, 2003). Children learning AAC are frequently expected to use their device, or alternative system, as a means of expression, yet they are equally expected to comprehend spoken language (Light, 1997). This asymmetry does not match
typical language development patterns when the child’s communication modality (speech) is the same as the adult model (speech) (Goosens, 1989).

Binger and Light (2007), supported communication partners’ use of AAC models to help ease the demands of learning an asymmetrical system. This created yet another challenge in the implementation of AAC for beginning communicators. For communication partners to serve as models of the AAC system and promote further language development, they must be more fluent with the augmented system than potential users (Kaiser, Hester, & McDuffie, 2001).

Light, Collier, and Parnes (1985) reported that, during play routines with preschoolers and their caregivers, the preschoolers used their AAC systems infrequently because communicating required them to leave the play interaction. Similar results have been found during story reading interactions in which the children do not have access to their communication mode during the activity; therefore, they do not participate (Light, Binger, & Kelford Smith, 1994). Light et al. (1994) attempted to explain these situations by stating that it is difficult for parents and caregivers to handle the child, the AAC device, and the target object (e.g., book or toy) and still maintain social closeness during the interaction.

Consequently, the addition of an AAC device has important benefits for language but may potentially increase the demands of the interaction for both communication partners in terms of establishing and maintaining JA among the social partners, the AAC device, and the target object. Given the increased complexity of the social interactions, it is critical to develop strategies to reduce attention demands and maximize interactions.
Joint Attention and the Positioning of AAC

A potential strategy for reducing the JA demands of implementing aided AAC with beginning communicators involves manipulating the positioning of the device during an interaction. Work by Butterworth and Cochran (1980) found that between the ages of 6-18 months of age, infants are much more likely to engage in joint visual attention if the target is within their visual field. The authors found that infants consistently located targets with 40° of their midline to either side, but 75° from midline was the maximum distance they could variably locate targets. Infants were capable of following adult eye gaze, but could only successfully fixate on a target if it was within their visual field when using their peripheral vision.

Clibbins (as cited in Clibbens & Powell, 2003), asserted that using a visually based modality of language places greater emphasis on JA abilities. Visual communication, such as signing or using a graphic communication board, is most effective when it is in the direct line of sight of the individual (Clibbins & Powell, 2003). However, individuals using speech-generating devices must share their visual attention with the device in order to generate a message, which thereby increases the demands on users beyond those typically placed on speakers.

Some suggestions for reducing the attention demands for early AAC users have been recommended. Clibbens et al. (as cited in Clibbens & Powell, 2003) reported that the parents in child/parent dyads using sign as a modality for communication actually sign in the child’s line of sight or use the child’s body as the prop for the signs. Although this is effective for individuals who sign, it is not as easily accomplished with an aided
One suggestion by Light and Drager (2002) is to bring play aspects of children’s lives into AAC technologies. Although this is an exceptional idea to help in reducing the learning demands, it still creates challenges related to JA.

The concept for reducing the attention demands of beginning communicators using AAC by pairing the variables could be further developed by pairing other variables in the interaction. Instead of pairing the toy and the device as guided by Light and Drager (2002), another option is pairing the adult’s eye gaze and the device. This coupling may also lessen the quadratic demands of the interaction (Light, 2007).

Research Objectives

Although the JA literature supports the impact of JA on language development and the AAC literature identifies the complex attention demands required to learn to use AAC, at this time there is no explicit research to connect the two fields. Specific work linking the findings, goals, and clinical implications of these currently distinct areas of research is warranted.

The principle aim of the present study was to examine an approach for reducing the attention demands when implementing AAC with beginning communicators. The goal was to maximize the frequency and duration of passive and coordinated JA of beginning communicators when they are using communication devices. The objective was to determine the effects of pairing a communication device with adult gaze on the frequency and duration of JA of typically developing infants. Research questions included: a) What is the effect of the placement of an AAC device, in relation to eye gaze, on the frequency of CJA and PJA episodes? b) What is the effect of the placement
of an AAC device, in relation to eye gaze, on the duration of CJA and PJA episodes? It was hypothesized that the frequency and duration of PJA and CJA episodes would significantly increase when an AAC device was paired with adult gaze compared to when the AAC device was not paired with adult gaze.
CHAPTER 2: METHODS

Research Design

A within subjects experimental research design was used. All participants took part in each of the two conditions of the study. The independent variable was the position of a communication device (paired with adult eye gaze versus not paired with eye gaze). The dependent variables were the frequency and duration of children’s passive and coordinated JA episodes when interacting with the communication device, book, and the experimenter as measured by a JA coding scheme adapted from Bakeman and Adamson (1984).

Recruitment

Participants were recruited through advertising at local child-care centers in the Athens area and Ohio University Therapy Associates, fliers posted around Ohio University’s Athens campus, and through a university wide email sent to all faculty/staff and students. The advertisement form and email contained a brief description of the study and contact information for the researcher. Interested parties contacted the researcher via telephone and email. The researcher then contacted each interested parent and conducted a preliminary phone interview, lasting approximately 10 to 15 minutes. During the phone interview, the researcher asked selected questions from the Communication and Symbolic Behavior Scales Developmental Profile (CSBS DP) Infant-Toddler Checklist (Wetherby & Prizant, 2002) and questions targeting other demographic information (see Appendix A).
Recruitment of participants targeted infants within the acceptable age range without specific efforts to selectively enroll participants in a manner that would balance the demographic characteristics of the subject pool according to specific age groupings. This non-stringent approach was implemented as a means of maximizing the overall number of participants for the study.

After determining preliminary eligibility, interested parents were given a choice to complete the sessions within their home or at the Ohio University Hearing, Speech and Language Clinic in Grover Center. Parents chose the environment they felt was best for their child. The first session was then scheduled based on the parent’s preference for location and availability. At that session, parents were again given a brief description of the study and consented to participate with their child (see Appendix B).

Participants

Sixteen infant-parent dyads participated in the study ($M$ age = 10.56, $SD = 1.55$). The infants ranged from 9 to 14 months of age. Participants were 10 males and 6 females. All participants were typically developing (i.e., no known physical, cognitive, visual or hearing impairments) according to parent report. A battery of measures (as described below) was administered to ensure that the participants were beginning communicators who were able to participate in JA routines with their parents or caregivers. All participants met the following inclusionary and exclusionary criteria. See Table 1 for a summary of the demographic information for each participant.
Inclusionary Criteria

Infant participants were classified as ‘beginning communicators’ and met all of the following criteria: (a) identified as a beginning communicator by their parent as indicated by their responses to six target items from the CSBS-DP Infant Toddler Checklist (Wetherby & Prizant, 2002); (b) scored as a ‘responder’ to JA, as evidenced by responding to bids for JA at least 14% of the opportunities presented (2/14) on the Early Social Communication Scales (ESCS; Mundy et al., 2003) measures; (c) within normal limits on the Communication and Symbolic Behavior Scales-Developmental Profile Caregiver Questionnaire (CSBS-DP CQ; Wetherby & Prizant); and (d) be learning English as their primary language.

Selected items from the CSBS Infant-Toddler Checklist (Wetherby & Prizant, 2002) were used to prescreen for eligibility before scheduling the actual eligibility session of the study. Standard scores and levels of concern were not generated. Rather, parents were asked to respond “often,” “sometimes,” or “never” to six target questions that summarized conditions required for the variables of interest. The questions and required responses for eligibility included: (a) “When your child plays with toys, does he/she look at you to see if you are watching?” (sometimes or often); (b) “When you look at and point to a toy across the room, does your child look at it?” (sometimes or often); (c) “Does your child let you know that he/she needs help or wants an object out of reach?” (not yet or sometimes); (d) “Does your child try to get you to notice interesting objects—just to get you to look at the objects, not to get you to do anything with them?” (not yet or sometimes); (e) “Does your child point to objects?” (not yet or sometimes); (f)
“Does your child use sounds or words to get attention or help?” (not yet or sometimes). These questions took approximately 5 to 10 minutes to complete over the phone.

The abridged version of the ESCS (Mundy et al., 2003) a measure of individual differences in nonverbal communication skills was used to determine whether participating infants were initiators or responders. Infants classified as responders were eligible for the study because they represented the earliest communicators.

The abridged version of the ESCS (Mundy et al., 2003) contains 25 semi-structured interactions used to elicit target behaviors and takes approximately 15-25 minutes to administer depending on the child’s responses and cooperation. Three categories of early social-communication behaviors are measured by the ESCS (Mundy et al., 2003) including: JA behaviors, behavioral requests, and social interaction behaviors. Behaviors initiated by the child or responded to by the child are assessed. Behaviors are further classified as high/low level, yielding a better description of the infant’s actual early social-communicative skills. The abridged version of the ESCS (Mundy et al., 2003) was created to serve as a more functional research and clinical tool. Information supporting the validity and reliability of the abbreviated version of the ESCS (Mundy et al., 2003) is available in multiple papers (Markus, Mundy, Morales, Delgado, & Yale, 2000; Mundy & Gomes, 1997; Mundy, Kasari, Sigman, & Ruskin, 1995; Mundy, Signam, & Kasari, 1994; Mundy, Sigman, Kasari, & Yirmiya, 1988).
Table 1

Participant demographic information

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<td>0.64</td>
<td>12</td>
</tr>
<tr>
<td>M</td>
<td>12</td>
<td>87</td>
<td>0.43</td>
<td>19</td>
</tr>
<tr>
<td>M</td>
<td>12</td>
<td>102</td>
<td>0.57</td>
<td>11</td>
</tr>
<tr>
<td>M</td>
<td>13</td>
<td>99</td>
<td>0.79</td>
<td>17</td>
</tr>
<tr>
<td>F</td>
<td>14</td>
<td>81</td>
<td>0.57</td>
<td>15</td>
</tr>
<tr>
<td>Mean</td>
<td>10.56</td>
<td>99.94</td>
<td>0.46</td>
<td>13.38</td>
</tr>
</tbody>
</table>

*aAge adjusted for prematurity.

Infants had to respond to bids for JA for 2 of the 14 opportunities provided during the ESCS administration to ensure that infants had the capacity to respond to adult-initiated JA. To participate in the procedures of the study it was important that the infants could respond to JA bids. The criteria of at least 2 of 14 was selected to ensure that responding to JA was an emerging or established skill.

The Communication and Symbolic Behavior Scales-Developmental Profile (CSBS-DP; Wetherby & Prizant, 2002), a norm-referenced evaluation tool measuring children’s communicative competence, was also used to determine participant eligibility. The CSBS-DP (Wetherby & Prizant, 2002) has evidence-based validity and reliability for screening and evaluating children with developmental delays (Wetherby, Allen, Cleary, Kublin, & Goldstein, 2002). Two of the three different subtests or tools within the CSBS-DP were used for the present study, including the Infant Toddler Checklist and the Caregiver Questionnaire.

The CSBS-DP Infant-Toddler Checklist (Wetherby & Prizant, 2002) is typically completed by a caregiver. It is often used independently as the first step in routine screening to determine if a developmental evaluation is needed for children aged 6 to 24.
months. The checklist contains 24 items. The complete checklist yields a raw score corresponding to a standard score, which is then assigned a binary concern level based on the child’s age. Composite scores for social, speech, and symbolic sections are calculated. In this study, the CSBS-DP (Wetherby & Prizant, 2002) checklist was adapted into a telephone questionnaire to screen for preliminary eligibility as a beginning communicator.

The *CSBS-DP Caregiver Questionnaire* (Wetherby & Prizant, 2002) is an assessment tool also designed to be completed by a caregiver of children aged 6 to 24 months. It contains 45 items requiring either a not yet/sometimes/often choice, selection of options from a list, or open-ended responses. The questionnaire takes approximately 15 to 25 minutes to complete. The 7 variables assessed by this tool include emotion and eye gaze, communication, gestures, sounds, words, understanding, and object use. The *CSBS-DP Caregiver Questionnaire* (Wetherby & Prizant, 2002) provides information regarding communication development to determine if there are any indications of a language/communication delay.

**Exclusionary Criteria**

The beginning communicators did not: (a) score as an “initiator” of JA, as evidenced by a ratio of greater than 20% of higher level initiations (e.g., pointing, showing) compared to the total initiations, including lower level behaviors (e.g., eye contact, alternating), on the *ESCS* (Mundy et al., 2003), (b) use words to communicate, per parent report, (c) have known developmental impairments, (d) have a known visual
impairment, (e) have a known hearing impairment (as tested by Auditory Brainstem Response [ABR] at birth).

The abridged version of the ESCS (Mundy et al., 2003), as described above, ensured that the infant was not regularly initiating JA routines, because that would have deemed them too advanced for the study. Parent reports of word use, general development, vision, and hearing were accepted for eligibility purposes.

Stimuli

The stimuli for both conditions were developed using Boardmaker with Speaking Dynamically Pro®. The stimulus pages were presented on a touchscreen tablet PC. Using Speaking Dynamically Pro® with the computer allowed the tablet PC to function as a speech output AAC device.

Two books, *Brown Bear, Brown Bear, What Do You See* (1995) and *Polar Bear, Polar Bear, What Do You Hear* (1991), written by Bill Martin Jr. and illustrated by Eric Carle, were used in the study (see Appendix D). Each page of the two children’s books were scanned into the computer.

The pages appeared on the screen as in the physical book; however, three additional active buttons were placed on each page. The main button allowed an audio message, consisting of the specific animal’s sound to be played when touched. Two other buttons were used to change the screen either forward or backward within the book. A screen shot of one of the pages is shown in Figure 1. The figure shows the red outline of the animal as it appeared when the animal was pressed and the sound was activated. The forward page button was hidden in the upper right corner of the page and the backward...
page button was hidden in the lower right corner. The physical board books were also present in each experimental condition.

In addition to the device and book for the experimental conditions, a set of JA toys were utilized during a free play interaction with the researcher to build rapport. The toys were different from those used in the ESCS and included common objects such as a ball, a car, a puppet, blocks, a picture book, small nesting cups, and a set of people figures.

![Image of a bear from a children's book](image.png)

*Figure 1.* Screen shot of the AAC device display illustrating the sound activation button.

**Procedures**

The primary researcher was assisted during all sessions by one of two individuals. One of the assistants was a graduate student in Speech-Language Pathology and the other student was an undergraduate student in Hearing, Speech and Language Sciences. They...
helped set up the environment, set up and operate the video camera, and care for participant siblings during interactions as needed throughout the study. Three of the participating families opted to complete the sessions at home.

Session One

The first session allowed the researcher to further determine the infant’s eligibility for the study. Tasks administered during the first session determined the infant’s communication status (i.e., whether the infant was a beginning communicator).

All interactions included as part of session one were videotaped. For these interactions the camera was set at an angle allowing a view of the child’s face and a profile of the adult’s face (researcher).

During the first session, the parent and child engaged in a ten-minute free play interaction with a standard set of toys (see the materials section) to allow the child to familiarize with the setting. Next, the researcher and child participated in a five-minute free play interaction, with toys similar to those used in the parent interaction to increase the child’s comfort level with the unfamiliar communication partner. The parent completed the CSBS-DP CQ (Wetherby & Prizant, 2002) during the researcher/child play interaction. Finally, the researcher completed the ESCS (Mundy et al., 2003) protocol as the child sat across a collapsible table in their parent’s lap at eye level with the researcher. Parents received $10 at the end of the session for their participation.

After scoring the CSBS-DP CQ (Wetherby & Prizant, 2002) and the ESCS (Mundy et al., 2003) protocol, an eligibility determination was made. All participants were contacted regarding their eligibility. No participants that completed session one
were excluded from the study because all infants were judged to meet the eligibility criteria for the study. The eligible participants were contacted to schedule a second session which was held in the same location as the first session. At the second session, participants were given a copy of a report containing descriptions of the measures administered during session one and a record of the infant’s performance/score on those measures. A template of the report is included in Appendix C. One participant had to drop out of the study due to scheduling conflicts for session two. A copy of the report described above was mailed to the infant’s parents.

Session Two

Session two was scheduled with the parent after eligibility was determined. The second session ranged from 1 to 11 days following the first session with a mean of 7 days between sessions.

The second session was videotaped with two cameras to facilitate JA coding. The angle of one camera was similar to the angle during the first session allowing a full view of the infant’s face and a partial view of the researcher. The other camera allowed a side view of the interaction and was used to capture the entire researcher-child interaction.

During the second session, the communication device was introduced in two experimental conditions, paired and split, as described below. The order of book/condition combinations were counterbalanced. Prior to each of the interaction sessions, the touchscreen tablet PC was cleaned and calibrated to increase instrumental reliability.
In both conditions, the researcher read the book with the communication device (with the physical board book present) while sitting on the floor on a blanket. The length of the book reading interactions ($M$ length in seconds = 282.03, $SD$ in seconds = 31.68, range in seconds = 242-384) was similar across all interactions. Parents were allowed to bring a familiar comfort object for the child to manipulate during the interactions, but no parents chose to include another object in the interaction.

Similar to the administration protocol of the ESCS (Mundy et al., 2003), the infants sat in a parent’s lap during the interactions; however, the interaction took part on the floor instead of at a table. The parent was instructed to remain neutral, quiet and seemingly uninvolved, during the interactions. They were asked to sit still and only smile if their infant turned to look at them during the interaction. They were also instructed to allow their child to get up if the child attempted to do so.

The procedures for the activity were similar to those used by Light (2007) in her webcast presentation. During each reading of the story, the researcher accessed the communication device through direct selection to activate the sound of the animal on the page. Next, the researcher read the page. The researcher then turned to the next page of the book, waited five seconds, and then accessed the sound for the animal represented on that page via the communication device. The researcher modeled direct selection on the communication device for each page of the story when the animal was first viewable, before labeling the animal and reading the page. There were 11 models provided during each interaction, which is equal the number of open pages in the books. A script of the interactions is provided in Appendix D, including potential infant behaviors during the
book reading tasks and the researcher’s response to those situations. Consistent responses to behaviors across infants were critical to ensure experimental control. The book reading process occurred twice, with the presentation of each condition, during session number two, with a brief break between condition interactions to switch books and files on the communication device and as needed by the infant.

If a child became upset during an interaction, a 5-minute break consisting of free play with one of the toys from the JA interactions was allowed. During these breaks the infant could play with the parent, the researcher, or alone. The interrupted interaction was then resumed after the page at which it had been discontinued ensuring that each page was presented only once. One of the participants required two breaks during an interaction; however, the other 15 infants took only one or no breaks during each story reading interaction.

*Independent variable.* In the paired condition (see Figure 2), the child was seated across from the researcher at eye level in his/her parent’s lap. The researcher held the communication device immediately under, but near her face with the given book scanned into the device. The device was paired with the researcher’s eye gaze. The physical board book was also present to the side of the interaction, on the floor, below the level of the communication device.

In the split condition (see Figure 3), the child was seated across from the researcher at eye level in his/her parent’s lap. The communication device was placed on the floor with the pages of the given book scanned into the device. The device was not
paired with the researcher’s eye gaze. The physical board book was also present in the interaction, on the floor, on the opposite side of the device.

*Figure 2.* Schematic of AAC device placement in the paired condition.

*Figure 3.* Schematic of AAC device placement in the split condition.
Counterbalancing. In order to control for preferences between books, the presentation of the books was counterbalanced so that each book was used in each condition an equal number of times. Additionally, due to the within subjects design, the presentation of each condition as first or last could have resulted in order effects with the infants who simply exhibited greater attention earlier or later in the experimental session. Counterbalancing of each condition was implemented to ensure that each condition was presented first and last an equal number of times. Counterbalancing the book and order resulted in four possible combinations. Each possible combination contained four participants.

Coding

Data coding procedures were adapted from Bakeman and Adamson’s (1984) scheme. Transcripts of the story reading interactions were developed indicating where the infant was looking in relation to the time stamp of the recording. The camera angle showing the front of the infant’s face was used to generate the transcripts except for during times when the view of the child was obstructed, in which case the side camera angle was examined. Five codes, including coordinated JA, augmented coordinated JA, passive JA, person engagement, and unengaged (each described below) were applied to the transcripts. Examples of the code applications can be found in the coding manual located in Appendix E. Frequency and duration of the codes were tallied for each infant.

Guidelines

All attention episodes or engagement states were required to last at least 3 seconds in duration to be initiated. The 3-second duration could be one singular event or
the combination of events, as applicable within each code. Episodes were terminated in one of two ways. An episode was terminated by 5 consecutive seconds of engagement with (objects or persons) outside of the given code. Additionally, episodes were terminated if four consecutive events occurred and did not contain each of the objects/persons within that code. Specific descriptions of each of the coding categories are provided below.

*Coordinated joint attention.* Episodes of CJA were coded when infants were actively involved with and coordinated their attention between an object and the researcher. The infants were required to coordinate their attention between the researcher and the specific object by shifting their eye gaze back and forth from the device or book to the adult, indicating that they are aware of the adult’s joint focus. For example, CJA was coded when infants looked at the device and then shifted to the researcher and back to the device. All CJA episodes contained three events including an object and the researcher. At least 2 of the events were the same object/person encompassing the other target item. Back-to-back shifts between object/person or person/object initiated a CJA episode if the infant returned to the initial object/person within 5 seconds. More complex examples of CJA are available in Appendix E.

CJA codes were differentiated depending on the object included in the attention shifting. Therefore, frequency and duration of CJA with the device and CJA with the book were tallied separately.
**Augmented coordinated joint attention.** Episodes of augmented coordinated joint attention (ACJA) were coded when the infant was actively involved with both objects in the interaction. ACJA codes included coordination of attention between the device and the book. Due to the uniqueness of this code in relation to prior researcher, ACJA code requirements were more rigorous than other codes. All ACJA episodes contained at least four object events consisting three back-to-back shifts between the objects. For example, ACJA was coded when infants looked at the device, then shifted to the book, back to the device, and finally back to the book. Appendix E contains examples of ACJA code applications.

**Passive joint attention.** Episodes of PJA were recorded when the infants were engaged with an object (either the book or the device) but the infant did not make any attempts to interact with the researcher. During PJA episodes, infants did not provide any evidence they were aware the researcher was also engaged. PJA episodes were only required to contain one event including an object but could contain multiple events if infants were primarily interested in the object but shifted to an outside event very briefly (less than 5 seconds). An object engagement event, lasting at least 3 seconds in duration, not meeting the criteria as part of a CJA or ACJA code, initiated a PJA episode. See Appendix E for examples of PJA.

PJA codes were differentiated depending on the object of interest. Therefore, frequency and duration of PJA with the device and PJA with the book were tallied separately.
Person Engagement. Episodes of person engagement were similar to PJA episodes but included bouts of attention in which infants were only interested in the researcher. During person engagement episodes infants did not make show interest in an object. Person engagement episodes were only required to contain one event including the researcher but could contain multiple events if infants were primarily interested in the researcher but shifted to an outside event very briefly (for less than 5 seconds). One event of researcher engagement, at least three seconds in duration, not meeting the criteria for a CJA code, initiated a person engagement episode. Appendix E contains an example of person engagement.

Unengaged. Unengaged episodes were coded when infants did not appear interested with any of the objects or researcher in the interaction. This code included instances when infants were looking around the room or were seemingly uninterested. The unengaged episode met the same criteria as the other codes for initiation and termination. An example of an unengaged episode can be found in Appendix E.

Other. All seconds of the story reading interaction were coded. Events which did not meet any of the criteria for above codes received an other code. Appendix E shows an example of when to apply the other code.

Reliability

Procedural Reliability for ESCS

Procedural reliability was calculated by an independent coder for 10% (2) of the ESCS administrations by viewing the DVDs from session one. The individual used a
copy of the ESCS procedures to determine all procedures were followed accurately. The results revealed 95.9% procedural reliability for the ESCS administrations.

**Procedural Reliability for Story Reading Interactions**

Procedural reliability was calculated by an independent coder for 10% (2) of the story reading interactions by viewing the DVDs from session two. The individual used a copy of the interaction script to determine all procedures were followed accurately. The results revealed 97.8% procedural reliability for the condition interaction administrations.

**Coding**

Two phases of coding reliability were implemented. An independent coder first verified the accuracy of the transcripts used for later coding. The coder was instructed to create a transcript using the time stamp on the DVDs to indicate where the infant was looking throughout the interactions. The coder had access to both camera angles from session two and independently created transcripts for 15% (6 books) of the story reading interactions. Point-by-point comparisons of event shifts revealed 92.2% agreement between the transcripts. These results were interpreted as sufficient to ensure the transcripts were reliable for continuation of coding.

The independent coder was then trained by the primary researcher on the categories of codes described above to calculate frequency and duration of CJA, ACJA, PJA, person engagement, unengaged, and other. The coder was provided a copy of the coding manual containing examples of the application of codes and each code was thoroughly discussed. The coder and the researcher then coded one transcript together during which the coder was allowed to ask questions related to the application of codes.
The coder then coded one transcript independently in the presence of the researcher without asking questions with 100% accuracy. The coder then independently completed inter-rater reliability of coding for 15% (6 books) of the story reading interactions. She coded frequency and duration for all codes during those interactions. The results from each coder (the primary researcher and the independent coder) were compared and the number of agreements was divided by the number of disagreements plus agreements to yield an overall reliability score. Reliability scores for the story reading interactions equaled 89.5% for the frequency of JA episodes and 86.2% for the duration of JA episodes.

Validity

The number of participants in the study was relatively low for an experimental study. However, efforts to maintain validity were made throughout the experiment. First, the use of two different books helped eliminate any learning effects from the first to the second condition. The two books were very similar in content, format, and illustration. The books contained the same number of pages and characters (animals/persons).

Additionally the researcher, not parents, was used as the interaction partner with the infants during the condition interactions. This decision may have decreased the external validity of the results, as an unfamiliar, trained partner took part in the interactions. However, internal validity was gained as the interactions with all participants were structured and controlled by the researcher. Light (1997) found that mothers of children using AAC frequently dominate communicative interactions during reading and play activities; therefore, the use of the researcher as the interaction partner
ensured that each child had the same opportunities to interact during the experimental conditions.
CHAPTER 3: RESULTS

Overview of Analyses

The goal of this investigation was to determine the effects of device positioning (pairing versus splitting gaze) on infants’ engagement in JA. First, the effects of device placement on both the overall frequency and duration of the different types of JA episodes were examined. Next, the effects of device placement on JA episodes with the device were explored. Finally, since JA emerges between ages 9-15 months, the role of developmental level (i.e. age) on JA engagement was explored. The frequency and duration of JA were tallied for each infant in each condition. Two-tailed, paired t-tests were conducted (alpha levels <.05 unless otherwise noted) to determine the effects of device placement on the frequency and duration of CJA and PJA. Correlations and t-tests were used to examine the effects of age on JA engagement.

Evaluation of Counterbalancing

A one-way ANOVA was used to evaluate the effectiveness of the counterbalancing scheme. No significant differences were found between the four conditions for frequency or duration $F(3,60) = .17, p = .92$ and $F(3,60) = .14, p = .94$ indicating that the order of book or experimental condition did not have an impact on the results.

Effects of Device Placement on Overall Frequency and Duration of Forms of Joint Attention

There were no significant condition differences on the overall frequency or duration of PJA episodes in paired versus split device placement conditions, $t = -1.68, p =$
.114, \( d = .40 \) and \( t = -.62, p = .545, d = .15 \). There were also no significant condition differences for the overall frequency or duration of CJA episodes in paired versus split device placement conditions, \( t = 1.26, p = .226, d = .30, t = -.22, p = .826, d = .05 \). The mean and standard deviation results of frequency and duration of PJA and CJA episodes for each condition (paired and split) are displayed in Table 2.

### Table 2

**Means and Standard Deviations of Overall Frequency and Duration of the Forms of Joint Attention in the AAC Device Paired with Eye Gaze versus AAC Device Split from Eye Gaze Conditions**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Condition</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency PJA</td>
<td>Paired</td>
<td>3.44</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>Split</td>
<td>5.38</td>
<td>3.98</td>
</tr>
<tr>
<td>Duration PJA</td>
<td>Paired</td>
<td>44.19</td>
<td>66.10</td>
</tr>
<tr>
<td></td>
<td>Split</td>
<td>58.63</td>
<td>45.43</td>
</tr>
<tr>
<td>Frequency CJA</td>
<td>Paired</td>
<td>5.06</td>
<td>2.93</td>
</tr>
<tr>
<td></td>
<td>Split</td>
<td>3.88</td>
<td>2.30</td>
</tr>
<tr>
<td>Duration CJA</td>
<td>Paired</td>
<td>119.63</td>
<td>61.90</td>
</tr>
<tr>
<td></td>
<td>Split</td>
<td>125.31</td>
<td>72.17</td>
</tr>
</tbody>
</table>

*Note.* PJA = Passive Joint Attention. CJA = Coordinated Joint Attention.
Effects of Device Placement on Joint Attention with Device

Although there were no significant condition differences for the overall frequency and duration of joint attention including the device and book, the effects of device placement on episodes of joint attention the infants shared with the AAC device were of particular interest.

Within the device paired with eye gaze condition, significant differences emerged between the frequency of the types of JA with the device, \( t = 4.33, p = .001, d = 1.03 \). However, there were no significant differences between PJA and CJA in the split gaze condition, \( t = .08, p = .940, d = .02 \). (See Figure 4.)

Significant duration differences between CJA and PJA with the device were also found in both the paired and the split gaze condition, \( t = 5.91, p = .000, d = 1.40 \) and \( t = 2.81, p = .013, d = .67 \), when using a p level of .05. However, after adjusting the p level to account for use of multiple t-tests (.05/4) the latter finding between JA types in the split gaze condition was no longer significant. (See Figure 5.)
Figure 4. Comparison of the frequency of the types of JA episodes with the AAC device in the AAC device paired with eye gaze versus AAC device split from eye gaze conditions.
Effects of Age and Device Placement on Forms of Joint Attention

The relations among age and the JA measures were examined using one-tailed Pearson product-moment correlations. (See Table 3.) Based on significant correlations between age and key JA measures and non-statistical examination of eligibility measures, participants were divided into two age groups: (1) young infants, 9-10 month-olds and (2) older infants, 11-14 month-olds. While chronological age was the determining factor for group placement, careful review of participants’ scores on the ESCS revealed common skills within the groups further supporting the distinction between the groups. Of the 9 participants in the younger group, 7 had a RJA ratio of less than .50, meaning they
responded to less than half of the JA bids, or opportunities for responding, given by the researcher. Additionally, 2 of the infants in the younger group exhibited any higher level IJA skills on the ESCS. In contrast, 6 of the 7 infants in the older group had an RJA ratio of .50 or greater. Also, all but one infant in the older group exhibited higher level IJA skills.

See Table 4 for the means and standard deviations of the JA measures of each group. The young infants engaged in a greater amount (i.e. frequency) of PJA in the split condition than the paired condition, \( t = -2.38, p = .045, d = .56 \), but there were no significant condition differences in the duration of PJA, \( t = -.51, p = .622, d = .12 \). Further, there were no condition differences in the frequency or duration of CJA, \( t = -.20, p = .845, d = .05 \) and \( t = -.65, p = .533, d = .15 \), for the young infants.

In contrast, the older infants engaged in a greater frequency of CJA episodes in the paired condition than in the split condition, though this difference was not statistically significant, \( t = 2.12, p = .078, d = .50 \). There were no condition differences in the duration of CJA episodes, \( t = .50, p = .633, d = .12 \), or the frequency or duration of PJA episodes, \( t = .88, p = .411, d = .21 \) and \( t = -.37, p = .726, d = .09 \), for the older infants.
### Table 3

**Intercorrelations Between Age and the Frequency and Duration of Joint Attention Episodes**

<table>
<thead>
<tr>
<th></th>
<th>Age (Months)</th>
<th>Frequency CJA Paired</th>
<th>Frequency CJA Split</th>
<th>Frequency PJA Paired</th>
<th>Frequency PJA Split</th>
<th>Duration CJA Paired</th>
<th>Duration CJA Split</th>
<th>Duration PJA Paired</th>
<th>Duration PJA Split</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (Months)</strong></td>
<td>—</td>
<td>.67**</td>
<td>.40</td>
<td>.54*</td>
<td>-.19</td>
<td>.43*</td>
<td>.25</td>
<td>-.19</td>
<td>-.38</td>
</tr>
<tr>
<td>Frequency CJA</td>
<td>—</td>
<td>—</td>
<td>-.02</td>
<td>.48*</td>
<td>-.18</td>
<td>.60**</td>
<td>-.19</td>
<td>-.26</td>
<td>-.28</td>
</tr>
<tr>
<td>Paired</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Frequency CJA</td>
<td>—</td>
<td>—</td>
<td>-.18</td>
<td>.09</td>
<td>-.17</td>
<td>.68**</td>
<td>-.08</td>
<td>-.16</td>
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<tr>
<td>Split</td>
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<td></td>
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<tr>
<td>Frequency PJA</td>
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<td>—</td>
<td>-.02</td>
<td>.14</td>
<td>-.24</td>
<td>-.02</td>
<td>-.28</td>
<td></td>
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</tr>
<tr>
<td>Paired</td>
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<tr>
<td>Frequency PJA</td>
<td>—</td>
<td>—</td>
<td>.03</td>
<td>-.27</td>
<td>-.36</td>
<td>.73**</td>
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<tr>
<td>Split</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Duration CJA</td>
<td>—</td>
<td></td>
<td></td>
<td>-1.5</td>
<td>-.50*</td>
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<td></td>
</tr>
<tr>
<td>Duration CJA</td>
<td>—</td>
<td>—</td>
<td>.31</td>
<td>-.34</td>
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<tr>
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<td>Paired</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration PJA</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td>—</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Split</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. CJA = Coordinated Joint Attention. PJA = Passive Joint Attention; *p < .05, **p < .01*
Table 4

Means and Standard Deviations of the Forms of Joint Attention by Age in the AAC Device Paired with Eye Gaze versus AAC Device Split from Eye Gaze Conditions

<table>
<thead>
<tr>
<th>Measures</th>
<th>Conditions</th>
<th>Younger Infants (N=9)</th>
<th>Older Infants (N=7)</th>
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<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Frequency PJA</td>
<td>Paired</td>
<td>2.56</td>
<td>1.88</td>
</tr>
<tr>
<td></td>
<td>Split</td>
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<td>4.83</td>
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<tr>
<td>Duration PJA</td>
<td>Paired</td>
<td>52.33</td>
<td>87.57</td>
</tr>
<tr>
<td></td>
<td>Split</td>
<td>73.00</td>
<td>47.21</td>
</tr>
<tr>
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<td>Paired</td>
<td>3.44</td>
<td>1.94</td>
</tr>
<tr>
<td></td>
<td>Split</td>
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<td>1.80</td>
</tr>
<tr>
<td>Duration CJA</td>
<td>Paired</td>
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<td>68.64</td>
</tr>
<tr>
<td></td>
<td>Split</td>
<td>116.33</td>
<td>71.71</td>
</tr>
</tbody>
</table>

Note. PJA = Passive Joint Attention. CJA = Coordinated Joint Attention.
CHAPTER 4: DISCUSSION

Summary of Major Findings

Although device placement did not appear to significantly impact the overall frequency and duration of PJA and CJA episodes, device placement did affect the different forms of JA with the device (i.e., alternations between the AAC device and adult). The paired condition resulted in significantly greater frequency and duration of CJA than PJA episodes with the AAC device and adult. Additionally, significant age effects were revealed: The younger infants engaged in more PJA in the split condition while, although not statistically significant, the older infants were more likely to engage in CJA in the paired condition.

Although differences did not emerge in the overall rates of either type of JA across the conditions, including the device in a story reading interaction resulted in interesting findings related to JA with the device itself. In the placement condition with the device paired with adult eye gaze, the infants in the study engaged in significantly more frequent and longer lasting CJA than PJA episodes with the device. This supports the proposed speculation that by pairing two of the variables in an AAC device interaction, infants were more likely to coordinate their attention between the device and the researcher than to be passively exploring the device by themselves. When the JA specifically involving the communication device was explored, findings revealed children were more likely to engage in CJA in the paired condition than the split condition.

In contrast, there were no significant differences in the frequency or duration of CJA episodes with the device relative to PJA episodes with the device in the split from
adult eye gaze device placement condition. The infants were as likely to become engaged with the device alone and not reference the adult, as they were to coordinate between the two.

These findings suggest that pairing an AAC device with adult eye gaze in an interaction may support beginning communicators in their efforts to coordinate their attention between the novel device and the interaction partner. These findings are important because the communication device is a tool that can augment the forms of social communication shared between people. Bakeman and Adamson (1984) argue for the importance of CJA for typical language learning such as forming correct associations between words and their referents. However, there is also evidence that typically developing toddlers are able to learn vocabulary without engaging in JA interactions through incidental learning because they are exposed to the everyday language of others (Akhtar, Jipson, & Callanan, 2001).

For individuals who require a visually based modality of language, such as an external, aided AAC device, the increased importance of JA, despite increased demands, is evident (Clibbins, as cited in Clibbens & Powell, 2003). The device is intended to serve as an instrument for enhancing communication and thus requires frequent and sustained interaction between the adult, the child, and the assistive technology. Further, the incidental language learning experienced by typically developing children is not paralleled for children who require AAC, as there is a noted asymmetry between the receptive and expressive language systems of these individuals (Smith & Grove, 2003).
Cress (2002) noted the lack of AAC models by other individuals thus decreasing the probability of any incidental language learning.

It is important to note that the nature of the task may have impacted the results. The interactions were highly structured and, as a consequence, bouts of JA may have been superficially initiated by the actions of the researcher. The results of the study may have been different if the interaction had been more natural and less structured. However, the amount of structure in the experimental task may have been advantageous. Based on the attention demands for beginning communicators when introducing an AAC device, the highly structured nature of the experimental task may be more representative of the structure needed in an actual intervention setting. Less structure may exacerbate the attention demands. A highly structured activity may provide the support necessary to help beginning communicators manage by shifting their attention to interactions with an AAC device.

One possible explanation for the non-significant differences between conditions on the overall frequency and duration of the types of JA may be the developmental level of the participants in the study. It is possible that for the typically developing infants in this study, pairing two of the variables in a structured interaction was not necessary for them to engage in JA episodes. Additionally, the age range of the children participating in the study encompasses a transitional period in early social and communicative development, including the emergence of JA skills (Carpenter et al., 1998). While all of the participants demonstrated the ability to engage in at least some CJA episodes, the skill was still emerging for many of the participants, especially the younger infants who
engaged in significantly more PJA episodes in the split condition than in the paired condition. Based on prior JA development research (Bakeman & Adamson, 1984; Carpenter et al., 1998), children in this age range are just beginning to develop the ability to coordinate their attention and thus likely to engage in more passive episodes overall. In contrast, older infants demonstrated a definite trend for engaging in more CJA episodes in the paired condition than in the split condition. These findings suggest that the paired condition may be more facilitative of CJA episodes for children who are developmentally ready to coordinate their attention.

Limitations and Future Directions

The limitations to the present study should be considered when interpreting the results. First, typically developing infants were used to represent the early social and communicative level of older children with disabilities. None of the infants in the study were delayed or in need of an AAC system to help them communicate. Ways to minimize the attention demands when introducing a communication device to children who require AAC are not known and therefore should be investigated. Future research should replicate the procedures of this study to determine the effect of device placement on the types of JA for children with disabilities who actually require AAC.

In addition to participant characteristics, the high level of structure in the story reading interactions may have inflated the bouts of JA observed, because the infant had a very limited set of persons/objects with which to coordinate his or her attention. Additionally, the researcher had to turn the pages on the device and in the book frequently, perhaps drawing infants’ attention to objects they may have previously been
uninterested in. These limitations advocate for future comparisons of JA when the position of a communication device is varied in a less structured type of interaction. A free play related interaction with the infant’s parent or caregiver as the interaction partner would be more parallel to prior research on joint attention (Bakeman & Adamson, 1984; Tomasello & Farrar, 1986). Possible research directions could include a qualitative investigation identifying natural tendencies of parents/caregivers for device positioning in interactions including the device and other objects. Additionally, the current within-subject methodology could be applied to a free play interaction (in place of the storybook reading) with a parent/caregiver serving as the interaction partner (instead of the researcher).

Another limitation to the current study was the small overall number of participants. When the participants were split by age to investigate the effects of age, there were an unequal number of participants in the two groups and there were less than ten individuals per group. Therefore, replicating the current study with more participants overall, and in each of the age groups, might reveal results which were not detected in the small sample. Future investigations should also consider the role of other individual differences beyond age such as children’s temperament and parent-child interaction style. Finally, measuring children’s social communication behaviors in the context of a quadratic paradigm (as introduced in this study) rather than the traditional triadic paradigm may further explain variations in the emergence of children’s JA skills.
Clinical Implications

The findings of the current study are promising and may be helpful when introducing AAC to beginning communicators. Clinicians introducing AAC to beginning communicators should consider ways to minimize the attention demands in the learning environment. The findings of this study suggest that pairing a communication device with adult eye gaze may facilitate communication and learning for beginning communicators because two of the factors in a quadratic attention setting are combined. Because beginning communicators are still developing their ability to coordinate JA among multiple entities, pairing the device with eye gaze may facilitate children’s ability to attend to clinicians’ models more regularly than if the device were placed to the side of the interaction where models could go unnoticed due to lack of ability to smoothly coordinate attention.

It may not be feasible for clinicians to balance a communication device near their own faces while interacting with clients and other therapy materials. Therefore, it is important that the clinicians develop strategies for managing objects involved in therapeutic interactions. Clinicians should prepare for pairing eye gaze with devices by becoming comfortable with balancing devices with one hand and navigating the pages needed for the target activity while viewing the device upside down. Pages for beginning communicators are by nature less complex than pages for advanced users but clinicians should also consider navigation demands when arranging pages.

Redesigning AAC technologies may also aid in the successful implementation of pairing AAC devices with adult eye gaze. Minor changes to the design of external AAC
systems, including manufacturing lighter and flatter devices would lessen the physical demands of the proposed intervention for clinicians. Similarly, engineering a support system that allows devices to fit around clinicians’ necks, or attach to clinicians’ chests may also be beneficial. Finally, the addition of a viewer screen at the top of the device, displaying a miniature screen shot of the main page may help clinicians navigate the screen from the upside down position.

Additionally, when attempting to lessen the quadratic attention demands created by introducing a communication device to a play interaction, pairing the device with eye gaze is only one of the potential pairing options. Clinicians should also consider creating activities, such as storybook reading interactions, which include only the device, so the device acts as a tool but also contains the activity. In the current study, the entire contents of the storybook were scanned into the device and therefore the physical board book was not necessary in the interaction to complete the story reading activity. However, this arrangement is more difficult to implement in an everyday common play and therapeutic activity such as rolling a ball (targeting turn taking) as a simulated ball rolling activity within the device is likely less appealing than using the tangible toy. In instances when incorporating the activity into the device is not easily accomplished, the AAC should be incorporated into the activity. Using light tech picture symbols with the actual toys is suggested. Clinicians should use the same symbols being used to represent target concepts in devices (if a device is being introduced) but the pictures could be attached to actual objects during play. This will allow children to begin understanding the
relationship between symbols and real objects, which is necessary if they will be using AAC to communicate.

Finally, clinicians should carefully consider the type of AAC most appropriate for specific intervention activities. For some highly active activities, unaided AAC (e.g., signs, gestures, facial expressions) may be more practical to implement and communicatively functional than trying to impose aided systems.

Pairing AAC devices with adult eye gaze will result in additional challenges for individuals who require AAC who also have concomitant physical or visual impairments. Interactions with individuals with physical and visual impairments will require clinicians to consider ideal placement of the device and activity materials in relation to area in which individuals could access and see the device. The actual position of AAC devices in an appropriate location is the most important factor for clinicians to contemplate and the practicality of pairing adult eye gaze with the AAC device in that location will warrant secondary consideration.
Conclusions

Successful implementation of AAC with beginning communicators is a complex, long-term process. The outcome of such an objective is dependent on multiple factors. Introducing an AAC system into interactions increases the attention demands of typical language development by requiring coordination of attention to multiple foci (Light et al., 2002) These interactions may also include multiple directive references by the adult communication partner to guide the child to use the communication system (Cress, 2002) despite literature findings that directive references are negatively related to vocabulary development in typically developing children (Tomasello & Farrar, 1986). Therefore, reducing the attention demands within the child’s social cognitive skill level is critical. Pairing two of the variables in the quadratic paradigm created in interactions involving aided AAC may help reduce those attention demands and thus facilitate language development. More specifically, pairing the device with adult eye gaze may support more successful language learning especially for younger children still developing their CJA skills. Future research should continue to investigate the importance of JA development on the social communicative function of children who require AAC.
REFERENCES


APPENDIX A: INITIAL PHONE INTERVIEW WITH POTENTIAL PARTICIPANTS

AND REQUIRED RESPONSES

“How did you hear about the study?”

[Briefly explain purpose and procedures of the study.]

“How do you have any questions?”
“Do you think this is a study you would be interested in participating in?” (yes or maybe)
“Would you answer a few basic questions to help me confirm if your child may be eligible for the study?” (yes)
“How old is your child – in months?” (9 to 15 months)
“Does your child have any vision problems you know of?” (No)
“Was your child’s hearing test (ABR) normal at birth?” (Yes, or follow-up was ‘normal’)
“Does your child have developmental disabilities you know of?” (No)
“I have 6 more very brief questions to ask you and then we are finished. These questions come from the Communication and Symbolic Behavior Scales Developmental Profile Infant Toddler Checklist. I would like you to answer ‘not yet’ ‘sometimes’ or ‘often’.”

1) “When your child plays with toys, does he/she look at you to see if you are watching? Not yet, sometimes, or often?” (sometimes or often)
2) “When you look at and point to a toy across the room, does your child look at it? Not yet, sometimes, or often?” (sometimes or often)
3) “Does you child let you know that he/she needs help or wants an object out of reach? Not yet, sometimes, or often?” (not yet or sometimes)
4) “Does your child try to get you to notice interesting objects – just to get you to look at the objects, not to get you to do anything with them? Not yet, sometimes, or often?” (not yet or sometimes)
5) “Does your child point to objects? Not yet, sometimes, or often?” (not yet or sometimes
6) “Does your child use sounds or words to get attention or help? Not yet, sometimes, or often?” (not yet or sometimes).

[If they do not meet eligibility, thank them for their time.]
[If they answered all questions as required, set up session 1]
APPENDIX B: INFORMED CONSENT FORM

**Title of Research:** The effect of pairing adult eye gaze with a communication device on the frequency and duration of joint attention episodes in typically developing infants.

**Principal Investigator:** Julia Smith, B.S.

**Advisors:** John McCarthy, Ph.D and Joann Benigno, Ph.D

**Department:** Hearing, Speech, and Language Sciences

Federal and university regulations require signed consent for participation in research involving human subjects. After reading the statements below, please indicate your consent by signing this form.

**Explanation of Study**

Some individuals, including young children, are unable to use their natural voice to speak and communicate. One option for these individuals is to use a communication device, similar to a computer, to help them speak. Communication develops at a very young age and therefore, when these aids are needed, they need to be introduced early. One of the problems with teaching an infant to use one of these devices, is that it is hard for young children to pay attention to many different things at once. They like to look at the faces of the adults but to use the ‘computer’ they also have to look at it.

As a participant in this study, you can choose if the researcher will come to your home to work with you and your child, will come to another location that is familiar to your child, or if you would like to come to the Ohio University Hearing, Speech, and Language Clinic to participate in the study. Each session will be videotaped so it can be watched later. The entire study will take 2 visits. Each visit should last about an hour and a half. During the first visit you will fill out some surveys about your child and what they do at home when they are with you. The information you give will help the researcher understand your child’s skills. You can watch while the researcher plays with your child. The activities will be specific but fun for your child. Also, you will be asked to play with your child in a normal way with some specific toys while we videotape so we can see how your child interacts with someone they know.

If the information you provide and the researcher sees when playing with your child shows that they are a beginning communicator, there will be another session. During the second visit the researcher will show your child the ‘computer’ and read a fun book with them while they sit in your lap. During this part, we will watch your child and keep track of how often they pay attention to both the ‘computer’ and the person they are interacting with. We will watch them when the ‘computer’ is sitting to the side, making the infant divide their attention and eye contact between the device and the adult’s face. We will also watch their responses when the ‘computer’ is held right underneath the adult’s face. This would allow the infant to see the device and the adult’s face at the same time. From
this study we will see if it is helpful to teach parents and people helping the children who
cannot speak, where to put the ‘computer’ to help the child the most.

**Risks and Discomforts**
Taking part in this study does not cause any extra risk to your child beyond everyday
activities. Every effort has been made to make the activities fun for your infant. You will
be present during all of the interactions with your child.

**Benefits**
From this study, you will receive a copy of a report detailing all of the information we
gathered about your child’s skills. This information will help you understand what your
child is currently doing to communicate and interact with you.

**Confidentiality and Records**
The videotapes will be used for research purposes, and neither you nor your child will be
identified by name on the labels. The tapes will be kept for 4 years and then will be
destroyed. The records of this study will be private. In any report we publish, we will not
include any information that will make it possible to identify you or your child. Records
will be stored securely and only researchers will have access to them.

**Compensation**
You will be paid $10 in cash for each session you and your child participate in. If we
decide your child is not a beginning communicator, you will get $10 for the first session.
If we are able to schedule a second session in your home or at the clinic and watch your
child with the computer, you will get another $10. The most you will earn from this study
is $20.
Contact Information
If you have any questions regarding this study, please contact:
John McCarthy, PhD.       Joann Benigno, PhD.
\texttt{mccarthj@ohio.edu} or \texttt{benigno@ohio.edu}  
(740)597-1764       (740)593-4149

If you have any questions regarding your rights as a research participant, please contact Jo Ellen Sherow, Director of Research Compliance, Ohio University, (740)593-0664.

I certify that I have read and understand this consent form and agree to participate as a subject in the research described. I agree that known risks to me have been explained to my satisfaction and I understand that no compensation is available from Ohio University and its employees for any injury resulting from my participation in this research. I certify that I am 18 years of age or older. My participation in this research is given voluntarily. I understand that I may discontinue participation at any time without penalty or loss of any benefits to which I may otherwise be entitled. I certify that I have been given a copy of this consent form to take with me.

Signature________________________ Date __________
Printed Name_______________________
APPENDIX C: COMMUNICATION DEVELOPMENT REPORT

Child:  (Name)  Age:  (Age) months  Date of Session:  (Date)

Information regarding (Name)’s early communication development was gained through her participation in the research study titled “The Effect of Pairing Adult Eye Gaze with a Communication Device on the Frequency and Duration of Joint Attention in Typically Developing Infants.” Two specific assessment protocols were utilized while determining eligibility for the study. The results of those measures can be found below.

The Communication and Symbolic Behavior Scales-Developmental Profile Caregiver Questionnaire (CSBS-DP CQ; Wetherby & Prizant, 2002) is a standardized assessment tool completed by caregivers. It provides valuable information about communication development as is used as a screening tool to determine if a complete speech and language assessment is needed. The questionnaire assesses seven variables including emotion and eye gaze, communication, gestures, sounds, words, understanding, and object use.

The CSBS-DP CQ yields a standard score and percentile rank for three overall composite areas include social, speech, and symbolic as well as a total score. The total standard score has an average of 100 with a standard deviation of 15 resulting in an average range of 85-115. Based on your report to the questions on the questionnaire, (Name)’s total standard score on the CSBS-DP CQ was (Score). This score (comparison) the average range and corresponds to a percentile rank of (%ile). This means (Name) is performing as well as or better than (%)% of other children (his/her) age.

The Early Social Communication Scales (ESCS; Mundy et al., 2003) is a videotaped observation measure containing 25 semi-structured interactions to elicit target early social-communication behaviors including: Joint Attention Behaviors, Behavioral Requests, and Social Interaction Behaviors. The focus of this study was on the Joint Attention Behaviors exhibited by (Name). Coding of the data revealed that (Name) engaged in joint attention with the researcher in a variety of ways. (SPECIFY BEHAVIORS OBSERVED) (He/She) shared attention with the researcher as evidenced by multiple eye contact episodes. (Name) also responded to the researchers bids for attention such as pointing to pictures in a book by following the point and attending to the picture of interest. (He/She) was not observed as directing the researcher’s attention by pointing to interesting objects in the room. The skills exhibited by (Name) fulfill the expectations for early social and communication development for a child (his/her) age.

Based on the results from the CSBS-DP CQ and ESCS, (Name) is currently developing early communication skills as expected for (his/her) age. If you have concerns in the future, please discuss them with your child’s pediatrician or school to determine if a more in depth evaluation is needed.

If you have questions about this report please contact the primary researcher or the advisors of the research project. Their contact information can be found below. Thank you again for your participation in this study.
Julia Smith, B.S., Researcher
(937)763-2616
js171703@ohio.edu

Advisors:
Joann Benigno               John McCarthy
(740)593-4149                 (740)597-1764
benigno@ohio.edu             mccarthj@ohio.edu
APPENDIX D: SCRIPT FOR READING BOOKS DURING INTERACTION

CONDITIONS

Before both books make sure, the infant is alert and calm and then begin with:
“Hi (name), we are going to look at book and read it together!”

Brown Bear, Brown Bear, What Do You See?

“This is the Brown Bear, Brown Bear, What Do You See? Story.”
[Cover of book on screen]
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Bear Sound]
“Brown Bear, Brown Bear, What do you see? I see a red bird looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Bird Sound]
“Red Bird, Red Bird, What do you see? I see a yellow duck looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Duck Sound]
“Yellow Duck, Yellow Duck, What do you see? I see a blue horse looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Horse Sound]
“Blue Horse, Blue Horse, What do you see? I see a green frog looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Frog Sound]
“Green Frog, Green Frog, What do you see? I see a purple cat looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Cat Sound]
“Purple Cat, Purple Cat, What do you see? I see a white dog looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Dog Sound]
“White Dog, White Dog, What do you see? I see a black sheep looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Sheep Sound]
“Black Sheep, Black Sheep, What do you see? I see a goldfish looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Bubbles Sound]
“Goldfish, Goldfish, What do you see? I see a teacher looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Teacher Sound]
“Teacher, Teacher, What do you see? I see children looking at me.”
[Turn page and wait 5 seconds] [Push animal on screen to make sound] [Laugh Sound]
“Children, Children, What do you see?”
[Turn page and wait 5 seconds][Push Bear] [Bear Sound] “We see a brown bear”
[Wait 5 seconds][Push Bird] [Bird Sound] “a red bird”
[Wait 5 seconds][Push Duck] [Duck Sound] “a yellow duck”
[Wait 5 seconds][Push Horse] [Horse Sound] “a blue horse”
[Wait 5 seconds][Push Frog] [Frog Sound] “a green frog”
[Wait 5 seconds][Push Cat] [Cat Sound] “a purple cat”
[Wait 5 seconds][Push Dog] [Dog Sound] “a white dog”
[Wait 5 seconds][Push Sheep] [Sheep Sound] “a black sheep”
[Wait 5 seconds][Push Fish] [Bubbles Sound] “a goldfish”
[Wait 5 seconds][Push Teacher] [Teacher Sound] “and a teacher looking at us.”
“That’s what we see”
Polar Bear, Polar Bear, What Do You Hear?

“This is the Polar Bear, Polar Bear, What Do You Hear? Story.”

[Cover of book on screen]

[Polar Bear, Polar Bear, What do you hear? I hear a lion roaring in my ear.] [Bear Sound]

[Lion, Lion, What do you hear? I hear a hippopotamus snorting in my ear.] [Hippo Sound]

[Hippopotamus, Hippopotamus, What do you hear? I hear a flamingo fluting in my ear.] [Flamingo Sound]

[Flamingo, Flamingo, What do you hear? I hear a zebra braying in my ear.] [Zebra Sound]

[Zebra, Zebra, What do you hear? I hear a boa constrictor in my ear.] [Boa Constrictor Sound]

[Boa Constrictor, Boa Constrictor, What do you hear? I hear a elephant trumpeting in my ear.] [Elephant Sound]

[Elephant, Elephant, What do you hear? I hear a leopard snarling in my ear.] [Leopard Sound]

[Leopard, Leopard, What do you hear? I hear a peacock yelping in my ear.] [Peacock Sound]

[Peacock, Peacock, What do you hear? I hear a walrus bellowing in my ear.] [Walrus Sound]

[Walrus, Walrus, What do you hear? I hear a zookeeper whistling in my ear.] [Whistle Sound]

[Zookeeper, Zookeeper What do you hear? I hear children]

[Turn page and wait 5 seconds][Push Bear] [Bear Sound] “growling like a panda bear”

[Wait 5 seconds][Push Lion] [Lion Sound] “roaring like a lion”

[Wait 5 seconds][Push Hippo] [Hippo Sound] “snorting like a hippopotamus”

[Wait 5 seconds][Push Flamingo] [Flamingo Sound] “fluting like a flamingo”

[Wait 5 seconds][Push Zebra] [Zebra Sound] “braying like a zebra”

[Wait 5 seconds][Push Snake] [Boa Constrictor Sound] “hissing like a boa constrictor”

[Wait 5 seconds][Push Elephant] [Elephant Sound] “trumpeting like an elephant”

[Wait 5 seconds][Push Leopard] [Leopard Sound] “snarling like a leopard”

[Wait 5 seconds][Push Peacock] [Peacock Sound] “yelping like a peacock”

[Wait 5 seconds][Push Walrus] [Walrus Sound] “bellowing like a walrus.”

“That’s what I hear”
Anticipated Infant Behaviors/Researcher Responses

If the child smiles or laughs → smile back
If the child looks back to parent for greater than 3 seconds → say the child’s name once and tap their shoulder
If the child attempts to get away → allow them to leave and continue the interaction
If the child remains away from the interaction for an entire page → say their name and take a play break if they do not return
If the child gets upset → stop and take a five minute play break with JA toys
The following engagement codes were applied to the outlines of the interactions. Any given event can only be coded with one code. Therefore once an engagement ‘state’ has begun, no new codes can be applied until the original engagement state code has been terminated according to the below rules. Additionally, the last event in a coded interaction must contain one of the involved objects/persons (important at the end of the books).

- **Coordinated Joint Attention**
  - Occurred when the infant shifted his/her attention between an object and a person
    - Device and Researcher or Book and Researcher
  - Initiated by back to back events of object-person or person-object
  - Included at least two attention shifts (three attention events)
    - The same object or person accounted for two of those events encompassing the other event between two events of the same object/person
  - Entire episode must have lasted at least three seconds
  - Continued until:
    - a shift(s) to an outside event (another object or person or unengagement) occurred and lasted for 5 seconds or greater
      - episode was terminated after the involved object or person event immediately preceding the external event(s) lasting 5 seconds
    - three consecutive shifts (four events) occurred without including both of the original objects/persons
      - episode was terminated immediately after the last shift between the original two items

**CJA Example #1**

<table>
<thead>
<tr>
<th>Time</th>
<th>Object</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2</td>
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<tr>
<td>0:00:31</td>
<td>Researcher</td>
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</tr>
<tr>
<td>0:00:32</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:00:33</td>
<td>Researcher</td>
<td>1</td>
</tr>
<tr>
<td>0:00:34</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:00:35</td>
<td>Researcher</td>
<td>1</td>
</tr>
<tr>
<td>0:00:36</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:00:37</td>
<td>Book</td>
<td>7</td>
</tr>
</tbody>
</table>

*Episode was initiated by the back to back events of Device-Researcher and the two Device events encompassed the Researcher event.*

*Episode was terminated by the Book event which lasted 7 seconds (5 seconds or greater).*
CJA Example #2

<table>
<thead>
<tr>
<th>Time</th>
<th>Object</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:03:39</td>
<td>Device</td>
<td>6</td>
</tr>
<tr>
<td>0:03:45</td>
<td>Researcher</td>
<td>2</td>
</tr>
<tr>
<td>0:03:47</td>
<td>Book</td>
<td>2</td>
</tr>
<tr>
<td>0:03:49</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:03:51</td>
<td>Researcher</td>
<td>5 *</td>
</tr>
<tr>
<td>0:03:55</td>
<td>Book</td>
<td>4 *</td>
</tr>
<tr>
<td>0:03:57</td>
<td>Researcher</td>
<td>2 *</td>
</tr>
<tr>
<td>0:04:01</td>
<td>Unengaged</td>
<td>4 *</td>
</tr>
</tbody>
</table>

Episode was initiated by the back to back events of Device-Researcher and two Device events encompassed the Researcher event.

Terminated here (immediately after last shift between the two objects).

Episode was terminated by four consecutive events (indicated with *) not including both of the original objects/persons (device).

This CJA episode lasted a total of 16 seconds.

Passive Joint Attention
- Occurred when the infant was highly engaged with one object that was also being attended to by the researcher but the infant was seemingly unaware of the shared aspect of the episode
- Initiated by 3 continuous seconds of engagement with the same object
  - Device or Book
- Continued until:
  - a shift(s) to an outside event (another object or person or unengagement) occurred and lasted for 5 seconds or greater
    - episode was terminated after the involved object event immediately preceding the external event(s) lasting 5 seconds
  - three consecutive shifts (four events) occurred without including the original object
    - episode was terminated immediately after the last shift to the object of attention

PJA Example #1

<table>
<thead>
<tr>
<th>Time</th>
<th>Object</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00:29</td>
<td>Book</td>
<td>7</td>
</tr>
<tr>
<td>0:00:36</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:00:37</td>
<td>Book</td>
<td>1</td>
</tr>
<tr>
<td>0:00:38</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:00:39</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:00:40</td>
<td>Book</td>
<td>4</td>
</tr>
<tr>
<td>0:00:44</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:00:45</td>
<td>Device</td>
<td>4</td>
</tr>
</tbody>
</table>

Episode was initiated by the engagement with the book (≥3 sec). No awareness of the researcher was apparent so it is not a CJA event.

This PJA episode lasted a total of 15 seconds as it is terminated after the last book event.

Episode was terminated by the combined events of Unengaged and Device which lasted 5 seconds.
PJA Example #2

<table>
<thead>
<tr>
<th>Time</th>
<th>Object</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:03:39</td>
<td>Device</td>
<td>6</td>
</tr>
<tr>
<td>0:03:45</td>
<td>Unengaged</td>
<td>2</td>
</tr>
<tr>
<td>0:03:47</td>
<td>Book</td>
<td>1</td>
</tr>
<tr>
<td>0:03:48</td>
<td>Device</td>
<td>5</td>
</tr>
<tr>
<td>0:03:53</td>
<td>Unengaged</td>
<td>1*</td>
</tr>
<tr>
<td>0:03:54</td>
<td>Book</td>
<td>1*</td>
</tr>
<tr>
<td>0:03:55</td>
<td>Unengaged</td>
<td>1*</td>
</tr>
<tr>
<td>0:04:01</td>
<td>Researcher</td>
<td>1*</td>
</tr>
</tbody>
</table>

Episode was initiated by the engagement with the device (≥3 sec). No awareness of the researcher was apparent so it is not a CJA event. Terminated here (immediately after event with the device).

Episode was terminated by four consecutive events (Indicated with *) not including both of the original objects/persons (device).

This PJA episode lasted a total of 14 seconds.

Augmented Coordinated Joint Attention
- Occurred when the infant shifted his/her attention between the two objects (device and book) of the interaction
- Initiated by four consecutive events of device-book or book-device shifts
  - Device-Book-Device-Book or Book-Device-Book-Device
- Included at least three attention shifts (four attention events) between the two objects
- Continued until:
  - A shift(s) to an outside event (another object or person or unengagement) occurred and lasted for 5 seconds or greater
    - Episode was terminated after the involved object or person event immediately preceding the external event(s) lasting 5 seconds
  - Three consecutive shifts (four events) occurred without including both of the original objects/persons
    - Episode was terminated immediately after the last shift between the original two items

ACJA Example #1

<table>
<thead>
<tr>
<th>Time</th>
<th>Object</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00:29</td>
<td>Book</td>
<td>2</td>
</tr>
<tr>
<td>0:00:31</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:00:32</td>
<td>Book</td>
<td>1</td>
</tr>
<tr>
<td>0:00:33</td>
<td>Device</td>
<td>5</td>
</tr>
<tr>
<td>0:00:38</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:00:39</td>
<td>Book</td>
<td>4</td>
</tr>
<tr>
<td>0:00:43</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:00:44</td>
<td>Researcher</td>
<td>8</td>
</tr>
</tbody>
</table>

Episode was initiated by four consecutive events of object-based shifting.

This ACJA episode lasted a total of 15 seconds as it is terminated after the last Device event.

Episode was terminated by the Researcher event which lasted 8 (≥5) seconds.
### ACJA Example #2

<table>
<thead>
<tr>
<th>Time</th>
<th>Object</th>
<th>Event #</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:03:39</td>
<td>Device</td>
<td>4</td>
</tr>
<tr>
<td>0:03:43</td>
<td>Book</td>
<td>2</td>
</tr>
<tr>
<td>0:03:45</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:03:46</td>
<td>Book</td>
<td>1</td>
</tr>
<tr>
<td>0:03:47</td>
<td>Researcher</td>
<td>2</td>
</tr>
<tr>
<td>0:03:49</td>
<td>Book</td>
<td>6</td>
</tr>
<tr>
<td>0:03:55</td>
<td>Device</td>
<td>4</td>
</tr>
<tr>
<td>0:03:59</td>
<td>Researcher</td>
<td>2</td>
</tr>
<tr>
<td>0:04:01</td>
<td>Book</td>
<td>1</td>
</tr>
<tr>
<td>0:04:01</td>
<td>Device</td>
<td>3 *</td>
</tr>
<tr>
<td>0:04:01</td>
<td>Researcher</td>
<td>3 *</td>
</tr>
<tr>
<td>0:04:01</td>
<td>Device</td>
<td>7 *</td>
</tr>
<tr>
<td>0:04:01</td>
<td>Unengaged</td>
<td>4 *</td>
</tr>
</tbody>
</table>

- **Episode was initiated by four consecutive events of object-based shifting.**
- **Despite the embedded CJA episode between the book and researcher, the ACJA code has not been terminated by the rules and therefore the CJA is not coded.**
- **Terminated here (immediately after event with the last shift between the book and device).**
- **Episode was terminated by four consecutive events (Indicated with *) not including both of the original objects (book).**

**This ACJA episode lasted a total of 26 seconds.**

### Person Engagement
- **Occurred when the infant was engaged only with another person**
  - Researcher or Parent
- **Initiated by 3 continuous seconds of engagement with the same person**
- **Continued until**
  - a shift(s) to an outside event (another object or person or unengagement) occurred and lasted for 5 seconds or greater
    - episode was terminated after the involved object or person event immediately preceding the external event(s) lasting 5 seconds
    - three consecutive shifts (four events) occurred without including the original person
    - episode was terminated immediately after the last shift to the person of attention

### Person Engagement Example #1

<table>
<thead>
<tr>
<th>Time</th>
<th>Object</th>
<th>Event #</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00:29</td>
<td>Researcher</td>
<td>4</td>
</tr>
<tr>
<td>0:00:33</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:00:32</td>
<td>Researcher</td>
<td>1</td>
</tr>
<tr>
<td>0:00:33</td>
<td>Device</td>
<td>9</td>
</tr>
</tbody>
</table>

- **Episode was initiated by the engagement with the researcher (≥3 sec).**
- **Episode was terminated by the Device event.**

**This episode lasted a total of 6 seconds.**
- **Unengaged**
  - Occurred when the infant was not engaged with any of the objects (device or book) or people (researcher or parent) of the interaction
  - Initiated by 3 continuous seconds of unengagement
  - Continued until:
    - a shift(s) to an outside event (another object or person) occurred and lasted for 5 seconds or greater
    - episode was terminated immediately after the preceding unengaged instance
    - three consecutive shifts (four events) occurred without including ‘unengaged’
    - episode was terminated immediately after the preceding unengaged instance

**Unengaged Example #1**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00:29</td>
<td>Unengaged</td>
<td>3</td>
</tr>
<tr>
<td>0:00:36</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:00:37</td>
<td>Book</td>
<td>1</td>
</tr>
<tr>
<td>0:00:38</td>
<td>Unengaged</td>
<td>7</td>
</tr>
<tr>
<td>0:00:39</td>
<td>Researcher</td>
<td>1</td>
</tr>
<tr>
<td>0:00:40</td>
<td>Book</td>
<td>4</td>
</tr>
<tr>
<td>0:00:44</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:00:45</td>
<td>Device</td>
<td>5</td>
</tr>
</tbody>
</table>

- Episode was initiated by the Unengaged event (≥3 sec)
- Despite the other events embedded in this series of events, none of them meet the requirements to terminated the unengaged episode.
- Episode was terminated by the Device event (5 seconds).

- **Other**
  - Other instances of attention which did not meet any of the above coding guidelines did not receive a code and were disregarded.

**Other Example #1**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:03:39</td>
<td>Device</td>
<td>3</td>
</tr>
<tr>
<td>0:03:42</td>
<td>Researcher</td>
<td>2</td>
</tr>
<tr>
<td>0:03:44</td>
<td>Device</td>
<td>2</td>
</tr>
<tr>
<td>0:03:46</td>
<td>Book</td>
<td>1</td>
</tr>
<tr>
<td>0:03:47</td>
<td>Unengaged</td>
<td>2</td>
</tr>
<tr>
<td>0:03:49</td>
<td>Book</td>
<td>8</td>
</tr>
<tr>
<td>0:03:57</td>
<td>Device</td>
<td>1</td>
</tr>
<tr>
<td>0:04:01</td>
<td>Book</td>
<td>4</td>
</tr>
</tbody>
</table>

- CJA episode coded for 7 seconds.
- The Book and Unengaged events are not long enough in duration and do not meet any code requirements.
- PJA episode with book coded for 13 seconds.
- There were 3 seconds receiving the ‘other’ code.
Example Showing All Codes

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:07:42</td>
<td>Researcher</td>
<td>2</td>
</tr>
<tr>
<td>0:07:44</td>
<td>Device</td>
<td>7</td>
</tr>
<tr>
<td>0:07:51</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:07:52</td>
<td>Device</td>
<td>2</td>
</tr>
<tr>
<td>0:07:54</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:07:55</td>
<td>Device</td>
<td>3</td>
</tr>
<tr>
<td>0:07:58</td>
<td>Researcher</td>
<td>10</td>
</tr>
<tr>
<td>0:08:08</td>
<td>Device</td>
<td>2</td>
</tr>
<tr>
<td>0:08:10</td>
<td>Book</td>
<td>1</td>
</tr>
<tr>
<td>0:07:52</td>
<td>Device</td>
<td>2</td>
</tr>
<tr>
<td>0:07:54</td>
<td>Book</td>
<td>1</td>
</tr>
<tr>
<td>0:07:55</td>
<td>Device</td>
<td>3</td>
</tr>
<tr>
<td>0:07:58</td>
<td>Researcher</td>
<td>10</td>
</tr>
<tr>
<td>0:08:08</td>
<td>Device</td>
<td>2</td>
</tr>
<tr>
<td>0:08:10</td>
<td>Researcher</td>
<td>1</td>
</tr>
<tr>
<td>0:08:11</td>
<td>Device</td>
<td>17</td>
</tr>
<tr>
<td>0:08:28</td>
<td>Unengaged</td>
<td>6</td>
</tr>
<tr>
<td>0:08:34</td>
<td>Researcher</td>
<td>1</td>
</tr>
<tr>
<td>0:08:35</td>
<td>Device</td>
<td>29</td>
</tr>
<tr>
<td>0:09:04</td>
<td>Researcher</td>
<td>2</td>
</tr>
<tr>
<td>0:09:06</td>
<td>Device</td>
<td>2</td>
</tr>
<tr>
<td>0:09:08</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:09:09</td>
<td>Book</td>
<td>11</td>
</tr>
<tr>
<td>0:09:20</td>
<td>Device</td>
<td>2</td>
</tr>
<tr>
<td>0:09:22</td>
<td>Book</td>
<td>4</td>
</tr>
<tr>
<td>0:09:26</td>
<td>Device</td>
<td>52</td>
</tr>
<tr>
<td>0:10:18</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:10:20</td>
<td>Book</td>
<td>2</td>
</tr>
<tr>
<td>0:10:22</td>
<td>Unengaged</td>
<td>1</td>
</tr>
<tr>
<td>0:10:23</td>
<td>Device</td>
<td>3</td>
</tr>
<tr>
<td>0:10:26</td>
<td>Book</td>
<td>1</td>
</tr>
</tbody>
</table>

**Other (2 sec)** = Does not meet any requirements.

**Passive JA with Device (14 sec)** = Begins with 7 seconds and the Unengaged events do not exceed 5 seconds.

**Person Engagement (10 sec)**

**Augmented CJA (9 sec)** = Four consecutive object shifting events.

**Coordinated JA (30 sec)** = Shifting between researcher and device.

**Unengaged (6 sec)**

**Coordinated JA (34 sec)** = Shifting between researcher and device but is terminated when there are 4 consecutive events not including the researcher.

**Passive JA with Book (17 sec)** = Begins with 11 seconds and the Device event does not exceed 5 seconds.

**Passive JA with Device (59 sec)** = Begins with 52 seconds and the Unengaged and Device events do not exceed 5 seconds combined.
FOOTNOTES