The Effects of Intensive Tact Instruction on Two- and Three-point Responding to Joint Attention

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Abstract

Low demonstration or lack of joint attention are one of the earliest indicators of children being diagnosed with autism spectrum disorder (ASD). Previous research shows that demonstrating joint attention is important for a child's development and is fully demonstrated by 12 to 18 months of age. Joint attention is defined as a child sharing an experience with another individual and this definition does not require ongoing coordinated eye gaze during the shared experience. To expand the joint attention literature, two experiments were conducted to increase joint attention in toddlers and children. The purpose of Experiment 1 was to induce joint attention (RJA and IJA) using an Intensive Tact Instruction (ITI) for children with listener and speaker skills and was a systematic replication of Harms (2020). The participants were selected based on a purposive and convenience sample and they were all receiving Special Instruction services at an Early Intervention center during the time of the experiment. The participants were between the ages of 2 and 3 years. The researcher recruited participants who did not emit three-point RJA. A nonconcurrent multiple baseline design was used to measure the Effects of the ITI on two-point RJA, three-point RJA, and IJA across 3 participants. Results indicated that 1 out of 3 participants increased three-point RJA and IJA to criterion-level but the remaining 2 participants did not increase three-point RJA after experiencing the ITI. The purpose of Experiment 2 was to target two-point RJA using an ITI intervention for children who emitted limited to no two-point RJA during the preintervention assessments. The participants were selected based on a convenience sample and they were all receiving Special Instruction services at an Early Intervention center or at a preschool during the time of the experiment. The participants were between the ages of 2 and 4 years. None of the participants demonstrated criterion-level of two-point RJA prior to beginning the experiment. The main dependent variable in this experiment

was two-point RJA while also assessing three-point RJA, IJA, vocal verbal operants, and the childhood joint attention rating scale (C-JARS). A concurrent multiple baseline design was used to measure the effect of the ITI on two-point RJA. The results indicated that participants who completed the experiment increased two-point RJA to criterion level and demonstrated a functional relation between the ITI and two-point RJA. Experiment 2 also successfully increased three-point RJA with one participant and IJA with one participant. The ITI used an elongated reinforcer experience as part of the consequence for correct tact responses and successfully paired social experiences as a reinforcer. This resulted in increasing two-point RJA to criterion level across all participants who completed the experiment. Results indicate that the ITI may successfully lead to an increase in two-point RJA in toddlers and children between the ages of 2 and 4 years old because it establishes reinforcement for sharing social experiences with another person.

Keywords: Joint Attention, Language, Intensive Tact, Natural Reinforcers

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Dedication

踊りが下手くそでも、いつも応援してくれているおばばへ、初めて焼いたクッキーで砂糖と塩を間違えても食べてくれたおばばへ、永遠にありがとう。

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CHAPTER I:

REVIEW OF THE LITERATURE

Joint Attention

Joint attention is believed to be a crucial developmental milestone that demonstrates correlations with social, emotional, and cognitive skills from an early age and builds foundations for language development (Abney et al., 2017; Bottema-Beutel, 2016; Dube et al., 2004; Jones & Carr, 2004; Leekam et al., 2000; Moore et al., 2014; Morales et al., 2005; Mundy et al., 2009; Mundy & Gomes, 1998; Murza et al., 2016; Pelaez & Monlux, 2018; Salo et al., 2018; Sheinkopf et al., 2004; Singer-Dudek et al., 2023; Trent et al., 2005; Zubrick and Farrant, 2011). Research also demonstrates there is a positive correlation between joint attention and academic success and cultural understandings (Gabouer & Bortfeld, 2021; Gavrilov et al., 2012; Mundy & Newell, 2007). Joint attention was first coined by Jerome Bruner and is an early non-vocal social-communicative behavior (Bruner, 1975). Joint attention occurs when an individual shares an experience with another individual (by shifting their eye gaze, pointing, or commenting) regarding an object or event in the environment (Poysa-Tarhonen et al., 2021; Schertz & Odom, 2004; Yoder & McDuffie, 2006). According to Bakeman and Adamson (1984), joint attention requires active coordination between two people, where one person is attempting to share an experience with the other person in regard to the object or event of interest. Active coordination is when a child is intentionally attending to the target object or event of interest and/or the other person and sharing the experience together through gaze following, gaze shifts, pointing and/or vocalizations. Researchers can observe that a child is intentionally engaging in active coordination when their eye gaze is shifting back and forth between the object or event of interest and the other person. For example, a jack-in-the-box pops open and the child makes a

surprised face and looks back at the other person. The child closes the jack in the box and makes it pop open again and looks at the other person for their reaction. This is an example of active coordination where the child is clearly engaging in a social behavior surrounding the exciting environmental event (the jack-in-the-box popping). Though this behavior may be difficult to observe and record, the active coordination observed in joint attention is what makes the experience social (Gabouer & Bortfeld, 2021).

Joint Attention and Social Behaviors

Joint attention is a social behavior. The identification of joint attention is correlated with a variety of other social behaviors (Stordahl et al., 2023). During a joint attention experience, the child is initiating and/or responding to social interactions with others. That is, a child may shift their eye gaze or engage in a point to draw someone's attention to the target stimulus or they may respond to someone else's cue to attend to the target stimulus (Amano et al., 2004). For example, if the mail carrier comes to the door and the child notices before the parent does, the child may draw the parent's attention to the mail carrier. Another example is if the dad came home and the mother pointed out to the child, "Look, dad's home!" and the child looks at the dad, smiles, and runs over to him, the child is responding to the mother's cue to attend to the dad When a child can initiate and respond to social interactions, they can both request and access a variety of reinforcers in the environment. These social interactions may consist of eye gaze coordination, gestures, or vocalizations (Slaughter & McConnell, 2003; Vivanti et al., 2017). These sharing experiences lead the child to learn social-communicative behavior and the importance of being part of a community (Adamson et al., 2019; Kasari et al., 2011; Landa, 2005). Children also learn from joint attention that not all social behavior or communication is vocal and consist of behaviors such as eye gaze and facial expressions (Morris, 2021; Warreyn et al., 2014). When a

child has more opportunities to engage in social interactions, they may form better communication and social skills in the future which leads them to form meaningful connections. Whalen et al (2006) found that after participants engaged in joint attention training, non-targeted behaviors such as social initiations, positive affect, imitation, play, and spontaneous speech increased. Social interactions such as joint attention teach novel language such as labels: the name of objects, images, and events. Hansen et al (2019) and Wetherby et al. (2007) also stated that joint attention is one of the foundational skills that can lead to complex social behavior such as perspective-taking and conversational skills. The result of previous research highlights the correlation between social behavior and joint attention since joint attention is often observed during social interactions (Ozerk et al., 2021; Lewy & Dawson, 1992; Schietecatte et al., 2012). Joint attention in and of itself is a vital social skill that toddlers develop. For social skills to be taught, social interactions should serve to reinforce behaviors. This reinforcing stimulus may need to be taught or paired for particular children, such as those with developmental delays or autism or for those with aversive social experiences or histories. There is a topography and form of joint attention. Previous experimenters have implemented interventions that focus primarily on shaping topographical behaviors related to joint attention in the absence of teaching appropriate reinforcement (Kryzak & Jones, 2015; Taylor & Hoch, 2008).

Joint Attention and Language

Research has demonstrated significant correlations between joint attention and language development (Carpenter et al., 2005; Hebert-Myers et al., 2006; Macarthur & Adamson, 1996; McCathren, 1996; McCathren et al., 1999; McCathren et al., 2000; Paparella & Kasari, 2004; Pelaez & Monlux, 2018; Roberts et al., 2002; Tomasello & Farrar, 1986; Tomasello & Todd, 1983). Baldwin (2014) found a correlation between infants sharing attention and word

comprehension skills while Mundy et al (2007) found that children who engaged in RJA (responding to joint attention) at 12 months and IJA (initiating joint attention) at 18 months predicted more robust language at 24 months. In addition, previous research found that one of the predictors of language is whether participants respond to a point (Charman et al., 2005; Mundy et al., 1990; Vouloumanos & Werker, 2007). Previous research also found that IJA is correlated with increased vocabulary growth, social skills, communication and executive functioning skills as they become older (Beuker et al., 2013; Brewe et al., 2018; Landry & Loveland, 1989; Markus et al., 2000; Miller & Marcovitch, 2015; Mundy et al., 2017; Poon et al., 2012). Similarly, children who emit higher frequencies of joint attention increase language skills after experiencing joint attention interventions (Bono et al., 2004; Toth et al., 2006). When an adult bids for joint attention (requests to share the experience through gaze shifting, pointing, and/or vocalizations), the adult often labels the object or event while having the child's attention (Adamson et al., 2004; Baldwin, 2014; Baron-Cohen et al., 1997; Kasari et al., 1990; Limosani et al., 2021). This joint focus of attention enables labeled words to become paired with the appropriate point of reference (Kasari et al., 2008). The result of previous literature suggests the importance of joint attention experiences for developing infants and children (Adamson et al., 2017; Vaughan Van Hecke, et al., 2007).

Joint Attention in Typically Developing Children

In comparison to typically developing children, autistic children showed early social attention impairments such as social orienting and joint attention (Dawson et al., 2004). Social orienting is when a child attends to and responds to social stimuli such as looking at faces and gestures and attending to voices (Dalmaso et al., 2020). Typically developing infants demonstrated a steady increase in joint attention. The behavior emerged at 9 to 12 months of age

(Bakeman & Adamson, 1984; Mundy et al., 2007; Schertz & Odom, 2007). At 3 months of age, infants begin engaging in face-to-face social play while at 6 months of age, infants begin showing interest in objects (Naber et al., 2008). When the toddler is 9 months old, they follow the adult's simultaneous looking and pointing behavior (Cilia et al., 2020; Morissette et al., 1995). When the toddler is 12 months old, they will follow the adult's gaze shift and head movement without any gesturing behavior (e.g., pointing) (Von Hofsten et al., 2005). Interestingly, Boyer et al. (2020) found that joint attention develops gradually and that it is not a repertoire that develops all at once. The seminal study of joint attention, Scaife and Bruner (1975), where the researchers observed participants interacting with their mothers between 6 and 18 months of age indicated that the frequency, duration, and intervals of participants engaging in joint attention increased with age (Bakeman & Adamson, 1984; Eriksson, 2019; Mundy et al., 2007; Van der Veken, 2022). Research has found that newborns preferred mother's voices and that they were most likely conditioned as a reinforcer while in the womb (Decasper & Fifer, 1980; Fadda & Lucarelli, 2017). Moon et al. (1993) found that toddlers and newborns also preferred the native language. Researchers found that it is around 2 years of age when typically developing children are engaging in joint attention regularly and consistently (Jones & Carr, 2004; Naber et al., 2007). This occurs seemingly without additional intervention because these children may have multiple opportunities to engage in joint attention behaviors and may also notice the bids for joint attention made by others.

Joint Attention in Autistic Children

Autistic children may demonstrate joint attention later in life or in smaller amounts and in early diagnosis for autism, such as the ADOS-G Module, delays in joint attention may indicate a core deficit. (Bakeman & Adamson, 1984; Bruinsma et al., 2004; Charman et al., 1997; Kamp-

becker et al., 2018; Lebersfeld et al., 2021; Lord et al., 2012; Meindl & Malone, 2011; Mundy, 1995; Nystrom et al., 2019; Siposova & Carpenter, 2019; Sullivan et al., 2007). Autistic children often show lower frequencies of making eye contact, responding to their name, and attending to stimuli in the environment (Cook et al., 2017; Dargue et al., 2022; Nadig et al., 2007; Ornitz et al., 1977). Autistic children may need to be explicitly taught how to or to want to engage in social behaviors, such as joint attention. Adamson et al. (2019) and Charman et al. (2005) found that toddlers who showed risk for autism spectrum disorder (ASD) and autistic toddlers showed less frequency and duration in joint attention, social behavior, and expressive language. These autistic toddlers demonstrated limited social interactions with others in comparison to typically developing children. Many studies demonstrate that autistic children show lower frequency in eye contact (Jones & Klin, 2009; Tregay & Gibbon, 2017). Holth et al (2009) proposed that non-vocal social behaviors such as smiles, nods and gaze shifts do not function as reinforcers for many autistic children. Carpenter et al., (2002) found that autistic children showed lower frequencies of gaze following when they are between 3 and 4 years old in comparison to typically developing children. Furthermore, previous studies have shown that autistic children showed low frequencies of gaze following and gaze shifting and have low frequencies of responding to bids for joint attention (Belen et al., 2023; Brooks et al., 2004; Charman et al., 2003; Yoon et al., 2024). Research demonstrates that gesturing is an effective form of antecedent to evoke RJA responses and leads to an increased duration of shared joint attention compared to using gaze shifts alone as the antecedent (Benjamin et al., 2014; Cilia et al., 2020). When a child follows another person's gesture toward a target, the gesture is said to be under stimulus control, as it reliably evokes attention to the indicated object or event. Moreover, autistic children have also shown lower frequencies of orienting to speech sounds, social stimuli, and engaging in vocal

and non-vocal social communication skills (Chawarska et al., 2012; Dawson et al., 1998; Ho et al., 2019; Mundy & Crowson, 1997; Spence, 2003). Additionally, children responding to joint attention may have a non-social reason to do so. For example, a child may not necessarily be evoked by social motivating operations to be shifting eye gaze to where another person is looking. The child may be shifting eye gaze to the event or object in the environment because it leads to the consequence of seeing interesting objects and events (Carpenter et al., 1998). The form may appear like joint attention, but this behavior would not be considered joint attention since the motivating operation (the environmental stimulus that changes whether a reinforcer or punisher is effective or not) is not to share the experience with another individual. We can isolate the form from function by attending to the intention behind the behavior. For example, if an adult says, "Look, a clown behind you!" and the child looks in the direction of the point and returns to their activity, this shows that the child has the form in repertoire (shifting their eye gaze towards the target object/event), but not the function (i.e., sharing the experience with another person.) Therefore, the motivating operation, the history of reinforcement and punishment can influence whether social reinforcement such as praise or pats on the back are effective forms of reinforcers which determine whether a child will engage in joint attention (Dube et al., 2004). Due to these deficits in social communication behaviors, many autistic children require individualized explicit instruction to demonstrate communication and joint attention (Meindl & Cannella-Malone, 2011; Murza et al., 2016). However, some have stated that autistic children increase responses of RJA later in their childhood whether they remain nonverbal or not (Mundy & Jarrold, 2010; Sigman & Ruskin, 1999; Stone et al., 1997). It is possible that these new responses emerge as a result of increased and prolonged social experiences and provide greater opportunities to engage with others. Coordinated attention and/or gaze shifting has been correlated with verbal behavior in

autistic children in a longitudinal study (Charman, 2003). However, the developmental trajectories of joint attention are different for autistic children versus typically developing children.

According to Bottema-Beutel (2016), their findings suggest that joint attention, especially responding to joint attention is more related to language for autistic children in comparison to typically developing children. There are several instances in research that show that adults labeling objects or events during a joint attention experience is correlated with language development in autistic children (McDuffie & Yoder, 2010; Smith & Ulvund, 2003). In addition, Charman (2003) found that gaze shifting at 20 months of age has also been positively related to language skills of 42-month-old autistic children. Researchers also demonstrated that autistic children who share experiences and follow the gaze of others have more complex language skills in repertoire (Charman, 2003; Morgenstern, 2014). According to Bottema-Beutel (2016), their longitudinal and meta-analytic evidence show that early childhood joint attention behavior are predictors of later verbal behavior though this evidence is correlational. Other research such as Kasari et al. (2008) and Schertz and Odom (2004) taught joint attention and showed that language also increased. Additional research is required to state this as a definitive finding. Autistic children often use gestures and gaze alternation during requests, but not to engage in RJA or IJA (Charman et al., 2003). Researchers have found that autistic children can point to pictures in a book as a form of non-social pointing since they do not look for social approval when doing so (Baron-Cohen, 1989; Butterworth & Jarrett, 1991). These findings suggest that when autistic children engage in pointing behavior, one cannot assume that the function is to gain social attention or interaction. Therefore, one cannot observe the form of a behavior and assume the function of that behavior. When a child engages in limited joint attention, the child's

experience of interacting with others becomes limited, leading the child to have even more limited social and learning opportunities (Meindl & Cannella-Malone, 2011).

Responding to Joint Attention

There are distinct versions of joint attention. One form of joint attention is described as when one responds to another individual's initiation of joint attention using a pointing or shift in eye gaze (Bruinsma & Koegel., 2004; Dawson et al., 2004; De Belen et al., 2023; Salley et al., 2016; Yoder et al., 2007). Researchers coined this behavior as responding to joint attention (RJA). There are two classifications of RJA: two-point RJA and three-point RJA. During two-point RJA, the adult will engage in gaze shift or gestures which leads the child to shift their eye gaze towards the target stimulus. An example of two-point RJA would be if the target individual was playing with blocks with an adult and the adult shifted their eye gaze from the child to the blocks and said, "Look at the tower I made!" and the target individual oriented to the tower. During three-point RJA, the adult will engage in gaze shift or gestures which leads the child to shift their eye gaze towards the target stimulus and looks back at the adult and/or the bidder. The difference between two-point and three-point RJA is that three-point RJA includes an extra social response where there is ongoing coordination between the object or event and other person through eye gaze and/or verbalizations. An example of three-point RJA would be if the target individual was playing with blocks with an adult and the adult shifted their eye gaze from the child to the blocks said, "Look at the tower I made!" and the target individual oriented to the tower and looked back at the adult and said, "That's cool!" The target individual looking back at the adult and emitting a verbal response is considered the extra social response seen in three-point RJA. However, three-point RJA does not require vocalizations. A non-vocal example of three-point RJA would be if the target individual oriented to the tower and looked back at the

adult. While shifting eye-gaze back towards the adult, the child may change their facial expressions to express an emotion (Hori et al., 2005). In this example, the child may look back at the adult and raise their eyebrows to show that they are impressed by the tower. The target individual looking back at the adult is considered the extra social response seen in three-point RJA that is not apparent in two-point RJA. Three-point RJA requires greater response effort than two-point RJA for the target individual. Mundy (2021) views RJA as a precursor to developing further social skills and communication.

Initiating Joint Attention

Another form of joint attention is described as an instance where an individual initiates the shift of an eye gaze or a gesture to share the experience of an object or event with another individual (Bruinsma et al., 2004; Meindl & Cannella-Malone, 2011). In other words, when a child is engaging in initiating joint attention (IJA), the child is the one beginning the interaction; meanwhile when a child is engaging in RJA, they are the one responding to someone else's initiation. Children may initiate joint attention through "eye contact, affect, gesture, vocalization, or symbolic communication" (Mundy & Stella, 2000 p. 55). IJA is seen as an instance where a child is requesting another person's attention and/or requesting to share an experience with another person. There are two definitions of IJA. According to Mundy et al., (2007), IJA can be defined as an identification of an event or object to another individual and does not require a coordinated look or gaze. An example of this definition of IJA is when the target individual points to the window and says, "Look, it's a school bus!" without engaging in a coordinated look or gaze with the other person. The other definition of IJA describes it as the act of directing another individual's attention toward an object or event while coordinating in gaze between the event or object and the other person (Gabouer & Bortfeld, 2021; Koegel, et al., 2009; Striano &

Rochat, 1999; Striano & Stahl, 2005). An example of this definition of IJA is when the target individual points to the window and says, “Look, it’s a school bus!” while engaging in a coordinated look or gaze with the other person. A non-vocal example of this definition of IJA would be if the target individual pointed to the window or looked out the window and looked back at the nearby individual. These are examples of two types of IJA. IJA requires more response effort than both types of RJA and requires a stronger establishing operation. Mundy (2021) views IJA as behavior that is related to the development of more complex social and communicative skills.

Three types of IJA

IJA consists of three types of behavior (Gabouer & Bortfeld, 2021). For the first type of IJA, one of the two people initiates joint attention by directing the other person’s attention to an object or event in the environment. The person initiating the joint attention is attempting to engage with the other person and to share the experience. This may happen vocally, visually, and/or with physical contact. For the second type of IJA, the responding person attends to the object or event and responds to the initiator’s eye gaze shift, gesture, and/or vocalization. This can occur vocally, visually, with physical contact and/or engaging with the object or event. For the third type of IJA, the person initiating joint attention acknowledges the other person’s engagement and shares an experience together. Gabouer and Bortfeld (2021) measured intention during a bid for joint attention by observing whether the person was orienting, physically orienting, engaging, or gesturing towards the target object or event. IJA is an ongoing behavior in comparison to RJA, especially two-point RJA.

In conclusion, RJA is representative of a listener response since the child is responding to a joint attention initiation by another person while IJA is representative of a speaker response

since the child is initiating a joint attention experience with another person. Three-point RJA and IJA requires eye contact to occur (the child making eye contact with an adult) according to the operant definition in the two experiments that are conducted in this experiment. In contrast, two-point RJA requires the participant to shift their eye gaze towards the target stimulus in the environment without engaging in eye contact with the adult.

Different Components and Behaviors of Joint Attention

Joint attention refers to a cluster of behaviors which include eye gaze alternation, gesturing/pointing, showing, vocalizations, labels, facial expressions, and eye contact between two people in reference to the same object or event (Bruinsma et al., 2004; Panganiban, 2017). Eye gaze alternation is defined as alternating one's eye-gaze between another individual and the object or event in the environment (Meindl & Cannella-Malone, 2011). Gesturing consists of pointing to the object or event in the environment (Butterworth, 1995; Leung & Rheingold, 1981). Showing is when a child brings the object or event/activity to another person to share the experience with that person. Vocalizations are any verbal behavior emitted by the child that may occur during the joint attention experience. Labeling items or events is evoked by an object or event in the environment. Since IJA can be considered as a non-vocal tact, during a joint attention experience, vocal tacts can occur simultaneously (Swope, 2010). A child can tact the object or event in the environment while engaging in joint attention. Bruinsma et al (2004) has described tacts as when a child "calls another individual's attention to an object or interest" (p. 170) whilst labeling the stimulus. Tacts and/or any verbal behavior such as conversational units are not necessary for it to be considered joint attention. Facial expressions are an example of nonverbal communication and are often seen during a joint attention experience. A child may change facial affect with the other person in the environment during joint attention (Lomoriello

et al., 2022; Schiano et al., 2022). The facial expressions exchanged between two people can alter the joint attention experience for both people. Engaging in joint attention allows a child to gauge how the other person feels and is thinking about the object or event in the environment. Many researchers state that eye contact, where the child looks back at the other person, is a key component of joint attention (Caruana et al., 2020; Wohltjen & Wheatley, 2021). A child who has quality eye contact will engage in complex behaviors that involve eye contact such as gaze shifting and gaze following. Still, Adamson et al (2019) also stated that during joint attention, a typically developing toddler focuses on the target object or event rather than solely on the other person. This may indicate that eye contact is not such an important measure of joint attention. Therefore, joint attention may occur without the presence of eye contact for both autistic and typically developing toddlers.

Gaze Following

There are additional behaviors that are observed in joint attention. Gaze following, or "joint visual attention," is the phrase used for shared attention (Colombo, 2001; Corkum & Moore, 2014; Jaworski & Eigsti, 2017; Scaife & Bruner, 1975). Gaze following is defined as a child attending to another person's eye gaze shift and shifting their own gaze towards the same object or event. Gaze following is interpreted as an indication that an infant or a child turns their head to attend to what another person is seeing and that they have an understanding that other people look and attend to stimuli in the environment (Holth, 2005; Tomasello, 1995). Essentially, a person engages in gaze following to observe what the other person is attending to or looking towards. Gaze following can be seen during two-point RJA, and three-point RJA. During two-point RJA, the child follows the gaze of another person while during three-point RJA, the child follows the gaze of another person then looks back at the other person. Joint attention increases

the interpretation of others' gaze directions and gaze following is seen as a fundamental behavior in joint attention (Edwards et al., 2020).

Gaze Shifting

Gaze shifting is another behavior observed in joint attention. Gaze shifting, also known as coordinated attention, is defined as an observing response when a child looks at the target object or event then at the adult or vice versa (Bottema-Beutel, 2016; Delgado et al., 2002). Therefore, when engaging in gaze shifting, the person is actively alternating their gaze between the other person and the object or event. Gaze shifting occurs when a child engages in IJA and can determine whether the adult is attending to the same object or event as they are (Dube et al., 2004). This history of reinforcement, punishment, and/or instructional history teaches children how to get the attention of another individual to share an experience in the future. Gaze shifting also occurs during three-point RJA where the child attends to the target object or event and shifts their gaze back at the other person to share the experience. Gaze shifting occurs in two-point RJA as well where a child may be preoccupied with an activity, but the child shifts their eye gaze when another person initiates a joint attention response. When gaze shifting increases, there is a higher likelihood that the child will produce behaviors that capture adult attention, which will lead them to contact social reinforcement and ultimately increase joint attention opportunities (Dube et al., 2004; Kidwell, 2009).

Joint Engagement

Following our discussion of different behaviors that comprise different joint attention types, we must discuss how joint attention fits with the broader topic of joint engagement. According to Adamson et al. (2014), joint engagement is when the child and another person are actively involved with the same target object or event. Joint engagement requires coordinated

looks which are not always present during joint attention. Under the umbrella of joint engagement are *supported* joint engagement and *coordinated* joint engagement. Supported joint engagement is when a child is observing the adult interact with the target object or event in the environment. In comparison, coordinated joint engagement is when the child actively attends to and interacts with the adult in the context of the target object or event in the environment. Coordinated joint engagement is described as reciprocal interactions where supported joint engagement does not require reciprocal interactions between the child and the adult. In the state of joint engagement, a child partakes in behavior that sustains the interactive experience. A child may engage in eye gaze coordination, emit vocalizations, or make gestures to sustain that engagement.

Form versus Function

Joint attention is characterized by its form and function, but the function of joint attention is most important and more complicated to determine. According to Jones et al. (2009), the function of joint attention is to direct attention towards an object or event and to contact social reinforcement. In addition, a child may engage in joint attention for the purpose of learning about their environment and communicating interests with others (Abdelaziz et al., 2025; Jones et al., 2006). This behavior indicates that the maintaining reinforcer of joint attention is social reinforcement, generalized social reinforcement, and sharing an experience with another person. According to Gabouer and Bortfeld (2021) and Crais et al. (2004), coordinated looking itself may not be social since the person orienting to the other person's gaze shift, gesture, or vocalization may not be engaging in joint attention without wanting to interact with others socially. Therefore, a child may be attending to the interesting object or event either because of their interest in the object or event itself or because of their interest in where the other person's

attention is located. The function of joint attention is characterized by why a child engages in joint attention while the form of joint attention describes the topography of the behavior. The function of joint attention also depends on what happens after they emit the behavior. Typically, the natural consequence is social interactions and sharing an experience with another person. Therefore, the intentionality behind eye contact is necessary to understand if a child is engaging in a social behavior such as joint attention. For joint attention to occur, the child must be engaging in eye contact for the purpose of sharing an experience with another person (Gabouer & Bortfeld, 2021). For example, during two-point RJA, the child may shift his or her eye gaze to the event or object in the environment but may have no interest in sharing the experience with the other individual. If a child does not have social stimuli conditioned as reinforcers, there is a low likelihood that the child will be motivated to engage in joint attention. As a result, educators should pair social stimuli as reinforcers so that the child will request them or engage in behaviors that lead them to have social interactions in the future (Dawson et al., 1998; Jones & Carr, 2004). Children's behavior needs to come under the relevant stimulus control for joint attention behaviors to occur. Joint attention behaviors occur and are a function of stimulus control where the child contacts social listener reinforcement when engaging in joint attention. In addition, some autistic children may require explicit instruction to engage in appropriate social interactions with others or have certain cusps induced to increase joint attention behavior. Behaviors related to appropriate social interactions can increase when the reinforcer is taught to the child. Therefore, it is important that educators pair social stimuli with reinforcers so that children can learn that engaging in social behaviors provides access to social interaction.

Joint Attention and Mands

The function of joint attention may in certain instances be perceived as being similar to the mand. A tact can be seen as a mand for attention. According to Skinner, mands are a type of verbal operant that is reinforced by gaining access to a preferred object or activity and is evoked by deprivation and/or aversive stimulation (Skinner, 1957; Harms, 2020). Mands serve the function of requesting a stimulus or stimulus change, such as an object, an event, or an action (Skinner, 1957). A mand can be emitted for social interactions, but a mand is not necessarily a social verbal behavior and depends on the type of mand. For example, a child may mand for play (e.g., "Come play with me") which would be a social behavior, but a child may mand for chips (e.g., "Can I have my chips, please?") which would not be considered a social behavior. These mands may not necessarily be vocal behavior and may be a more subtle version of a mand. In other words, manding is purely a social contract where the child understands that when a mand is emitted, their requested item or activity will most likely be delivered and is emitted for the fulfillment of the child themselves versus a social contact where the child comes into contact with social interaction and/or reinforcement during a joint attention experience (Greer & Du, 2015). In Harms' (2020) study, researchers found that mands during joint attention did not have the same function as RJA or IJA. The author stated that "a mand is emitted for the purpose of obtaining a reinforcer and alleviating a state of deprivation, rather than for correspondence, attention to stimuli or people, or social interactions…" (p. 86). The reason behind why a child engages in the behavior and what the child expects when engaging in the behavior determines whether the behavior is seen as joint attention or a mand. The topographical definition of joint attention does not consider the function of joint attention. Joint attention cannot occur without its social function since form alone does not necessarily indicate joint attention. In behavior analysis joint attention is defined by its function and not its form. Therefore, joint attention is different

from mands because mands are defined in terms of stimulus control; however joint attention is often times defined in terms of topography in previous research. When a child emits a mand, the child gains access to an item or activity while when a child engages in joint attention, the child gains access to social reinforcers.

Joint Attention and Tacts

Joint attention and tacting have the same function which is generalized social reinforcement. They are similar since they serve the function of commenting on a stimulus in the environment by pointing, shifting eye-gaze, showing, or labeling (Bruinsma et al., 2004; Meindl & Cannella-Malone, 2011; Warren & Yoder, 1998). Tacting and joint attention are not necessarily vocal behavior. During IJA and RJA, the function and intention is to share the experience of attending to an object or an event with another person (Jones & Carr, 2004). The consequence of engaging in joint attention is social reinforcement and sharing mutual interest (Fredericks et al., 2023; Pinto et al., 2024). The consequence of emitting a tact is to provide a comment or label for a stimulus and is evoked by a nonverbal stimulus and is reinforced by generalized conditioned reinforcers such as social attention and interactions, rather than to gain access to the labeled stimulus. According to Skinner, the purpose of a tact is to extend the listener's senses where the speaker emits the tact to bring the listener into contact with what the speaker is experiencing. Therefore, a tact is similar to the form of joint attention where a tact requires that the child attends to the target object or picture with the other person to emit a label. A child engages in joint attention to share the experience with another person. Previous research indicates that autistic children engage in verbal behavior to gain access to objects or activities and emit more mands than tacts on average based on the verbal behavior literature (Sundberg & Partington, 1998). Many autistic children acquire manding as a skill more quickly and emit it more

consistently in comparison to tacting and joint attention. Therefore, although autistic children may have the pointing or labeling repertoire, there is a possibility that they do not engage in these behaviors as a social reference (Bruinsma et al., 2004). Joint attention and tacts have similar functions while mands do not, unless the mand is for social stimuli such as attention.

Joint Attention in a Behavioral Analytic Framework

This paper will view joint attention in the context of applied behavior analysis. From the behavioral perspective, joint attention is when a child coordinates their attention between another person and the target object or event in their environment for the purpose of coming into contact with social reinforcers. To build upon that, joint attention is defined as an instance where the child or another person emits a non-verbal or verbal tact of a stimulus in the environment and attempts to share the experience with another person (Dube et al., 2004). Behavior analysts view joint attention as a crucial behavior for engaging in social interactions and communication skills (Krstovska-Guerrero & Jones, 2016). Through my behavioral lens, the goal is not to teach the form of joint attention, but to teach the function of joint attention or to induce the reinforcer to increase joint attention behaviors. For this reason, the researcher should teach the reinforcer of joint attention to increase instances of behavior related to joint attention. In terms of the 3-term contingency, joint attention consists of the antecedent, which is the interesting object or event in the environment, the behaviors, which are the coordinated look(s), and the consequence, which is the social interaction (sharing an experience with another person). See Table 1 for the definitions of RJA and IJA in a behavioral analytic framework based on the three-term contingency.

Table 1

Operant Definition of RJA and IJA, Experiment 1

	Antecedent	Behavior	Consequence
Two-point RJA/ Orienting	Researcher makes eye contact with participant then looks at an interesting stimulus in the environment (i.e., a toy or a picture)	Participant looks at the interesting stimulus	Attending to the same object or event as another person.
Three-point RJA	Researcher makes eye contact with participant then looks at an interesting stimulus in the environment (i.e., a toy or a picture)	Participant looks at the interesting stimulus and looks back at the researcher	Sharing experience of attending to the same object or event as another person
IJA	Researcher presents a cause and effect toy	Participant looks and/or engages with the toy and looks back at the researcher	Sharing experience and social interaction

Behavioral Three-Term Contingency: The Antecedent

Joint attention occurs based on a three-term contingency depending on its antecedent events and consequences, or events occurring just prior to or following the behavior (Delgado et al., 2002). Antecedent events can be described as a variety of interesting events that occur in the child's environment in the presence of another person. These antecedent events can have both "reinforcer-establishing and evocative effects on joint attention" (Dube et al., 2004). During IJA it is the interesting object or event that functions as the antecedent and leads a child to engage in behaviors to access adult-attending stimuli which serve as social conditioned reinforcers

(Delgado et al., 2002). Adult-attending stimuli are defined as visual indicators that ensure that the adult is observing the interesting object or event while the target individual is attending to the same stimulus. The form of an adult-attending stimuli is the adult's eye gaze towards the target object or event. Adult-attending stimuli become conditioned reinforcers due to a reinforcement history where the presence of the adult and the interesting object or event functions as a discriminative stimulus for a joint attention experience. Children learn over time that when adults are attending and sharing the experience, there is an increased likelihood of social reinforcement for engaging with the adult. Engaging in joint attention functions as the antecedent and sharing the experience with another person functions as the consequence. Therefore, the interesting event or object is value-altering on how effective adult-attending stimuli are functioning as reinforcers (Delgado et al., 2002). The presence of adults and the interesting object or event not only functions as the discriminative stimulus and antecedent but also as a conditioned reinforcer.

Behavioral Three-Term Contingency: The Consequence

The consequence component in the three-term contingency is equally significant in maintaining and initiating joint attention behaviors. The consequences that occur after joint attention are "socially mediated reinforcers that maintain joint attention (Dube et al., p. 197). During the presence of an interesting event, a child may engage in certain behaviors due to a relevant history (Delgado et al., 2002). When a child engages in these behaviors, adult-attending behaviors function as a reinforcer. The shared experience of attending to an interesting object or event in a social way functions as the reinforcer for engaging in joint attention behaviors. Therefore, the reinforcing value of these consequences increase based on the type of generalized social reinforcers such as verbalizations, smiling, and gentle pats (Dube et al., 2002). There are three reinforcer types that potentially function as the consequences for joint attention (Dube et

al., 2004). The first potential reinforcer of joint attention is adult-generated generalized social reinforcers such as a smile, a pat on the back, verbalizations, conversations about the object or event, or gestures. The second potential reinforcer is receiving assistance with an object, event, or activity. The consequence is receiving the help from an adult without explicitly asking for it by sharing the object or experience together (Delgado et al., 2002). In this scenario, the adult attending stimuli serve as the discriminative stimulus for receiving help. The third possible reinforcer is when a child looks to the adult for approval or disapproval of an event based on their facial expression when there is an aversive situation present. The joint attention may function as negative reinforcement by gauging whether a situation is safe or unsafe with the presence of an adult. The third possible reinforcer however does not function as a reinforcer of joint attention since the consequence is identical to that of social referencing (Isaksen & Holth, 2009).

Comparing Perspectives across Various Disciplines

Several perspectives on joint attention emerge depending on the field of research under discussion. Thus far, we have examined joint attention from a behavioral perspective. There are several psychological perspectives of joint attention such as developmental psychology, social psychology, cognitive psychology, and clinical psychology. However, the core of the way that various disciplines view joint attention is similar. Specifically in developmental psychology, joint attention is viewed as a key early social cognitive skill that emerges and is important for social and cognitive development of an infant (Akhtar & Gernsbacher, 2007; Cochet & Guidetti, 2018; Dawson et al., 2002). In social psychology, joint attention is observed in the context of social interactions, communication skills, and relations with others and examines empathy, perspective-taking, and being part of a community (Moll & Meltzoff, 2011; Mundy & Newell, 2007; Wolf et

al., 2016). In cognitive psychology, joint attention is understood as a cognitive process that involves visual perception, attention, and social cues and investigates the mental processes during joint attention (Mundy et al., 2000; Mundy & Newell, 2009). In clinical psychology, if a child does not demonstrate joint attention, they are likely to have a developmental disorder such as ASD (Gabouer & Bortfeld, 2021; Mundy & Newell, 2009; Mundy, 2018). Joint attention has been researched across different developmental and clinical contexts (Whalen & Schreibman, 2003). Synthesizing these perspectives is important to develop effective interventions that increase the different behaviors observed in social skills such as joint attention. To conclude, the behavioral perspective does not view joint attention as a skill, but a behavior that occurs when social stimuli (i.e., praise, sharing an experience together) functions as a reinforcer. However, all disciplines believe in the importance of joint attention in a child's life.

Terminology Across Disciplines

The language and terms used in various developmental and clinical perspectives will be translated into behavioral terms (Bowman, 2022; Foxx, 1996). Joint engagement and coordinated joint engagement are terms used when discussing joint attention in developmental psychology (Bottema-Beutel, 2016). Supported joint engagement is when a child and an adult are engaged with the same object or event, but the child does not assess whether the adult is attending (Adamson et al., 2009; Bakeman & Adamson, 1984; Bakeman & Adamson, 1986; Nelson et al., 2008). This form of engagement is similar to two-point RJA discussed above. During joint engagement, a child can be engaging in an activity in a coordinated play setting but may or may not be aware of the presence of the other individual. According to this definition, joint engagement is not always inherently a social behavior. In comparison, coordinated joint engagement is when a child and an adult are engaged similarly with the same object or event

while the child is attending the adult. This form of engagement is similar to IJA. Coordinated joint engagement can be seen as a social behavior from the behavioral perspective.

Protoimperative versus Protodeclarative

In addition, various fields of psychological research use terms that will be translated into behavioral terms. Previously, the difference between mands and tacts and similarities between tacts and joint attention were discussed. Developmental psychology uses the terms protodeclarative and protoimperative to define functions of communication in infants. Protodeclarative actions are used for social purposes such as sharing attention and are therefore reinforced by social stimuli (Gabig, 2013). From the behavioral perspective, tacts and joint attention have a protodeclarative function. In comparison, protoimperative actions are used to request for an object or event to acquire a desired outcome (Gabig, 2013). Therefore, from the behavioral perspective, mands have a protoimperative function.

Interventions to Increase Joint Attention

Previous research has conducted a multitude of different interventions to increase joint attention. According to Holth (2009) and Murray et al (2008), research demonstrated that RJA and IJA are separate joint attention behaviors that need to be taught separately and sequentially. These procedures consist of prompts, prompt fading, time-delay, manipulations of the natural environment, prelinguistic milieu training (naturalistic teaching), discrete trial training (DTT), pivotal response training (PRT), joint attention symbolic play engagement and regulation (JASPER), parent and peer training, imitation, modeling and video modeling, and scripting (Meindl & Cannella-Malone, 2011).

Studies have used a variety of prompts including vocal, gestural, physical, and visual prompts to increase joint attention behaviors. Prompt fading and time-delays have also been used

to increase joint attention (Martins & Harris, 2006; Meindl & Canella-Malone, 2011). Researchers conducted interventions to prompt participants to engage in joint attention behaviors such as RJA and IJA (Kryzak & Jones, 2015; Taylor & Hoch, 2008: Whalen & Schreibman, 2003). Prompt fading and/or least-to-most prompting have also been used in previous research to increase joint attention (Buffington et al., 1998; Freeman & Dake, 1996; Freeman et al., 1998). The various types of prompts included pointing, moving the face, vocal cues, and physical cues. When prompts were used as a tactical procedure to increase joint attention, the researchers delivered contingent reinforcement and used natural antecedents such as the presence of an interesting object or event and the presence of another person to evoke IJA (Jones, 2009; Jones et al., 2016; Kasari et al., 2008; Krstovska-Guerrero & Jones, 2016; Macdonald et al., 2006; Schreibman, 2003). Joint attention has also been taught by prompting correct RJA responses with pointing and gazing while consequating with tangible reinforcers. These experimental procedures may establish the operants but are unlikely to teach the reinforcers that maintain joint attention behaviors in the future. Joint attention behaviors taught by using incorrect consequences can be difficult to generalize in naturalistic joint attention contexts due to the correct stimulus control not being established (Fredericks et al., 2023).

Imitation has also been used as a tactic across studies to increase joint attention. Imitating the participants' play actions, movements, and verbal and non-verbal behavior have also been used to increase joint attention. The intervention is implemented by imitating the participants' behavior to facilitate social awareness such as eye contact, turn-taking and joint attention (Hwang & Hughes, 2000; Ingersoll, 2012; Klinger & Dawson, 1992; Mahoney & Macdonald, 2003; Siller & Sigman, 2002). In the studies, researchers imitated a variety of behaviors such as eye contact, turn-taking, and joint attention. Researchers are mirroring the behaviors of the

participants in these instances. The goal is for the participants to increase their social awareness when the researchers imitate their behavior. The imitation experiments did lead to positive effects on joint attention.

Naturalistic teaching interventions have also been used to increase joint attention where the therapist will follow the child's lead, will happen alongside daily routines, deliver natural consequences, and is flexible. White et al., (2011) discuss how joint attention was taught in the context of play and the natural, non-contrived environment. In the natural environment, researchers used tactics such as imitating the child, following the child's lead, turn-taking, commenting on the child's actions, using simple language, and using visual supports such as visual activity schedules (Roos et al., 2008; Waddington et al., 2021). Researchers imitated the child by mirroring their actions and vocalizations. Researchers also followed the child's lead by engaging in activities that the child is interested in and joined in on the activity instead of redirecting the child to another activity. During turn-taking, researchers modeled taking turns during structured play and conversational units and attempted to teach the idea of reciprocity. In addition, researchers commented on the child's actions by emitting verbalizations based on the actions or activities that the child was engaging in. An example may include a researcher saying, "Wow that tower that you built is very tall, good for you!" The researchers also used simple and clear language when interacting with the child and attempted to use short phrases or labels to help increase comprehension by the child. Finally, researchers also used visual supports such as activity schedules to help structure the activities that the child was engaging in and provide predictability and encourage independence. The application of these strategies such as creating positive, predictable and socially supported environments while adults mirrored the child's behaviors helped increase social behavior such as joint attention in a naturalistic setting.

Previous research also found that when naturalistic teaching interventions were combined with discrete trial training (DTT) and pivotal response treatment (PRT), participants increased joint attention behavior (Whalen & Schreibman, 2003). DTT is an evidence-based teaching method that uses discrete trials, often used in behavior analysis, and teaches small steps of skills in a controlled setting. Each discrete trial consists of the antecedent, which is the direction given by the researcher, the behavior, which is the response emitted by the child, and the consequence, which usually comes in the form of positive reinforcement or a correction procedure. PRT is also a teaching method used in behavior analysis but is often conducted in a naturalistic play setting to increase communication and social skills. PRT is less structured in comparison to DTT and focuses on the child's interests and uses natural reinforcers (Koegel & Koegel, 2012; Schreibman & Stahmer, 2014). During these interventions, tactics such as clear prompts, interspersal of known items, and delivering contingent reinforcement are used. Specifically, PRT used the child's natural interests and motivations to teach a variety of social behaviors such as joint attention (Ebrahim, 2020). The combination of naturalistic teaching interventions with DTT and PRT led to an increase in joint attention behaviors.

Prelinguistic milieu teaching has also been used to increase joint attention which is an extension of milieu teaching where a language intervention is conducted that includes naturalistic teaching procedures (Cowan & Allen, 2007; Ingersoll & Schreibman, 2006; McGee et al., 1992; Warren et al., 1993; Yoder & Warren, 1999). The researchers manipulated the environment to elicit joint attention, delivered contingent imitation, verbal praise, scripting, and followed the child's attentional lead while using prompts and modeling (Ingersoll & Schreibman, 2006). Responses of joint attention were reinforced with natural consequences such as social attention and interaction with the adult and continued attention to the object of joint attention.

Some studies have successfully increased joint attention when combining different procedural techniques. Taylor and Hoch (2008) used natural consequences whilst delivering prompts such as bids for RJA. Whalen and Schreibman (2003) found that combining joint attention interventions led to increases in joint attention of autistic children. JASPER is a naturalistic developmental behavioral intervention (Chang et al., 2016; Engelstad et al., 2024; Kasari et al., 2021; Paparella & Freeman, 2015; Ross, 2017; Shih et al., 2021; Shire et al 2019; Waddington et al., 2021). JASPER is based on developmental and behavioral principles and involves both natural procedures and explicit teaching strategies (Schreibman et al., 2015). The core strategies used in JASPER include environment arrangement, imitating and modeling play, establishing and expanding play routines, communication strategies, and programming (Kasari et al., 2021). With JASPER, the researcher creates a contrived environment and imitates and models appropriate play and communication strategies to the child. The researcher also establishes and expands play routines by providing multiple opportunities to respond to appropriate play activities and making them more complex and novel throughout the procedure. The procedure encourages children to initiate new play and increase diversity and complexity in play. Programming involves providing additional opportunities for the child to learn appropriate play and communication skills. According to Waddington et al (2021)'s systematic review, JASPER led to improvements of joint attention, but states that additional research is required to determine whether the procedure can lead to a wider range of outcomes.

Parent training has also been used as an intervention procedure to increase joint attention, especially RJA (Bordini et al., 2024; Drew et al., 2002; Frieda Pinto et al., 2024; Jones et al., 2006; Jones & Feeley, 2007; Kasari et al., 2011; Killmeyer & Kaczmarek, 2017; Schertz & Odom, 2007). Parent training is often paired with tactics discussed previously such as DTT and

PRT. Parents were trained to increase responsiveness to their child's communications and were taught to respond to their child appropriately. Parents were taught to use familiar vocabulary when interacting with their child, understanding their child's communication skills, creating play routines, adjusting their language and gestures during interactions with their child, and engaging in coordinated eye gaze with the child during play. Other comparable parent training interventions included focused playtime intervention and joint attention-mediated learning (Paparella & Freeman, 2015) while others trained parents to prompt (full physical prompt, partial physical prompt, gestural prompt, and independent) joint attention (Bordini et al., 2024). Results of parent training research suggest that a positive parent-child relationship can increase joint attention (Schertz & Odom, 2007). Another parent-training procedure that increased joint attention was joint attention-mediated learning where parents were taught to conduct an attending to faces program, a turn-taking program, and a joint attention program (Schertz et al., 2013; Suarez-Rivera et al., 2019). In addition, Prelock et al. (2011) used More than Words (MTW) and Joint Attention Training (JAT) which implemented DTT with a combination of PRT or a developmental mediated learning procedure to train parents to facilitate communication and joint attention in their children. Overall, results of previous research demonstrated that parent training led to positive changes in the participants for social communication skills. Parents also increased confidence and positive experiences with their children.

Sibling training and peer training has also been used as a tactic to increase joint attention (Cassel et al., 2007; Ferraioli & Harris, 2011; Hansen et al., 2018; Pierce & Schreibman, 1995). The siblings were taught how to deliver prompts such as tapping or showing their sibling a toy or prompting eye contact. Similarly, peer training has also been used to increase joint attention. Peers were used to teach social skills and joint attention to participants with ASD (Pierce &

Schreibman, 1995; 1997a; 1997b). The peers modeled appropriate social behaviors and reinforced social attempts during activities such as turn-taking which led to an increase in joint attention. Furthermore, peers were taught tactics such as modeling, role play, integrated play techniques, and feedback to increase joint attention in their autistic peers (Kourassanis-Veasquez & Jones, 2019; Zercher et al., 2001). Likewise, an integrated playgroup was implemented which led to an increase in joint attention (Zercher et al., 2001). The peers were trained to deliver specific cues as antecedents to elicit joint attention, symbolic play, and language with the participants. Hansen et al (2022) suggested that peer training interventions reflect natural contingencies, and that the procedure maintains generalization.

Thematic ritualistic activities, also known as circumscribed interests, have been implemented in previous research to increase joint attention by incorporating them into typical games that they engage in with their siblings (Baker, 2000; Goldberg et al., 2005; Kryzak & Jones, 2015). One of the typical games was a bingo-style game based on their thematic ritualistic behavior. The most valuable aspect of using thematic ritualistic activities to increase joint attention is to use the interests of the participant and incorporating them into activities. Examples of these activities included animated television characters, board games, cooking, arts and crafts, and video games. When the participants and peers participated in these activities, results demonstrated that all participants increased the time engaged with peers and verbal initiations. Although these activities may not be ritualistic, incorporating the ritualistic interests of the participants as a point of inspiration for activities led to an increase in their socialization skills.

Video modeling has furthermore been used as an intervention to increase joint attention (Charlop & Milstein, 1989; Clifford & Dissanayake, 2008; Ho et al., 2019; Maione & Merenda, 2006; Paterson & Arco, 2007; Rudy et al., 2014; Wert & Neisworth, 2003). Participants were

required to observe videos that modeled correct target behaviors such as joint attention to observe if these behaviors occurred later. Scripting and script fading has also been used as a procedure to increase joint attention in children (MacDuff et al., 2007). The researchers gradually fade the scripts to increase independent joint attention behavior in participants.

Consequences Used in Joint Attention Interventions

Most previous studies suggest that delivering natural consequences is vital during activities that occur during interventions. These natural consequences are what maintains joint attention behaviors. The natural consequence for engaging in joint attention should be the social interaction where the adult or the child comments, points to an object or event, and/or engages in coordinated looks. These social interactions may not function as a reinforcer for autistic children and that instead specific idiosyncratic forms of social interactions and attention function as a reinforcer such as an exaggerated smile, a funny face, tickles, a loud noise, or a loud phrase (Stephany et al., 2023; Sulzer-Azarolff & Mayer, 1991). Review of the different interventions to increase joint attention in the literature shows the importance of using natural reinforcers instead of contrived reinforcers (Fredericks et al., 2023). Few of the studies used social consequences as the reinforcer for engaging in joint attention (Gibson, 2009; Meindl & Cannella-Malone, 2011). Many of the studies that taught joint attention used nonsocial consequences as reinforcers such as objects in the environment, edibles, and tangible reinforcers (Isaksen & Holth, 2009; Martins & Harris, 2006; Meindl & Cannella-Malone, 2011; Naoi et al., 2008). As seen in Table 1, the natural reinforcers of joint attention are social and involve sharing the experience with another person. The natural consequences are essential when teaching joint attention to teach the correct function of joint attention. Holth et al. (2009) suggest that contrived reinforcers may not increase

or generalize joint attention. Natural social consequences are vital when teaching social behaviors such as joint attention because they result in the correct stimulus control.

Intensive Tact Instruction

The current experiment will use intensive tact instruction (ITI) to increase joint attention of participants. There has been research on this procedure in the behavior analysis literature and its effects on language and verbal behavior. Previous research has shown that the ITI increased vocal verbal operants such as pure tacts and mands in non-instructional settings (Delgado & Oblak, 2007; Lydon et al., 2009; Ninio & Bruner, 1978; Pistoljevic & Greer, 2006; Schmelzkopf, 2010) spontaneous speech (Carpitelli et al., 2018; Cooper & Aslin, 1990; Costa & Palaez, 2014; Greer & Du, 2010; Winder et al., 2013), audience accurate tacts and conversational units (Schauffler & Greer, 2006), naming (Hotchkiss & Fienup, 2020; Pistoljevic, 2008), and joint attention (Harms, 2020). The ITI provides additional opportunities for a child to emit tacts and to come into contact with social stimuli (i.e., praise, playful physical contact, sharing an experience with another person). The ITI purports to condition social stimuli such as behaviors associated with joint attention (i.e., gaze shifting, pointing, commenting, eye contact between the target object/event and the other person) as reinforcers. The component that makes the ITI intensive is the additional opportunities presented to the participants. Traditionally, ITI requires a participant to emit 100 total tacts across 5 different categories, making 20 opportunities per category during each session. In these experiments, we delivered 50 total tacts across 5 different categories, making 10 opportunities per category during each session. Previous research shows that additional opportunities to respond increases the likelihood of contacting reinforcement throughout a session which may lead to positive effects such as conditioning praise as a reinforcer (Pistoljevic & Greer, 2006).

ITI is traditionally conducted by having the participants tact pictures such as flashcards, pictures on electronic devices, or objects. The researcher presents pictures one by one to the child and/or presents a picture with or without a vocal antecedent such as, “What’s this?” A correct response was considered the label of the item in the picture while an incorrect response was considered an instance where the child emitted a label that did not have one-to-one correspondence with the item in the picture or did not emit a correct response within 3 s. When the child emitted a correct response, the researcher presented behavior-specific praise and playful physical contact. When the child did not emit a correct response, the researcher modeled the correct response and re-presented the antecedent to the child at least two additional times or until the child emitted a correct response. Correct responses during the correction procedure were not reinforced by the researcher. Harms (2020) conducted an intervention that required participants to tact objects, actions, pictures in a book, the activity they were engaging in, and items that they found therefore increasing the variability in the type of stimuli participants were required to tact. Furthermore, the researcher implemented interactive tacts where when the participants emitted a correct tact response, the researcher delivered social stimuli (i.e., behavior-specific-praise) and elongated the reinforcer by continuing the joint attention experience. The researcher did this by commenting and initiating conversations about the stimuli tacted. For example, if the child tacted a broom in the room, the researcher delivered social praise and continued to model cleaning with the broom while providing the child with opportunities to interact with the broom. Therefore, the ITI that was conducted by Harms (2020) can be considered as a more social procedure which required longer shared experiences during the reinforcer.

The accumulative effect of the ITI may condition sharing social interactions and experiences as a reinforcer. The ITI combines additional opportunities to tact instruction (contact

with social reinforcement) and the elongated reinforcing experiences during the interactive tacts. When a participant emitted a correct response, the experimenter delivered behavior-specific praise and/or playful-physical contact in combination with the elongated reinforcer. Therefore, although praise may not serve as a conditioned reinforcer, they are receiving a variety of social reinforcers, not only specific to praise. Many joint attention research studies have focused on teaching the topography by prompting gaze following and orienting. The ITI was used to increase joint attention reinforcers to teach the function of joint attention and to have social experiences become a conditioned reinforcer. When a child has this in repertoire, they engage in topography that is represented in the class of responses seen in joint attention.

Prerequisites to Joint Attention

Understanding the prerequisites of increasing joint attention is essential for identifying the types of interventions that can effectively increase joint attention. Previous research discusses and indicates the potential correlations between joint attention, vocal verbal operants (language), and cusps and capabilities of the verbal behavior development theory (Singer-Dudek et al., 2010). In addition, the childhood joint attention scale (C-JARS) was used to measure the indirect parent-reported joint attention behavior in participants. The C-JARS was measured to provide additive qualitative data that will be correlated with directly measured joint attention behavior. Molina and Bulagrelli (2012) indicated the importance of parents' contribution in evaluating children's early communication and social skills.

Vocal Verbal Operants. There are correlations between language acquisition and joint attention. Vocal verbal operant assessments have been used to assess language skills of children (Hawkins et al., 2007; Naresh, 2022). According to Skinner (1957), verbal behavior is defined as "behavior reinforced through the mediation of other persons" (p. 2). The vocal verbal operant

assessment measured different verbal behavior based on Skinner's (1957) taxonomy of the functions of verbal behavior. Skinner (1957) identified four primary verbal operants: mands, tacts, echoics, and intraverbals. Skinner (1957) defined mands as a type of verbal behavior that is under the control of deprivation or an aversive stimulus. The mand is reinforced by the item or activity that the person is under deprivation of or by the removal of the aversive stimulus. A mand is not considered as joint attention since the child emits a mand to gain access to an object or an activity. Tacts were defined as a type of verbal behavior that is under the control of stimuli in the environment. According to Skinner (1957), tacts are reinforced by social reinforcement. Joint attention is an example of a tact since the child emits a tact to gain access to social reinforcers. However, joint attention does not require the child to shift eye-gaze or emit vocalizations. Echoics were defined as a type of verbal behavior where a person repeats or imitates what was heard and is reinforced similarly to mands or tacts. According to Skinner (1957), intraverbals are under the control of the other person's verbal behavior or the presence of the other person. Intraverbals are reinforced by social reinforcement. Later on, Skinner added two verbal operants: autoclitic and textual. Skinner defined an autoclitic as a type of verbal operant that changes the meaning of other verbal behavior. An example of an autoclitic is please. When please is added to other verbal operants, it alters the subtle nuances of the verbal behavior and makes the other verbal operant more polite. Skinner defined textual as a type of verbal behavior where the person is reading or writing. Researchers measure vocal verbal operant assessments differently and may include the primary verbal operants (Tincani et al., 2020).

Since the publication of Skinner's *Verbal Behavior* (1957), research has been conducted on Skinner's taxonomy of the functions of verbal behavior (Greer & Ross, 2004; Schools, 2009). Researchers state the importance of developing different verbal behavior for a child's growth.

For some autistic children these different verbal behaviors need to be explicitly taught (Raaymakers et al., 2019; Singer-Dudek, 2008, Speckman, & Nuzzolo, 2010). Mundy et al. (1990) demonstrated that joint attention was a predictor of language in autistic children. The verbal operant assessments are an empirically based form of measuring language in children (Greer & Keohane, 2005). From the verbal behavior perspective, IJA can be seen as an example of a tact since the speaker is bringing the listener into contact with what the speaker is experiencing. During a tact, the child attends to an object, picture, or event and labels the target stimuli to gain social attention. The functions of a tact and joint attention are similar since the consequence involves social attention for both. Previous research has shown that better joint attention led to greater language development (Bono et al., 2004). Findings indicate that measuring language accompanied by joint attention is important.

Trajectory of Verbal Developmental Cusps. This section outlines the cusps and capabilities that are related to the potential prerequisites for joint attention. The verbal behavior development assessment-revised (VBDA-R) is a tool based on Skinner's verbal behavior theory and is used to assess verbal behavior development (Singer-Dudek et al., 2023). Trajectory of verbal developmental cusps lead to incidental language learning and additional developmental skills. A cusp is when a child can learn novel, more difficult skills after acquisition. A capability is defined as a repertoire that enables a child to learn novel skills and to learn in a novel way while also increasing their rate of learning (Rosales-Ruiz & Baer, 1997). Singer-Dudek et al. (2023) found that there was a significant positive correlation between the participants' IJA with their mothers during free play and their listener and speaker cusps and capabilities of the VBDA-R. Researchers did not find a significant correlation between the VBDA-R scores and the RJA responses to their mothers' bids for joint attention.

Conditioned reinforcement for observing faces. When observing faces is a conditioned reinforcer, children will attend to another person's face and make better eye contact while interacting with others. Faces functioning as a conditioned reinforcer is a verbal behavior developmental cusp since demonstrating it leads children to come into contact with novel stimuli in the environment and to learn novel repertoires. A conjugate reinforcement procedure led to conditioning faces as a reinforcer (Maffei et al., 2014). During this procedure, the researcher paired looking at adult faces with reinforcing stimuli that involved the adult's face. These stimuli included silly faces, singing, noises, and speaking. During the assessment for determining whether a child had observing faces conditioned as a reinforcer, the researcher recorded whether the child would attend to adult faces during the 5s partial interval recording assessment. Once faces were successfully conditioned as a reinforcer for these participants, their number of vocal verbal operants, and rate of learning, increased. Demonstrating conditioned reinforcement for observing faces is about orienting towards another person's face in the environment. Therefore, it appears to be a prerequisite to three-point RJA and IJA. Both types of joint attention require the child to attend to another person's face to share the experience.

Conditioned reinforcement for observing voices. When children demonstrate having adult voices conditioned as a reinforcer, they will respond to their names being called, listen to stories with and without pictures, and attend to auditory stimuli. Having voices conditioned as a reinforcer is a verbal behavior developmental cusp since having it in repertoire leads a child to come into contact with novel stimuli and to acquire novel repertoires. A conjugate reinforcement procedure also successfully led to conditioning voices as a reinforcer (Maffei et al., 2014). During the assessment for conditioned reinforcement for observing voices, the researcher recorded whether the participant depressed a button to hear adult voices telling a story during a

5s whole interval recording assessment. Another procedure used to condition voices as a reinforcer was a stimulus-stimulus pairing procedure (Greer et al., 2011). Both procedures led to successfully conditioning adult voices as a reinforcer which led them to increase their rate of learning, and decreased frequency of stereotypy. Having conditioned reinforcement for observing voices is about orienting towards another person's voice in the environment. This is a prerequisite to two-point and three-point RJA because there are instances where the other person is emitting a vocalization while shifting eye gaze or gesturing towards an object or event. Having conditioned reinforcement for observing voices is not a prerequisite of IJA, but vocalizations or conversations may occur during IJA. Furthermore, having voices conditioned as a reinforcer functions as a prerequisite to listener and speaker behaviors. A speaker must function as a listener to communicate with others.

***Conditioned reinforcement for observing 3D stimul*i.** When children have observing 3D stimuli conditioned as a reinforcer, they will attend and engage with a variety of 3D stimuli (preferred and non-preferred) in the environment. Having 3D stimuli conditioned as a reinforcer is a cusp because children can learn novel repertoires by observing 3D stimuli. A visual tracking procedure with preferred and nonpreferred stimuli has been used to condition 3D stimuli as reinforcers (Speckman et al., 2017). Children were required to visually track items that were placed under a cup and moved. After children acquired 3D stimuli as conditioned reinforcers from the visual tracking procedure, the number of correct responses during 3D matching and object use imitation increased. Having conditioned reinforcement for observing 3D stimuli is about orienting towards objects and events in the environment. This cusp is a prerequisite of two-point RJA, three-point RJA, and IJA. During the joint attention experiences, the child may be attending to an object or event occurring in the environment. During a RJA experience, the child

is following the gaze of the adult towards the target object or event. During an IJA experience, the child is already attending to the object or event and shifts their eye gaze towards the adult to share the experience.

Conditioned reinforcement for observing 2D stimuli. When children have observing 2D stimuli conditioned as a reinforcer, they will attend to and engage with a variety of 2D stimuli (preferred and non-preferred) in the environment. Having 2D stimuli conditioned as a reinforcer is a cusp because children can learn novel repertoires by observing 2D stimuli. Having 2D stimuli such as pictures, symbols, and letters conditioned as reinforcers is extremely important for their academic progress. A stimulus-stimulus pairing procedure has been used to condition 2D stimuli as reinforcers (Delgado et al., 2009). Participants successfully acquired 2D stimuli as a conditioned reinforcer which led to an increase in their rate of learning and match-to-sample repertoire. Having conditioned reinforcement for observing 2D stimuli is about orienting towards pictures, symbols, text stimuli, or digital stimuli in the environment. Similar to conditioned reinforcement for 3D stimuli, having conditioned reinforcement for observing 2D is a cusp and is a prerequisite of two-point RJA, three-point RJA, and IJA. The only difference is that the stimuli they are attending to or shifting their gaze towards are 2D stimuli.

Summary of the Joint Attention Literature

Joint attention has been extensively studied over time across various fields. Due to the varying delays of joint attention in children with ASD despite its importance in childhood development, there exists decades of research that have attempted to create interventions that increase joint attention. After discussing the previous research conducted in the field of joint attention, it has become clear that many of the previous researchers have focused on teaching the form of joint attention in comparison to teaching the function of joint attention. Joint attention

literature thus far has used tactics such as physical and verbal prompts to teach children the form of joint attention while using primary and tangible reinforcers. Harms (2020) was one of the first joint attention studies to attempt to teach joint attention using an intensive tact instruction. Although it does not explicitly teach joint attention, the participants encountered social reinforcers after emitting tacts which taught the reinforcer of joint attention. Harms (2020) did not explicitly teach the form of joint attention but intended to teach the function of joint attention by reinforcing correct tact responses with praise, social reinforcers, and an elongated shared experience. This procedure increases the number of opportunities that the participants encounter social reinforcers. When these social reinforcers were presented, participants had opportunities to engage in joint attention as well. The assessments of joint attention in Harms' (2020) study aimed to condition sharing an experience with another individual as a reinforcer. The procedure in ITI requires participants to emit tacts. Emitting a tact and engaging in joint attention are similar. A tact is a label that is emitted to contact social reinforcers while joint attention is a vocal/non-vocal way of sharing an experience (an object or an event) with another person. In a joint attention experience, a child may tact the object or event. The child may label, react, or comment on the object or event which can be seen as an example of both a tact and joint attention. Increasing the number of opportunities for children to emit tacts can lead to conditioning the act of engaging in the joint attention experience. Although the current experiment may take a different approach to teaching joint attention, the objective remains the same: to find a procedure to increase behaviors associated with joint attention without explicitly teaching the form, but the function of joint attention.

Rationale for using Intensive Tact Instruction to Increase Joint Attention

There are many reasons to why the ITI may increase joint attention. Tacts that participants emit during the ITI have the same function as joint attention (Singer-Dudek et al., 2023). ITI requires the child to emit correct tacts for them to come into contact with social reinforcement (Eby & Greer, 2017; Katz, 2017; Olsen, 2011). The repeated exposure and given opportunities to contact social reinforcers eventually condition social consequences as a reinforcer. The ITI provides an intensive history in order for tacts to produce social contingencies and therefore increase joint attention during the assessments. According to Greer et al (2024), reinforcement plays a critical role since positive reinforcement increases the probability that a child will emit verbal behaviors. Although joint attention is not a form of verbal behavior, this idea of positive reinforcement increasing social interactions in the future is related to the theory that the ITI may increase behaviors associated with joint attention. When a child engages in behaviors related to joint attention, the sole reinforcer is gaining access to social reinforcers and sharing the experience of an object or event with another person. Similarly, when tacts are emitted, the child is labeling an object or event in the environment and receives social reinforcement which makes the function for both tact and joint attention similar. In a contrived environment, the tact is emitted when a stimulus such as a picture or an object is presented by a teacher. The teacher then consequates the behavior with social reinforcement such as praise or playful physical contact. In a non-contrived environment, the tact is emitted when a child notices an object or event in the environment and labels the stimulus. The other person then shifts their gaze towards either the child and/or the object or event in the environment and provides social reinforcement with either praise or continued social interaction. Tacts that occur in a non-contrived environment are similar to the joint attention experience, specifically IJA. However, for both types of tacts and joint attention, access to social reinforcement functions as the

reinforcer. Participants undergoing the ITI had access to social reinforcement throughout the intervention. Having additional opportunities to access social reinforcers increases the number of social interactions which are often limited in autistic children. By accessing social reinforcers when emitting tacts, the ITI can be used to teach participants that tacting stimuli can lead to social reinforcement. Tacting a stimulus does not require eye contact for it to be considered a correct response. This behavior is similar to IJA where a child initiates and bids another person's eye gaze towards the target object or event and attends to the same stimulus.

Teaching tacts can also lead to increasing and possibly conditioning shared visual focus. When a child is attending to faces more, this increases awareness of others and social skills such as joint attention. When children emit tacts, shared visual focus can be observed between the child and the other person (Pelaez et al., 2012). However, tacting does not require eye contact and can occur without observing the stimulus. (Bak et al., 2021; Skinner, 1957). In addition, tacting requires the child to shift their gaze and focus between the object and the other person. This process of tacting can generalize to joint attention in the form of IJA (Greer & Ross, 2008). When there is an increase in the emission of tacts, other social behaviors can become generalized such as joint attention. The process of tacting increases the child's ability to understand social cues such as gaze shifts and gestures (Sundberg & Michael, 2001).

The ITI requires participants to emit a variety of tacts such as pictures, and items. The current literature uses pictures the most during ITI interventions (Pistoljevic & Greer, 2006; Greer & Du, 2010; Costa & Palaez, 2014; Bak, et al., 2021). The ITI procedure replicated the study of Harms (2020) which required participants to emit responses to stimuli other than pictures. Participants were required to label objects in the environment, pictures in a book, actions of another person, hidden objects, and the activities that the child was engaging in (e.g.,

playdough, blocks, puzzles). During a joint attention experience, children usually identify objects or events that are unexpected. Therefore, increasing the variety in the tact stimuli may have led to successful increases in joint attention in Harms (2020). As discussed in the previous sections, tacts and joint attention are both reinforced by social attention such as praise, tickles, or a smile. The procedure of the ITI requires the researcher to consequate the participants' behaviors with praise and social reinforcers instead of tangible reinforcers such as edibles or toys. The ITI requires the participant to emit a correct tact to come into contact with social reinforcers. Therefore, the more instances that the participant emits a correct tact, the more socially reinforcing experiences the participants will have. Since the natural consequence of joint attention is praise, the ITI is hypothesized to increase language skills, which has a high correlation to increasing joint attention. The ITI procedure is replicated based on Harms (2020) where researchers used more salient and longer durations of social reinforcement when consequating correct tact responses. This elongated reinforcer led the researcher and participant to engage in joint engagement and share experiences with one another. The ITI was used so that participants would have repeated exposure to joint engagement with the researcher through the elongated reinforcing social experiences. This extended social reinforcement mirrors the joint attention experience. Engaging in the ITI will help children increase their time engaging in shared activities, enjoyment, and interactions with others (Jones & Carr, 2004).

Joint attention and language are correlated, and the ITI procedure has increased language in previous research. The ITI has shown to condition praise as a reinforcer and has increased vocal verbal operants and/or language. Children who do not have any or few words have increased language due to an increase in joint attention after intervention (Kasari et al., 2014). Since there is a correlation between joint attention and language, there is a possibility that

implementing the ITI to increase language can also lead to an increase in joint attention since the function of both behaviors are identical. Harms (2020) found that when children acquired additional verbal behavior developmental cusps, it predicted joint attention. Singer-Dudek et al., (2023) suggests that focusing on speaker behavior can lead to an increase in joint attention.

In addition, previous research has shown that teaching joint attention in play and natural settings can lead to an increase in joint attention in comparison to contrived settings. White et al.'s (2011) meta-analysis demonstrated that conducting interventions that use play and take place with natural communication partners increased generalization of joint attention. The ITI using the tactics used in Harms (2020) attempts to include play to condition social stimuli as reinforcers. The intervention is also conducted across a variety of settings such as the tabletop and free play setting. Play and natural settings are included in the ITI which supports the growth of joint attention.

Participants partaking in the ITI are constantly coming into contact with social reinforcers when they emit correct tact responses. When the participants receive social reinforcers to their responses, this repeated exposure, and opportunities eventually condition social consequences as a reinforcer (Pistoljevic & Greer, 2006). The consequences for both tacts and joint attention are social. The experimenter utilized the ITI to increase two-point RJA by focusing on conditioning the sharing of social experiences during the elongated reinforcers. This procedure is different from most previous procedures since it promotes the development of joint attention behaviors through conditioning rather than by directly teaching the topography of joint attention. The speaker emitting the tact brings the listener into the world of the speaker (Skinner, 1957). A tact is a social behavior that is identical to joint attention where both involve sharing an experience with another person. The difference between joint attention and a tact is that joint attention does

not require a verbal response while a tact does. In addition, children who do not have any or few words have increased language skills due to an increase in joint attention after intervention (Kasari et al., 2014). Similarly, the ITI has been shown to condition praise as a reinforcer and increase vocal verbal operants (language). Since joint attention and language are correlated, when one increases, the other is hypothesized to increase as well. ITI was selected as the independent variable because it provides instruction for conditioning social stimuli without directly teaching the form of joint attention. This procedure allowed social behaviors such as joint attention to emerge as a byproduct of experiencing the elongated reinforcers during the ITI. Therefore, the primary research question is whether ITI leads to an increase in behaviors associated with RJA and/or IJA. The secondary research question is whether we see a correlation between language and joint attention in the results. The aim of Experiment 1 will be to increase behaviors associated with joint attention after conducting the intensive tact instruction with the participants.

CHAPTER II

Experiment 1

Introduction

The review of the literature confirms the importance of joint attention in a child's development. Results of previous research highlight the importance of explicitly teaching the function of joint attention for the behavior to be maintained and generalized to other settings and environments. Previous research has used contrived reinforcers instead of natural and social reinforcers to teach joint attention. Therefore, often times the joint attention behaviors that were increased are not maintained or generalized. Researchers must create interventions that induce joint attention by delivering natural consequences versus prosthetic consequences to ensure that we are increasing behaviors associated with joint attention based on both the function and the form of the behavior. Previous research has focused on explicitly teaching the form/topography of joint attention by using a variety of prompts to shape behaviors seen in joint attention such as gaze shifts, gaze following, and gestures (Buffington et al., 1998; Dube et al., 2004; Eikseth et al., 2007; Lovaas, 1987; Mundy et al., 2007; Theuring et al., 2007). In comparison, the intensive tact instruction used in this experiment focuses on inducing joint attention by teaching the function of joint attention. The function of joint attention is sharing an experience with another individual. The intensive tact procedure requires children to emit a variety of tacts that are all reinforced by social attention, praise, and an elongated shared experience. Participants come into contact with social reinforcers by emitting tacts and therefore learn how to initiate social interactions and share an experience with another individual (Greer & Keohane, 2005; Ismail & Baker, 2023). We conducted an intensive tact instruction to increase behaviors associated with joint attention in children with listener and speaker verbal cusps and capabilities. The dependent

variables were joint attention measures: two-point and three-point responding to joint attention (RJA) and initiating joint attention (IJA). The independent variable was an intensive tact instruction that included five different categories making a total of 50 additional learn units to the participants' daily number of learn units. The purpose of Experiment 1 was to replicate the procedures used by Harms' (2020) dissertation with a smaller number of opportunities for responding (50 learn units instead of 100 learn units). The rationale for decreasing the number of opportunities in each session was that Harms (2020)'s participants were preschoolers who attended school for a longer period of time than the early intervention students.

Methods

Participants

Three children between the ages of 2 and 3 years participated in this experiment. All participants were receiving Special Instruction services at an Early Intervention (EI) center throughout the duration of the experiment. The EI center implemented the Comprehensive Application of Behavior Analysis to Schooling (CABAS®) model (Singer-Dudek et al., 2010) and included students with and without IFSPs (Individualized Family Service Plan) between the ages of 18 months to 36 months. See Figure 1 for the verbal behavior trajectory based on the CABAS® model. There were four self-contained classrooms and one integrated classroom. All the classrooms included at least one head teacher and one co-teacher. Researchers included these participants in the experiment since they did not show criterion-level of RJA and IJA behavior during assessment. Prior to the onset of the experiment, we ensured that the participant could emit one-word tacts, used vocal mands, and could echo up to six words. Table 2 displays the participants' descriptions. Table 3 displays the participants' relevant cusps and capabilities. Table 4 displays the participants' assessment results.

See Table 2 for participant descriptions. Vincenzo was a 35-month-old male with an IFSP at the beginning of the experiment. Vincenzo had been receiving services at the EI center for 10 months. When he began receiving services, he functioned as a listener pre-speaker. See Table 3 for participants' cusps and capabilities based on the verbal behavior trajectory. At the beginning of the experiment, Vincenzo functioned as a listener speaker. Vincenzo talked using three to five-word phrases. Vincenzo emitted tacts for a variety of categories (i.e., food, fruits, vegetables, vehicles, body parts, clothing, etc). Vincenzo manded using three to four-word phrases. Vincenzo's educational diagnosis was an unspecified disorder of psychological development and was not given a medical diagnosis. See Table 4 for participants' assessment results. Vincenzo received three different evaluations. On the Vineland-III Adaptive Behavioral Scale, Vincenzo received a standard score of 76 and functioned at the 5th percentile (age-based). On the Bayley Scales of Infant and Toddler Development (3rd Edition), he had a score of 75 and functioned at the 5th percentile. Vincenzo performed at an average level for cognitive skills and performed at a below average level for communication, adaptive, and social-emotional skills. Vincenzo also received occupational therapy (2x a week), speech therapy (3x a week), and physical therapy (1x a week) throughout the duration of the experiment.

Anna was a 31-month-old female with an IFSP. Anna began receiving services at the EI center at the onset of the experiment. At the beginning of the experiment and during the duration of her time at the center, she functioned as a listener speaker. Anna had tacting a variety of categories in repertoire (i.e., foods, vegetables, vehicles, clothing, body parts, etc). Anna manded using three to five-word phrases. Anna's educational diagnosis was mixed receptive-expressive language disorder and was not given a medical diagnosis. Anna was assessed using two different evaluations. Anna received the DAYC-2 Developmental Assessment of Young Children where

she demonstrated below average skills in cognition and average skills in social-emotional development and adaptive skills. She also received the HELP Strands (Hawaii Early Learning Profile) birth to 3 years which demonstrated that Anna demonstrated a 25% delay in cognitive skills. Anna received occupational therapy (1x a week), speech therapy (3x a week), and physical therapy (1x a week) throughout the duration of the experiment.

Sheryl was a 27-month-old female with an IFSP. Sheryl began receiving services at the EI center at the onset of the experiment. At the beginning of the experiment and during the duration of her time at the center, she functioned as a listener speaker. Sheryl had tacting a variety of categories in repertoire (i.e., foods, vegetables, vehicles, clothing, body parts, etc). Sheryl manded using three to five-word phrases. Sheryl's educational diagnosis was delayed milestones in childhood and had not received a medical diagnosis. Sheryl received a Preschool Language Scales Assessment (PLS-5) where she had a total language score of 74 and functioned at the 4th percentile. She demonstrated below average levels in the cognitive area and social-emotional area, while she demonstrated average levels in receptive language and expressive language. Sheryl received occupational therapy (2x a week), speech therapy (2x a week), and physical therapy (2x a week) throughout the duration of the experiment.

Table 2

Participant Descriptions for Experiment 1

Participant	Gender	Age in mos	IFSP	Educational Diagnosis	Medical Diagnosis	Verbal Behavior	Race
Vincenzo	M	35	YES	Unspecified disorder of psychological development		Listener Speaker	Hispanic
Anna	F	31	YES	Mixed receptive-expressive language disorder		Listener Speaker	Caucasian
Sheryl	F	27	YES	Delayed milestone In childhood		Listener Speaker	Caucasian

Table 3

Cusps in Repertoire for Participants in Experiment 1

Cusp	Participant		
	Vincenzo	Anna	Sheryl
CR+ for Observing 3D Stimuli	√	√	√
CR+ for Observing 2D Stimuli	√	√	√
CR+ for Faces	√	√	√
CR+ for Voices	√	√	√
CR+ for See-Do	√	√	√
Parroting	√	-	-
Auditory Matching	√	√	√
Listener Literacy	√	√	√
CR+ for Listening to Story Content	√	√	√
Unidirectional Naming (UniN)	√	√	√
Independent Mands	√	√	√
Independent Tacts	√	√	√
Echoics	√	√	√
Transformation of EOs across Mands and Tacts	√	√	√
Bidirectional Naming (BiN)	√	√	-
Conversational Units Between an Adult and a Child	IP	√	IP
Conversational Units between Children	IP	√	-
Say-Do Correspondence	-	√	-

Self-Talk Conversational Units in Solitary Play	-	√	-
Extensions of BiN	-	-	-

Note. √ = in repertoire. IP =. In progress. - = not in repertoire. CR+ = conditioned reinforcement of.

Table 4

Participants' Assessment Results in Experiment 1

Participants	Vineland-III	Bayley Scales	DAY C	HELP	PLS-5
Vincenzo	Standard Score of 76%, 5th percentile	Standard Score of 75, 5th percentile			
Anna			Below average in cognitive skills, Average in social emotional development and adaptive skills	25% delay in cognitive skills	
Sheryl					Standard score of 74%, 4th percentile

Setting and Materials

See Table 5 for materials used during Experiment 1. The experiment took place in the classrooms of the Early Intervention (EI) center, which was located outside of a large metropolitan city and was a publicly funded, private program. There was a total of three different classrooms at the EI center. Two of the three rooms were large enough that they were divided into two classrooms. The two classrooms were divided by using closets and the students' cubbies. Therefore, there were a total of five different classrooms at the EI center. This experiment was conducted during the COVID-19 pandemic and therefore students were required to socially distance with their peers. Due to the changes made during the pandemic, the students received one-to-one special instruction. During instruction, students sat at a rectangular table

with a researcher. There were clear and opaque partitions in all the classrooms that separated the students from other students. Each classroom had around four to five tables and four to five partitions. Each student had an assigned bin that had all the toys that they could play with that were cleaned daily by teachers. Group sessions were not conducted during this time due to restrictions from the state. Therefore, there were only five to six students in the classroom at a time. This led students to have a lack of opportunities to engage in social activities or to emit social responses with peers. In the middle of the experiment, the state allowed centers to begin group instruction. Intervention continued in a one-to-one setting.

Researchers used a variety of materials based on the categories in the intervention. For category one, the materials used included 3D school stimuli (e.g., white board, chair, door, white-out, hole-puncher, etc). Category two did not require any materials. Category three used a children's picture book. Category four required 3D objects, 3D matching objects, and toys that were placed inside an opaque bag. Category five required a variety of activities such as play dough, blocks, doll house, car ramp, dot paint, etc. See Table 5, 6, and 7 to see the materials used for each short-term objective.

Table 5

Materials Used for the Intensive Tact Instruction in Experiment 1

Categories	Materials
Category 1: Labeling 3D items in the Environment	White board, chair, door, white-out, hole-puncher, walkie-talkie
Category 2: Labeling Actions	N/A
Category 3: Labeling Pictures in a Book	Children's picture books
Category 4: Labeling Hidden Items	Opaque bag, 3D stimuli, matching 3D stimuli, toys
Category 5: Labeling the Activity	Playdough, blocks, doll house, car ramp, dot paint, crayons

Measurement

Dependent Variables

Dependent variables were the measures of joint attention (two-point and three-point RJA and IJA).

Joint attention. See Table 1 to see the definitions of two-point RJA, three-point RJA, and IJA. Joint attention was measured based on the number of correct responses after bids for responding to joint attention (RJA); initiating joint attention (IJA) was measured based on the number of instances the participant initiated a joint attention experience. Researchers measured two-point RJA and three-point RJA. A correct response for two-point RJA was if the participant shifted their eye gaze towards the target stimulus after an eye gaze shift or gesture made by the researcher within 30 s. An incorrect response for two-point RJA was if the participant did not shift their eye gaze towards the target stimulus after a bid within 30s or if the participant looked

at a stimulus different from the target stimulus. A correct response for three-point RJA was when the participant followed the gaze or point of another person and looked back at the adult within 30 s. An incorrect response for three-point RJA was when the participant engaged in two-point RJA or if the participant did not observe the researcher or the target stimulus within 30 s. The participants received a total of twelve opportunities to respond to joint attention (RJA). At the end of each session, the researcher added the number of correct responses and graphed the number of correct responses on Excel®.

Researchers also measured IJA. A correct response was if the participant looked or played with the toy and looked back at the researcher within 30 s. An incorrect response was if the participant looked or played with the toy but did not look back at the researcher, or if the participant did not attend or play with the toy within 30 s. If the participant pointed to the stimulus/toy but did not make a coordinated look with the researcher, the researcher considered this an incorrect response as well. The participants received a total of ten opportunities to initiate joint attention. At the end of each session, the researcher added the number of correct responses and graphed the number of correct responses on Excel®.

Table 6

Operants during ITI Intervention for Participant 1: STOs 1-2, Experiment 1

	STO 1	STO 2
Category 1: Labeling 3D Objects in the Environment	Walkie talkie, Broom, Light switch, Closet, Bulletin	Partition, Ruler, Binder, Hole puncher, Stapler
Category 2: Labeling Actions	Talking, Sneezing, Spinning, Zipping, Laughing	Stomping, Cutting, Pulling, Writing, Tapping
Category 3: Labeling Pictures in a Book	Curtain, Rug, Net, Picture frame, Pan	Whisk, Fire pit, Chef hat, Overall, Ladder
Category 4: Labeling Hidden Items/Answering Questions	Items in Repertoire	My birthday is, I live in, My mom's name is, I have a (sibling), My (sibling's) name is
Category 5: Labeling the Activity	Activities of Participants' Interest included Playdough, Puzzles, Coloring, Blocks, and Earning tokens	Activities of Participants' Interest included Playdough, Puzzles, Colors, Blocks, and Earning tokens

Note. STO = short term objective; ITT = Intensive Tact Instruction.

Table 7

Operants during ITI Intervention for Participant 2: STOs 1-4, Experiment 1

	STO 1	STO 2	STO 3	STO 4
Category 1: Labeling 3D Objects in the Environment	Highlighter, White board, Calendar, Book shelf, Ruler	Walkie talkie, Bulletin, Partition, Desk, Binder	Hole puncher, Stapler, Broom, Light switch, Closet	White-out, Paper clip, Graph, Folder, Wipes
Category 2: Labeling Actions	Waving, Eating, Stomping, Reading, Swimming	Sneezing, Spinning, Talking, Tapping, Driving	Pulling, Cutting, Writing, Tapping Zipping	Dancing, Drawing, Smelling, Twisting, Laughing
Category 3: Labeling Pictures in a Book	Curtain, Rug, Picture frame, Fire pit, Ladder,	Net, Overall, Bread, Scarf, Pan	Whisk, Oven, Rolling pin, Basket, Dreidel	Fireman's hat, Lobster, Squash, Cornflower, Robin
Category 4: Labeling Hidden Items/Answering Questions	Items in Repertoire	Items in Repertoire	My birthday is, I live in, My Mom's name is, I ate _ for snack, I drank _	My hair is (straight/curly/brown, etc), I like to play with, I have a (pet), My favorite show is, I like to drink
Category 5: Labeling the Activity	Activities of Participants' Interest included Playdough, Puzzles, and Earning tokens	Activities of Participants' Interest included Playdough, Puzzles, and Earning tokens	Activities of Participants' Interest included Playdough, Puzzles, and Earning tokens	Activities of Participants' Interest included Playdough, Puzzles, and Earning tokens

Note. STO = short term objective; ITT = Intensive Tact Instruction.

Table 8

Operants during ITI Intervention for Participant 3: STOs 1-4, Experiment 1

	STO 1	STO 2	STO 3	STO 4
Category 1: Labeling 3D Objects in the Environment	Door, Chair, Garbage can, Desk, Binder	Hole puncher, Stapler, Tape, Ruler, White-out	Walkie-talkie, Whiteboard, Graph, Wipes, Pencil	Binder, Clip, Calendar, Bookshelf, Partition
Category 2: Labeling Actions	Waving, Eating, Stomping, Reading, Swimming	Clapping, Drinking, Drawing, Driving, Cleaning	Dancing, Laughing, Spinning, Sneezing, Tapping	Zipping, Smelling, Talking, Pulling, Cutting
Category 3: Labeling Pictures in a Book	Clock, Apple, Mirror, Window, Flower	Whisk, Oven, Ladder, Picture frame, Lamp	Blanket, Sink, Plate, Rolling pin, Basket	Cupcake, Frog, Overall, Scarf, Pan
Category 4: Labeling Hidden Items/Answering Questions	Items in Repertoire	Items in Repertoire	Items in Repertoire	Items in Repertoire
Category 5: Labeling the Activity	Activities of Participants' Interest included Playdough, Magnet tiles, Coloring, and Earning tokens	Activities of Participants' Interest included Playdough, Magnet tiles, Coloring, and Earning tokens	Activities of Participants' Interest included Playdough, Magnet tiles, Coloring, and Earning tokens	Activities of Participants' Interest included Playdough, Magnet tiles, Coloring, and Earning tokens

Note. STO = short term objective, ITI = intensive tact instruction

Independent Variable

The participants received 50 additional learn unit opportunities to emit tacts in addition to their usual day-to-day programs. ITI included five different categories. Percent of correct RJA and IJA responses were calculated by dividing the number of correct responses by the total number of opportunities. See Table 6, 7, and 8 to see the operants used during each category and short-term objective for each participant.

Category 1. The participants tacted 3D stimuli in the school environment (e.g., white board, walkie talkie, stapler). A correct response was when the participant emitted the target tact within 3s. An incorrect response was when the participant did not emit the target tact or did not emit a response within 3s. The same number of opportunities and the same criterion was applied to the rest of the categories. At the end of every session, the researcher added up the number of correct responses out of ten and graphed the number on Excel®. This graphing process is identical for all five categories.

Category 2. The participants tacted actions (e.g., jumping, stomping, drawing) that the researcher or other adults in the classroom were engaging in. A correct response was when the participant emitted the target tact within 3s. An incorrect response was when the participant did not emit the target tact or did not emit a response within 3s.

Category 3. The participants tacted pictures in a book (e.g., lamp, mirror, clock). A correct response was when the participant emitted the target tact within 3s. An incorrect response was when the participant did not emit the target tact or did not emit a response within 3s.

Category 4a. The participants pulled out an item out of an opaque bag and were required to state what they found in a full sentence. All items in the bag were stimuli that participants had

in repertoire as one-word tacts. A correct response was when the participant stated what they picked out of the bag in a sentence within 5s of taking the item out of the bag. Examples of phrases included, “I found a bear,” “It’s a bear,” or “It is a bear.” The item taken out of the bag and the tacted item must have one-to-one correspondence. An incorrect response was when the participant did not state what they picked out in a sentence or if they did not emit a response within 5s. Therefore, if a participant emitted a one-word tact (e.g., “bear”), this response was counted as incorrect and if a participant did not make one-to-one correspondence between the chosen item and the tact, this response was considered incorrect.

Category 4b. The participants were required to emit an intraverbal response based on the verbal antecedent delivered by the researcher. A correct response was if the participant emitted the target intraverbal tact within 3s. If the intraverbal response was identical to the researcher’s verbal antecedent, the participant was required to add, “too” at the end of the phrase for the response to be considered correct (e.g., “My hair is brown, too). An incorrect response was if the participant did not emit the target intraverbal tact or did not emit a response within 3s.

Category 5. The participant engaged in an activity such as playdough, blocks, dollhouse, puzzles, coloring, or a token economy during instruction and were required to tact the completion of the activity. A correct response was when the participant was engaging in an activity and tacted their action in a sentence within 3s. For example, if they were playing with playdough, a correct response may be, “I made a heart!” or “I’m rolling the playdough.” If they were using a token economy during instruction, a correct response may be, “I earned a token!” or “I can trade in my tokens!” The participant was required to make one-to-one correspondence between the tacted action and the action they were engaging in for their response to be correct. An incorrect response was when the participant did not state their action in a sentence or if they

did not emit a response within 3s. For example, if the participant said, “token!” instead of “I earned a token,” this response was counted as incorrect.

Tactic. Some of the participants’ data required a decision to stop according to the Decision Protocol (Singer-Dudek et al., 2010). The tactic implemented to increase the number of correct responses was a two prompt to independent tactic (Kodak & Clements, 2009). Participants were given two vocal prompts at the beginning of the first session. A correct prompted response was when the participant emitted an echoic that had one-to-one correspondence with the vocal antecedent within 3s of the presentation of the antecedent. An incorrect prompted response was when the participant did not emit an echoic with one-to-one correspondence or if the participant did not emit a response within 3s. A correct independent response was when the participant emitted the correct tact within 3s. An incorrect independent response was when the participant did not emit the correct tact or if the participant did not emit a response within 3s.

Procedure

Assessments

Prior to intervention, the researchers conducted an assessment on the level of RJA and IJA behavior. See Table 1 for the operational definition of joint attention.

Responding to joint attention. See Table 9 for the antecedents presented during the two-point and three-point RJA assessment. RJA was measured based on four different types of bids that were presented. The four different antecedents included a point, a point with a vocal antecedent, eye gaze, and an eye gaze with a vocal antecedent. A vocal antecedent consisted of phrases such as “Woah!”, “Someone’s playing with bubbles!”, and “What is that?” The

researcher did not use the participants' name or use phrases that used the word "Look." During a bid for joint attention using eye gaze, the researcher had the participant look at them and looked at an interesting stimulus in the environment such as a toy or a picture. Researchers presented three bids for joint attention using eye gaze and another three bids for joint attention using eye gaze with a vocal antecedent. During a bid for joint attention using a gestural point, the researcher sat at a table with the participant and pointed to an interesting stimulus in the environment such as a toy or a picture. Researchers presented three bids for joint attention using a gestural point and another three bids for joint attention using a point with a vocal antecedent. Criterion was set at 80% accuracy across two sessions. See Table 10 for antecedents presented during RJA assessment.

Table 9

Antecedents Presented during RJA Assessment, Experiment 1

Antecedent
1. Researcher presented a vocal antecedent (e.g., "Woah!", "Look who walked through the door", "What was that?") with a gestural point to the target object or picture
2. Researcher presented a gestural point to the target object or picture
3. Researcher presented a vocal antecedent (e.g., "Woah!", "Look who walked through the door", "What was that?") with a gaze shift to thee target object or picture
4. Researcher presented a gaze shift to the target object or picture

Initiating joint attention. See Table 10 for the antecedents presented during the IJA assessment. IJA was measured by presenting cause and effect toys to the participant. The

researcher sat at least 15 to 30 cm away from the participant after presenting the toy to the participant. Researchers presented a total of ten opportunities for participants to engage in IJA. The participants were given 30 s to engage with the cause-and-effect toys and the IJA was measured while the child engaged with the given toy. If necessary, the researcher helped the participant activate the cause-and-effect toys. Criterion was set at 80% accuracy across two sessions. See Table 11 for antecedents presented during IJA assessment. See Table 1 for operant definitions of RJA and IJA.

Table 10

Antecedents Presented During IJA Assessment, Experiment 1

Target Object/Toy	Description of Antecedent
1. Remote Controlled Car	A remote-controlled car was turned on and placed in front of the participant. The researcher activated the toy car by driving it and presented the controller to give the participant an opportunity to drive the car.
2. Press n' Zoom Car	The car was placed in front of the participant. If necessary, the researcher demonstrated that pressing the rider in the car led the car to move by itself. The participant was given an opportunity to engage with the car.
3. Button-Activated Car	The car was placed in front of the participant. If necessary, the researcher demonstrated that pressing the button on the car will make it drive by itself. The participant was given an opportunity to engage with the car.
4. Cause-and-effect barn toy	The researcher placed the barn in front of the participant and pressed the button on the barn and the chicken clucked. The researcher gave the participant an opportunity to interact with the toy and click the button.
5. Car Ramp	The researcher placed the barn in front of the participant and gave him or her a car. If the participant did not engage with the car ramp, the researcher demonstrated pushing the car down the ramp and gave the participant an opportunity to engage with the car ramp.
6. Pop-up Train	The researcher placed the train in front of the participant. If the participant did not engage with the train, the researcher demonstrated pressing and turning the levers to activate the train. The researcher gave the participant an opportunity to interact with the train.

7. Rocket Launcher	The researcher placed the rocket launcher in front of the student. The researcher demonstrated stepping on the pump and activating the rocket launcher. The participant received opportunities to activate the rocket with a helping hand of the researcher if necessary.
8. Washing Machine	The researcher placed the washing machine in front of the student. If necessary, the researcher demonstrated pressing the button to turn on the washing machine which led the tub to spin around. The participant received opportunities to engage with the washing machine
9. Bongo Drums	The researcher placed the bongo drums in front of the student and gave the participant opportunities to engage with the drums.
10. Bubble Machine	The researcher placed the bubble machine in front of the student and if necessary demonstrated to the student how to activate the machine. The participant received opportunities to turn on and off the bubble machine.
11. Jack-in-the-Box	The researcher placed the jack-in-the-box in front of the student and if necessary demonstrated to the student how to turn the lever. The participant received an opportunity to engage with the jack-in-the-box with help from the researcher if necessary.
12. Crocodile Teeth Toy	The researcher placed the crocodile teeth toy in front of the student and took turns pressing down one tooth at a time until the crocodile closed its mouth. The participant received multiple opportunities to press down on the teeth and received help from the researcher if necessary.
13. Moving Ball	The researcher placed the moving ball in front of the student. The researcher demonstrated to the participant how to activate the ball by moving or bouncing it for it to start bouncing

	by itself. The participant received an opportunity to engage with the moving ball.
14. Barking Dog	The researcher placed the barking dog in front of the student. Once it was turned on, the dog automatically began barking and did a backflip. The participant received an opportunity to engage with the dog.
15. Toy Piano	The researcher placed the toy piano in front of the student. If necessary, the researcher demonstrated playing the piano by pressing down on the keys and flipping the lever for it to play music. The participant received an opportunity to engage with the piano.
16. Toy Bee	The researcher placed the toy bee in front of the student. If necessary, the researcher demonstrated how to activate the bee by pressing the nose and rolling the bee for it to move by itself. The participant received an opportunity to engage with the bee.
17. Candy Dispenser	The researcher placed the candy dispenser in front of the student. If necessary, the researcher demonstrated pressing down on the lever for the candy to come out. The participant received an opportunity to engage with the dispenser.
18. Light-up Ball	The researcher placed the light-up ball in front of the student. The lights activated based on the ball's movement. The participant received an opportunity to engage with the ball.
19. Rolling Caterpillar	The researcher placed the rolling caterpillar in front of the student. The balls on the caterpillar's back moved when the participant rolled the caterpillar. The participant was given an opportunity to engage with the caterpillar.
20. Surprise Container	The researcher shook and placed the surprise container in front of the child to show that

	there was an item inside. The participant was given an opportunity to open the container and see the item that was placed inside. Items inside the container included toys, crayons, and edibles
21. Pop-up Book	The researcher placed the pop-up book in front of the participant. The participant was given an opportunity to engage with the book.
22. Wind-up Animals	The researcher placed the wind-up animal (included a bunny, crocodile, and dinosaurs) in front of the participant. If necessary, the researcher demonstrated or helped the participant with winding up the animal. The participant was given an opportunity to engage with the animals.
23. Light-up Wand	The researcher gave the light-up wand to the participant. If necessary, the researcher demonstrated pressing the button to activate the spinning movement and the lights. The participant was given an opportunity to engage with the wand.
24. Potty-Training Dog	The researcher placed the potty-training dog in front of the participant. The researcher demonstrated to the participant that pressing the tongue or the tail led water to fly out. The participant was given an opportunity to engage with the dog.
25. Push and Pull Train	The researcher placed the train in front of the participant. The researcher demonstrated to the participant that pushing or pulling the train lightly led the train to move quickly and the gears inside the train moved. The participant was given an opportunity to engage with the train.
26. Crocodile Toy	The researcher placed the crocodile toy in front of the participant. The researcher demonstrated to the participant that pushing the head of the crocodile led it to move by itself. The participant was given an opportunity to engage with the crocodile.

27. Peg and Hammer	The researcher placed the peg and hammer toy in front of the participant. If necessary, the researcher demonstrated to the participant that banging the hammer on one of the pegs led another peg to pop out. The participant was given an opportunity to engage with the peg and hammer.
28. Microphone Toy	The researcher handed the microphone to the participant. If necessary, the researcher showed which button activated the microphone to play music. The participant was given an opportunity to engage with the microphone.
29. Mixer Toy	The researcher placed the mixer in front of the participant. There was a food item placed in the mixer. If necessary, the researcher demonstrated how to activate the mixer by placing the bowl on the mixer and pressing the button. The participant was given an opportunity to engage with the mixer.
30. Gear Toy	The researcher placed the gear toy in front of the participant. Pressing the buttons led the gears to light up, spin, and play music. The gears could be taken out. The participant was given an opportunity to engage with the gear toy.
31. Card Dispenser	The researcher placed the card dispenser in front of the participant and demonstrated that pushing down on the lever led a card to fly out. The participant was given an opportunity to engage with the card dispenser.
32. Trick Ball Toy	The researcher placed the ball toy in front of the participant. There were five balls on the toy and when pushing one of the balls, another ball popped out. The participant was given an opportunity to engage with the toy.
33. BeatBo® Robot	The researcher placed the robot in front of the participant. The researcher demonstrated that pressing one button played music while pressing the other button enabled a recording

	mechanism. The participant was given an opportunity to engage with the robot.
34. Cellphone Toy	The researcher handed the cellphone toy to the participant. If necessary, the researcher demonstrated the different functions of each button. The participant was given an opportunity to engage with the toy.
35. Nightlight Projector	The researcher placed the nightlight projector in front of the participant. The researcher demonstrated that the button turned on the light of the projector. The participant was given an opportunity to engage with the projector.
36. Ball Tower with Hammer	The researcher placed the ball tower in front of the participant. If necessary, the researcher demonstrated that banging the hammer led the ball to fall down the tower. The participant was given an opportunity to engage with the tower.
37. Light-up Headband	The researcher placed the headband in front of the participant. The researcher placed the headband on the participants' head or on an animals' head. The participant was given an opportunity to engage with the headband.
38. Puppet Theater	The researcher set up the puppet theater in front of the participant. Initially, the researcher used the finger puppets and engaged in self-talk. The participant was given an opportunity to use the finger puppets in the theater.
39. Cause-and-Effect Toy	The researcher placed the cause and effect toy in front of the participant. The participant was given an opportunity to engage with the toy.
40. Block Tower	The researcher placed some blocks on the table and began building a block tower with the participant. Then, the researcher pushed the block tower over. The participant was given an opportunity to respond to the event.

41. Microwave Toy	The researcher placed the microwave toy and food items in front of the participant. If necessary, the researcher demonstrated to the participant that pressing the button led the microwave dish to spin. The participant was given an opportunity to engage with the microwave.
42. Cash Register Toy	The researcher placed the cash register toy with some coins in front of the participant. If necessary, the researcher demonstrated that pressing the lever led coins to fall into the cash register coin compartment. The participant was given an opportunity to engage with the cash register.
43. Electronic Book	The researcher placed the electronic book in front of the participant. The participant was given an opportunity to engage with the electronic book
44. Action Figure	The researcher placed the action figure in front of the participant. If necessary, the researcher demonstrated to the participant that the action figure could be make movements and sounds using the buttons. The participant was given an opportunity to engage with the action figure.
45. Water Drawing Board	The researcher placed the drawing board with the water filled pens in front of the participant. If necessary, the researcher demonstrated that the pens can be used to draw on the board. The participant was given an opportunity to engage with the drawing board.
46. Light-up Ball Popper	The researcher placed the ball popper in front of the participant. If necessary, the researcher demonstrated that pressing down on the button or rolling the ball popper led the balls to pop and light up. The participant was given an opportunity to engage with the ball popper.
47. Spinning Monkey	The researcher placed the spinning monkey in front of the participant. If necessary, the

	researcher demonstrated that pushing the button and/or the monkey led it to spin, light up, and play music. The participant was given an opportunity to engage with the monkey.
48. Mechanical Dinosaur	The researcher placed the mechanical dinosaur in front of the participant. Once the toy was turned on, it moved by itself and played music. The participant was given an opportunity to engage with the dinosaur.
49. Mechanical Dinosaur with Fog Machine	The researcher placed the mechanical dinosaur in front of the participant. Once the toy was turned on, it moved by itself, played music and released fog from its mouth. The participant was given an opportunity to engage with the dinosaur.
50. Baby Shark® Electronic Shape Sorter	The researcher placed the shape sorter in front of the participant. If necessary, the researcher demonstrated that taking a shape out and placing it back in led it to play music. The participant was given an opportunity to engage with the shape sorter.
51. Mailbox Toy	The researcher placed the mailbox in front of the participant. If necessary, the researcher demonstrated that the mail can be taken out and put back in through the slot which activated a sound. The participant was given an opportunity to engage with the mailbox.
52. Camera Toy	The researcher placed the camera in front of the participant. If necessary, the researcher demonstrated that the camera had some buttons that activated a variety of sounds and actions. The participant was given an opportunity to engage with the camera.
53. Circular Saw Toy	The researcher placed the circular saw in front of the participant. If necessary, the researcher demonstrated that pressing the lever led the saw to spin. The participant was given an opportunity to engage with the saw.

54. Toy Iron	The researcher placed the toy iron in front of the participant. If necessary, the researcher demonstrated that pressing the button led the iron to light up and release fog. The participant was given an opportunity to engage with the iron.
55. Key and Lock House	The researcher placed the key and lock house in front of the participant. If necessary, the researcher demonstrated that unlocking a door led the door to open and helped the child if necessary. The participant was given an opportunity to engage with the key and lock house.
56. Pop-up Book	The researcher placed the pop-up book in front of the participant. If necessary, the researcher opened the book and flipped open the tabs or gave gestural or visual prompts. The participant was given an opportunity to engage with the book.

Note. There were a variety of some of the toys listed above (e.g., bubble machine, jack-in-the-box, car ramp, remote control car, light-up wand, moving ball, press n' zoom car, ball tower, cause-and-effect toy, surprise box, ball popper toy, and pop-up book).

Intensive Tact Instruction Intervention

The researchers taught 50 tacts per day across 5 categories (10 opportunities per category). The intensive tact instruction intervention consisted of five different categories. Across all five categories, the researchers reinforced correct responses with praise, social attention (i.e., smiles, high fives, pat on the back, etc), and commenting in regard to the target stimulus. A correct tact response was when the participant vocally emitted the name of the target stimulus within 3 s. An incorrect response was considered when the participant emitted a vocalization that did not have one-to-one correspondence with the target stimulus or did not emit a response within 3s Examples of commenting included, “That is a door, great job! Let’s see if there’s anybody inside, knock knock”, “Yes I am jumping! Come on, do it with me!” The researchers conducted the correction procedure when participants emitted incorrect responses by delivering the correct response and re-presenting the antecedent at least three times to provide participants with additional opportunities to emit an independent response. Criterion was set at 90% accuracy across two sessions or 100% accuracy in one session across all five categories.

Category 1. The researcher guided the participant around the school and delivered antecedents by pointing to 3D stimuli and providing participants with an opportunity to emit a tact. Responses included both pure tacts and intraverbal tacts. During a pure tact, the researcher presented the antecedent by pointing to the target stimulus. During an intraverbal tact, the researcher presented the antecedent by pointing to the target stimulus while giving a vocal antecedent, “What’s this?” or “What is that?” A correct response was when the participant emitted a label of the target stimulus within 3 s (e.g., “ball”). An incorrect response was considered when the participant emitted a vocalization that was not the label of the target stimulus or did not emit a response within 3 s.

Category 2. Researchers delivered the antecedent by engaging in an action or asking another adult in the classroom to engage in the action. If the researcher had another adult engaging in the action, he or she pointed towards that adult. While engaging in the action or having another adult engage in an action, the researcher delivered the vocal antecedent, "What am I doing?" or "What are they doing?" Responses included both pure tacts and intraverbal tacts. During a pure tact, the researcher presented the antecedent by pointing to the adult or engaging in the action themselves. During an intraverbal tact, the researcher or adult engaged in the action while giving the vocal antecedent, "What am I doing?" or "What is she/he doing?" A correct response was when the participant emitted the correct tact within 3 s (e.g., "jumping"). An incorrect response was considered when the participant emitted a vocalization that did not match the label of the target stimulus or did not emit a response within 3 s.

Category 3. Researchers delivered the antecedent by pointing to a picture in the book. Responses included both pure tacts and intraverbal tacts. During a pure tact, the antecedent consisted of the researcher pointing to the picture in the book. During an intraverbal tact, the researcher pointed to the picture in the book and delivered the vocal antecedent, "What's that?" or "What is this?" A correct response was when the participant emitted the tact of the picture on the page within 3 s (e.g., "sun"). An incorrect response was considered when the participant emitted a vocalization that did not match the label of the target stimulus or did not emit a response within 3 s.

Category 4a. During the antecedent, the researcher presented the opaque bag to the participant and gave the vocal antecedent, "Pick one out" or "Choose one." After the participant pulled out an item from the bag, the researcher either waited for the participant to emit a response or delivered the antecedent "What is that?" or "What did you find?" A correct response

was when the participant emitted the tact of the object that was taken out within 3 s (e.g., “It’s a ball,” “I found a block”). An incorrect response was considered when the participant emitted a vocalization that did not match the label of the target stimulus or did not emit a response within 3 s.

Category 4b. The researcher delivered a vocal antecedent that provided an opportunity to the participant to emit a response. See Table 11 for all vocal antecedents used during intervention. A correct response was when the participant emitted an accurate answer within 3 s (e.g., what color is your shirt? “red”). An incorrect response was considered when the participant emitted an answer that did not match the label of the target stimulus or did not emit a response within 3 s.

Category 5. The researcher presented the antecedent by initiating an activity or a token economy during instruction. During the antecedent, the researcher either pointed to the activity (when they observed that the participant engaged in an action) or delivered a vocal antecedent, “What did you do?”, “What did you make?”, or “What are you doing?” A correct response was when the participant emitted the tact of the activity the participant was engaging in within 3 s (e.g., “finished puzzle,” “I made a pizza”). An incorrect response was considered when the participant emitted a vocalization that did not match the label of the action/activity or did not emit a response within 3 s.

Tactic. A tactic was used if the participants came to a decision point during the ITI. The researchers delivered two echoics for each operant (applies to Categories one, two, and three) at the beginning of the first session. Echoics were delivered by the researcher. During an independent response, the researcher delivered vocal (“What’s that?”) or non-vocal antecedents (e.g., a point). If the participant emitted two consecutive incorrect responses for an operant at the

end of the session, the researcher delivered two echoics at the beginning of the next session for that operant.

Table 11

Antecedents for Intraverbals for Participant 1 and 2, Experiment 1

Antecedent
My name is (teacher's name)
My birthday is (teacher's birthday)
I live in
My mom's name is
I have a (sibling)
My (sibling's) name is
I ate _____ for snack
I drank _____
My hair is (straight/curly/brown, etc)
I like to play with _____
I have a (pet)
My favorite show is
I like to drink _____

Experimental Design

Experiment 1 was conducted during the COVID-19 pandemic, which made conducting concurrent single-subject designs difficult due to children's school schedules. We utilized a nonconcurrent multiple baseline design to evaluate the effects of the intensive tact instruction procedure on RJA and IJA (Slocum et al, 2022; Watson & Workmen, 1981). Prior to conducting the experiment, the researcher pre-determined four baseline lengths: 3 sessions, 4 sessions, 5 sessions, and 6 sessions. Then, the researcher used randomizer.org to assign baseline lengths to participants to determine the number of baselines that will be conducted for each participant. The predetermined number of baselines were between three and six sessions. Participants were assigned the number of baselines before intervention began. Thus, the researchers collected baseline data until the participant received the predetermined number of baseline sessions. Then, the researchers implemented the intensive tact instruction procedure. Once the participant demonstrated criterion-level across all five categories of the intervention, the researcher conducted at least three assessments to determine if the participant required additional intervention sessions. Criterion was set at 80% accuracy across two consecutive sessions. Researchers conducted follow-up assessments with Anna. The different baseline lengths controlled for internal validity.

Interobserver Agreement

A second independent observer collected data for the purpose of assessing interobserver agreement (IOA). When the researcher was conducting the assessment or experiment, the second independent observer was a co-worker of the researcher at the school that the researcher was working at and had been trained to conduct IOA based on the CABAS teacher ranks and/or was a master's student at the educational institution that the researcher was attending. When the

participants' teacher was conducting the assessment or researcher, the researcher was the second independent observer. Trial-by-trial IOA was calculated by adding the number of agreements across both observers and dividing by the total number of opportunities presented the participants and multiplying by 100%. IOA was collected for 41% of probe sessions and agreement was 95% (range = 75% to 100%). IOA was collected for 18% of intervention sessions and agreement was 98% (range = 80% to 100%).

Treatment Fidelity

An independent observer recorded the accuracy of implementing baseline and intervention sessions for the purpose of calculating treatment fidelity. The observer evaluated the implementation of antecedents and consequences delivered during probe sessions and intervention sessions. To evaluate the accuracy of these components, a trained and independent observer completed a teacher performance rating assessment (TPRA) (Ross et al., 2005). The TPRA outlined the antecedents delivered and the consequences presented to the participants and the trained observed recorded the accuracy of the researcher's antecedents and consequences per learning opportunity. Treatment fidelity was calculated by dividing the total number of correct researcher responses in a session by the total number of opportunities provided and multiplying by 100%. We collected treatment fidelity for 41% of the baseline sessions and 18% of the intervention sessions. Treatment fidelity was 99% (range 92% to 100%) for all conditions of the experiment with all participants.

Results and Discussion

Responding to Joint Attention

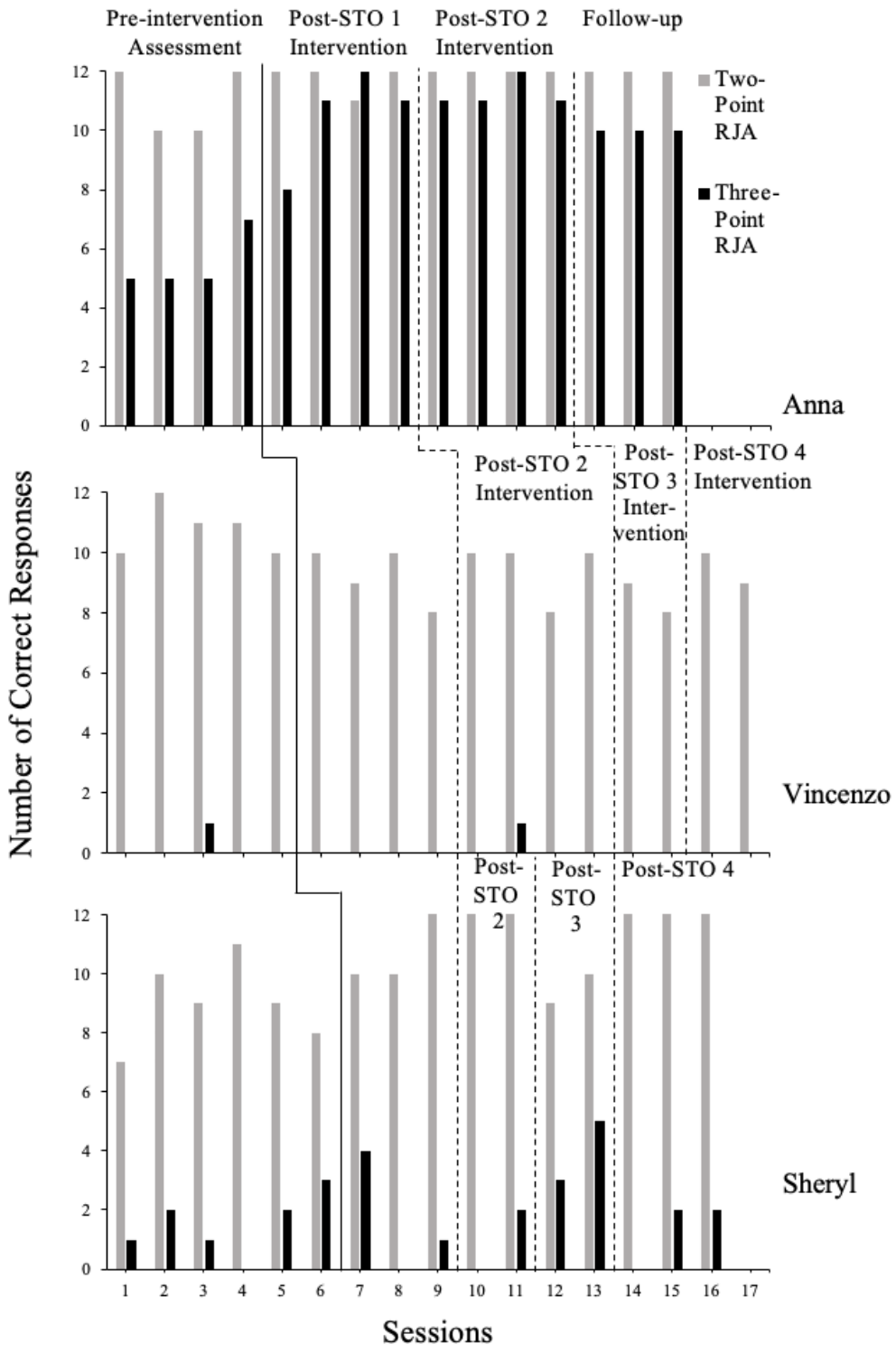
Figure 1 displays pre- and post-intervention two-point RJA and three-point RJA data for Anna, Vincenzo, and Sheryl. Anna demonstrated a low number of correct three-point RJA

responses during the four pre-intervention assessment sessions (M = 5.5, range, 5 to 7). Anna then increased her number of correct responses after meeting criterion on the first short-term objective (M = 10.5, range, 8 to 12). Anna then increased her number of correct responses after meeting criterion on the second short-term objective (M = 11.25, range 11 to 12) and meeting criterion with 80% accuracy across two post-intervention assessment sessions. During the three follow-up assessment sessions, Anna maintained RJA responses at criterion-level (M = 10, range 10 to 10). Anna demonstrated a high number of two-point RJA responses during the four pre-intervention assessment sessions (M = 11, range 10 to 12). Anna increased two-point RJA responses after the completion of the first short-term objective (M = 11.75, range 11 to 12), after the completion of the second short-term objective (M = 12, range 12 to 12), and maintained a high number of two-point RJA responses during the follow-up (M = 12, range 12 to 12). Vincenzo demonstrated a low number of correct responses during the pre-intervention assessment sessions (M = 0.2, range 0 to 1) as well as during the first post-intervention assessment sessions (M = 0, range to 0 to 0), the second (M = 0.25, range to 0 to 1), the third (M = 0, range to 0 to 0), and the fourth post-intervention sessions (M = 0.5, range to 0 to 1). Vincenzo demonstrated a high number of two-point RJA during the five pre-intervention assessment sessions (M = 10.8, range 10 to 12). Vincenzo decreased the number of two-point RJA after meeting criterion on the first short-term objective (M = 9.25, range 8 to 10). Vincenzo maintained the number of two-point RJA after meeting criterion on the second short-term objective (M = 9.5, range 8 to10). Vincenzo then decreased the number of two-point RJA after meeting criterion on the third short-term objective (M = 8.5, range 8 to 9). Vincenzo then increased the number of two-point RJA after meeting criterion on the fourth short-term objective (M = 9.5, range 9 to 10). Vincenzo demonstrated no trend in his three-point RJA data and emitted

variable two-point RJA. Sheryl demonstrated a low number of correct responses during the pre-intervention assessment sessions (M = 1.5, range 0 to 3). Sheryl then increased her number of correct responses after meeting criterion on the first short-term objective (M = 1.7, range 0 to 4). Sheryl then decreased her number of correct responses after meeting the second short-term objective (M = 1, range 0 to 1). After meeting the third short-term objective, Sheryl increased her number of correct responses (M = 4, range 3 to 5). Sheryl then decreased her number of correct responses after meeting the fourth short-term objective. (M = 1.3, range 0 to 2). Sheryl demonstrated a high number of two-point RJA during the six pre-intervention assessment sessions (M = 9, range 7 to 11). Sheryl increased two-point RJA after meeting criterion on the first short-term objective (M = 10.7, range 10 to 12) and the second short-term objective (M = 12, range 12 to 12). Sheryl decreased the number of two-point RJA after meeting the third short-term objective (M = 9.5, range 9 to 10). Sheryl then increased the number of two-point RJA after meeting the fourth short-term objective (M = 12, range 12 to 12). Overall, Sheryl had a variable data pattern in two-point and three-point RJA. The data demonstrated that Vincenzo and Sheryl did not acquire joint attention after experiencing the intensive tact instruction. Anna did increase three-point RJA to criterion-level and maintained criterion-level during the three-month follow up session.

Figure 1

Number of correct two-point and three-point RJA responses, Experiment 1

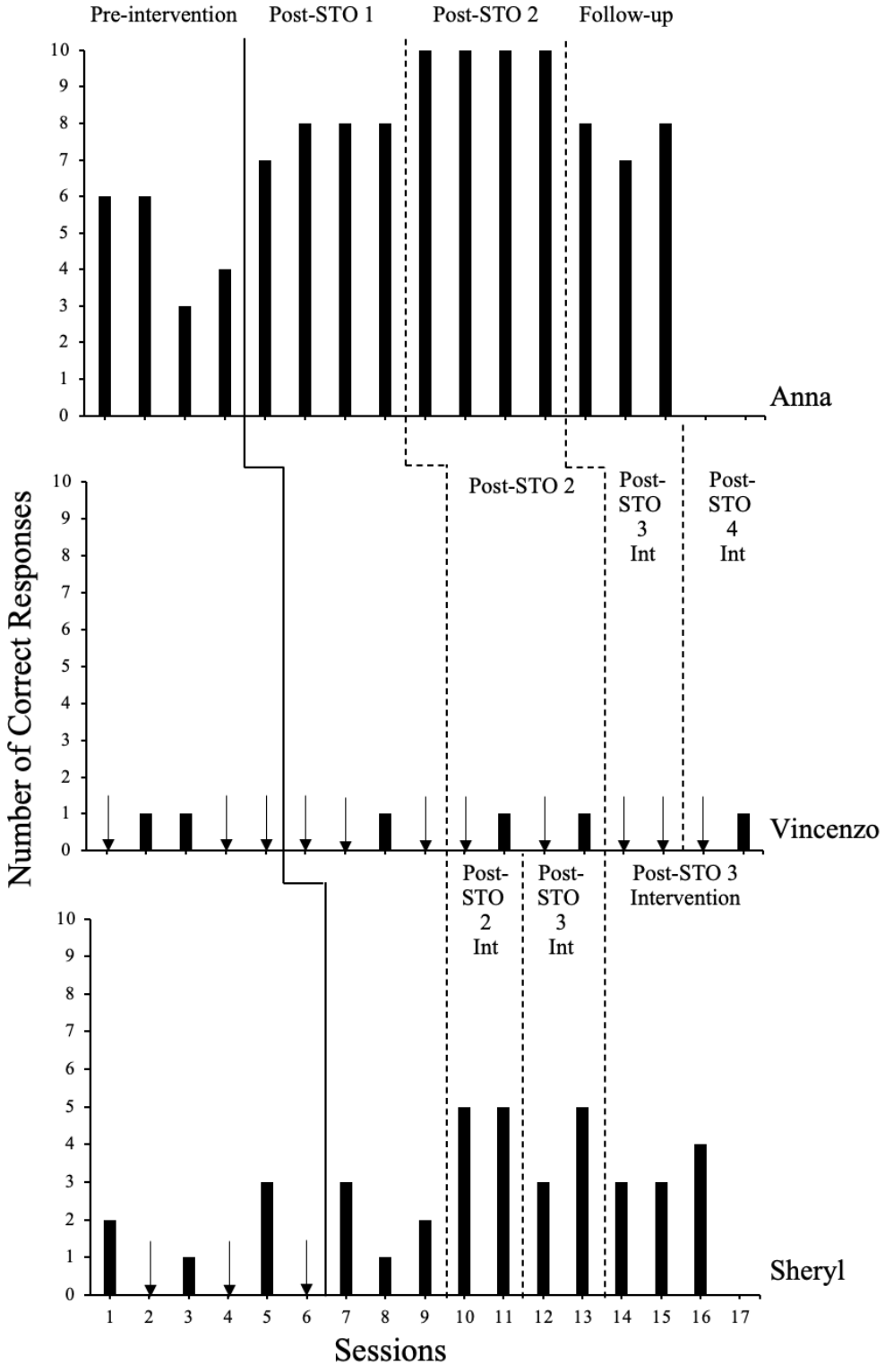


Initiating Joint Attention

The number of correct responses for IJA can be found in Figure 2. Anna demonstrated a low number of correct responses during the four pre-intervention assessment sessions (M = 4.75, range, 3 to 6). Anna then increased her number of correct responses after meeting criterion on the first short-term objective (M = 7.75, range, 7 to 8). Anna then increased her number of correct responses after meeting criterion on the second short-term objective (M = 10, range 10 to 10) and meeting criterion with 80% accuracy across two post-intervention assessment sessions. During the three-month following assessment sessions, Anna maintained criterion-level of IJA (M = 7.67, range 7 to 8). Vincenzo demonstrated a low number of correct responses during the pre-intervention assessment sessions (M = 0.4, range 0 to 1) as well as during the first post-intervention assessment sessions (M = 0.25, range to 0 to 1), the second (M = 0.5, range to 0 to 1), the third (M = 0, range to 0 to 0), and the fourth post-intervention sessions (M = 0.5, range to 0 to 1). Vincenzo demonstrated no trend in his IJA data. Sheryl demonstrated a low number of correct responses during the pre-intervention assessment sessions (M = 1.0, range 0 to 3). Sheryl then increased her number of correct responses after meeting criterion on the first short-term objective (M = 2, range 1 to 3). Sheryl then increased her number of correct responses after meeting the second short-term objective (M = 5. Range 5 to 5). After meeting the third short-term objective, Sheryl decreased her number of correct responses (M = 4, range 3 to 5). Sheryl then decreased her number of correct responses after meeting the fourth short-term objective. (M = 3.3, range 3 to 4). Overall, Sheryl had a variable data pattern in IJA similar to three-point RJA. The data demonstrated that Vincenzo and Sheryl did not increase joint attention after experiencing the intensive tact instruction. Anna did increase IJA to criterion-level and maintained criterion-level during the three-month follow up session.

Figure 2

Number of correct IJA responses, Experiment 1



Intensive Tact Instruction

Figure 3 displays STO 1 data of Vincenzo during the ITI. Vincenzo contacted 80 learn units to meet criterion of labeling target objects in the environment, 80 learn units to meet criterion on labeling actions, 80 learn units to meet criterion on labeling pictures in a book, 60 learn units to meet criterion on labeling hidden items, and 100 learn units to meet criterion on labeling the activity. On average, Vincenzo had the highest learn units to criterion during the fifth category where he was required to label the activity he was engaging in. Figure 4 displays STO 2 data of Vincenzo during the ITI. Vincenzo contacted 100 learn units to meet criterion on labeling objects in the environment, 60 learn units to meet criterion on labeling actions, 100 learn units to meet criterion on labeling pictures in a book, 120 learn units to meet criterion on labeling hidden items, and 80 learn units to meet criterion on labeling the activity. On average, Vincenzo had the largest learn units to criterion during the fourth category where he was required to label hidden items. Figure 5 displays STO 3 data of Vincenzo during the ITI. Vincenzo contacted 100 learn units to meet criterion on labeling objects in the environment, 40 learn units to meet criterion on labeling actions, 100 learn units to meet criterion on labeling pictures in a book, 140 learn units to meet criterion on labeling hidden items, and 80 learn units to meet criterion on labeling the activity. On average, Vincenzo had the largest learn units to criterion during the fourth category where he was required to label hidden items. Figure 6 displays STO 4 data of Vincenzo during the ITI. Vincenzo contacted 80 learn units to meet criterion on labeling objects in the environment, 40 learn unit to meet criterion on labeling actions, 100 learn units to meet criterion on labeling pictures in a book, 160 learn units to meet criterion on labeling hidden items, and 160 learn units to meet criterion on labeling the activity. On average, Vincenzo had

the largest learn units to criterion during the fourth category where he was required to label hidden items.

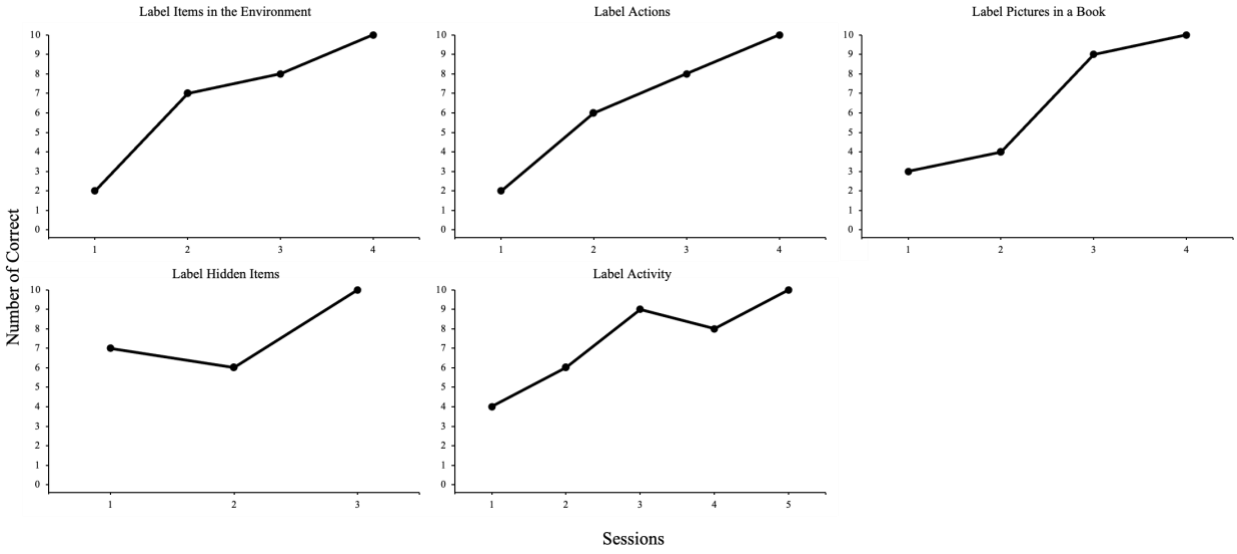
Figure 7 displays STO 1 data of Anna during the ITI. Anna contacted 140 learn units to meet criterion on labeling objects in the environment, 80 learn units to meet criterion on labeling actions, 100 learn units to meet criterion on labeling pictures in a book, 60 learn units to meet criterion on labeling hidden items, and 100 learn units to meet criterion on labeling the activity. On average, Anna had the largest learn units to criterion during the first category where he was required to label objects in the environment. Figure 8 displays STO 2 data of Anna during the ITI. Anna contacted 200 learn units to meet criterion on labeling objects in the environment, 40 learn units to meet criterion on labeling actions, 180 learn units to meet criterion on labeling pictures in a book, 80 learn units to meet criterion on labeling hidden items, and 60 learn units to meet criterion on labeling the activity. On average, Anna had the largest learn units to criterion during the first category where she was required to label objects in the environment.

Figure 9 displays STO 1 data of Sheryl during the ITI. Sheryl contacted 180 learn units to meet criterion on labeling objects in the environment, 140 learn units to meet criterion on labeling actions, 160 learn units to meet criterion on labeling pictures in a book, 200 learn units to meet criterion on labeling hidden items, and 495 learn units to meet criterion on labeling the activity. In the fifth panel of Figure 9, Sheryle required tactics and additional opportunities to meet criterion level of the ITI. On average, Sheryl had the largest learn units to criterion during the fifth category where she was required to label the activity she was engaging in. Figure 10 displays STO 2 data of Sheryl during the ITI. Sheryl contacted 300 learn units to meet criterion on labeling objects in the environment, 2200 learn units to meet criterion on labeling actions, 260 learn units to meet criterion on labeling pictures in a book, 140 learn units to meet criterion on

labeling hidden items, and 260 learn units to meet criterion on labeling the activity. On average, Sheryl had the largest learn units to criterion during the first category where she was required to label items in the environment. Figure 11 displays STO 3 data of Sheryl during the ITI. Sheryl contacted 200 learn units to meet criterion on labeling objects in the environment, 140 learn units to meet criterion on labeling actions, 220 learn units to meet criterion on labeling pictures in a book, 160 learn units to meet criterion on labeling hidden items, and 180 learn units to meet criterion on labeling the activity. On average, Sheryl had the largest learn units to criterion during the third category where she was required to label pictures in a book. Figure 12 displays STO 4 data of Sheryl during the ITI. Sheryl contacted 120 learn units to meet criterion on labeling objects in the environment, 80 learn units to meet criterion on labeling actions, 200 learn units to meet criterion on labeling pictures in a book, 160 learn units to meet criterion on labeling hidden items, and 140 learn units to meet criterion on labeling the activity. On average, Sheryl had the largest learn units to criterion during the third category where she was required to label pictures in a book.

Figure 3

Intervention data of Vincenzo, STO 1, Experiment 1

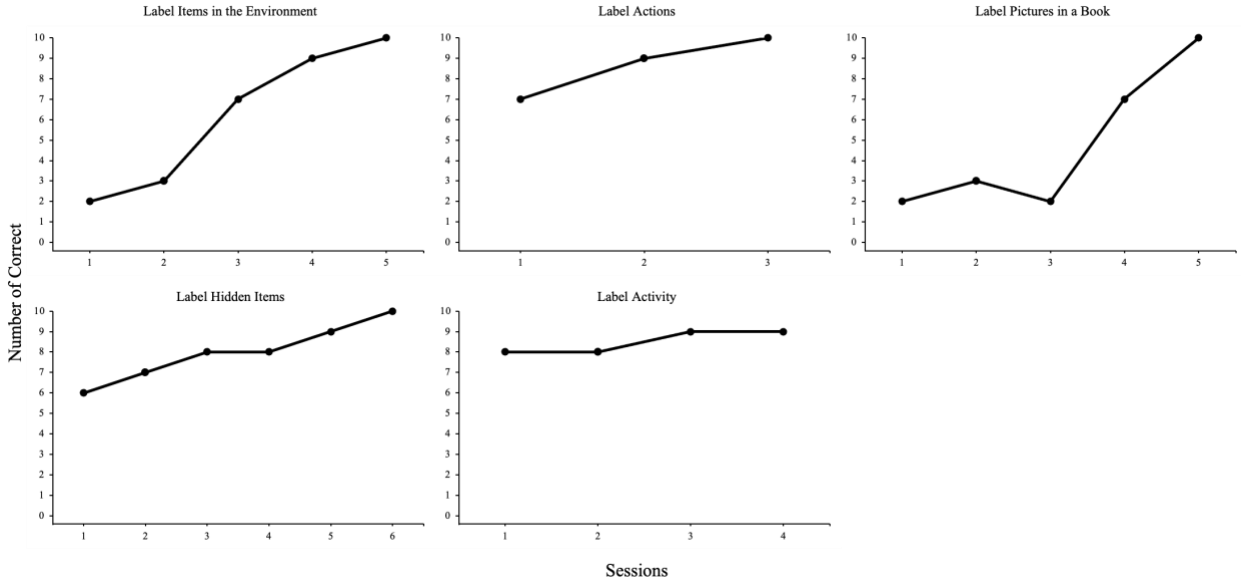


Note. 10 learn units were delivered per category making a total of 50 learn units per session.

STO=short term objective.

Figure 4

Intervention data of Vincenzo, STO 2, Experiment 1

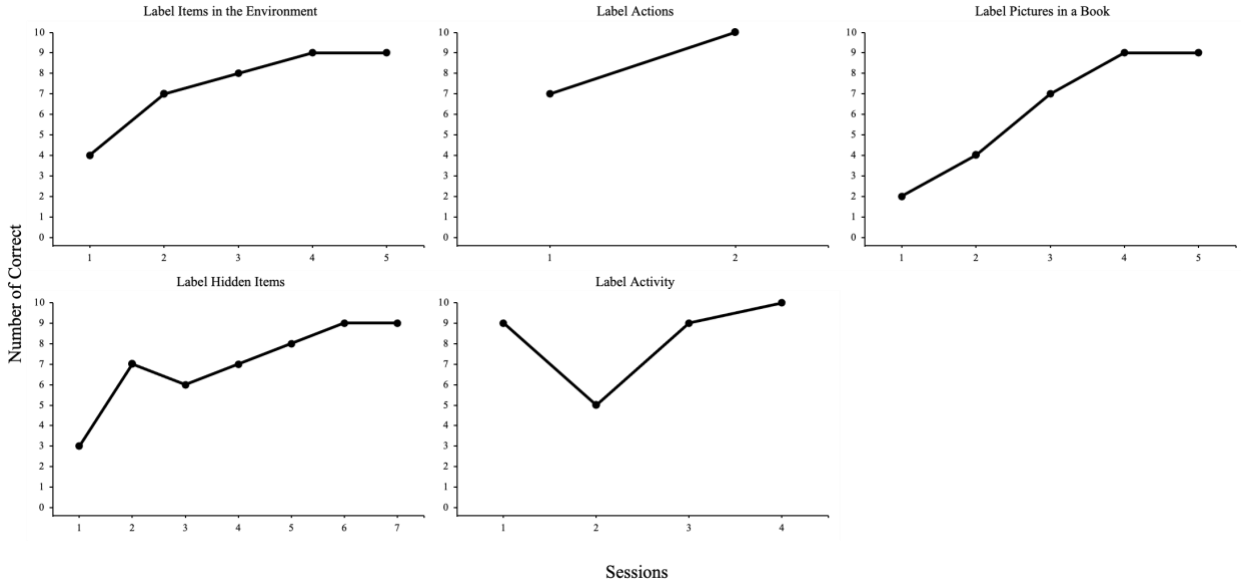


Note. 10 learn units were delivered per category making a total of 50 learn units per session.

STO=short term objective.

Figure 5

Intervention data of Vincenzo, STO 3, Experiment 1

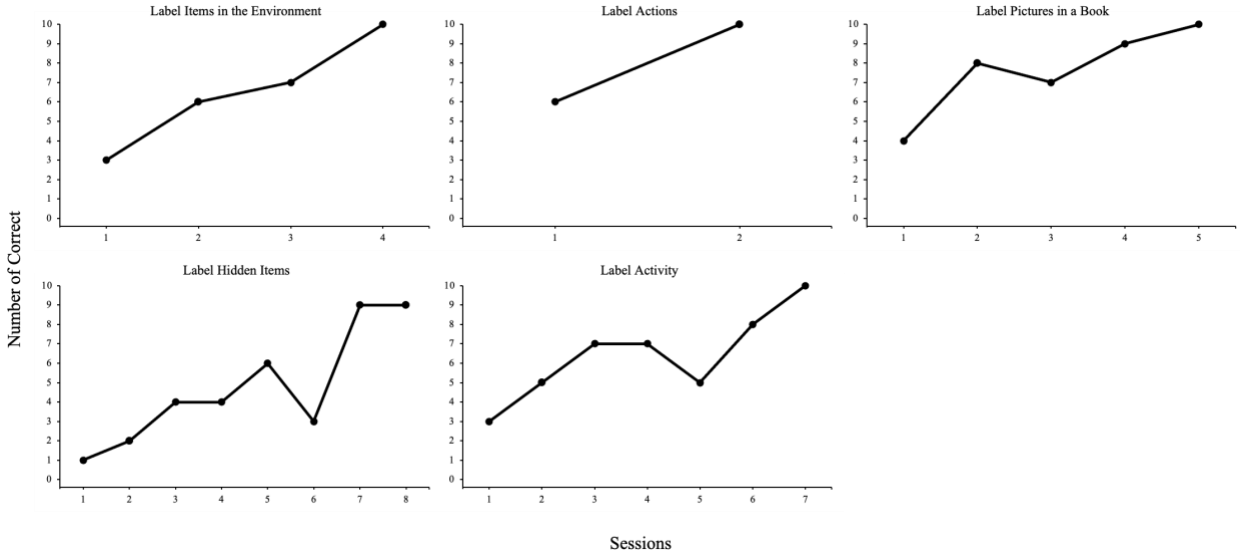


Note. 10 learn units were delivered per category making a total of 50 learn units per session.

STO=short term objective.

Figure 6

Intervention data of Vincenzo, STO 4, Experiment 1

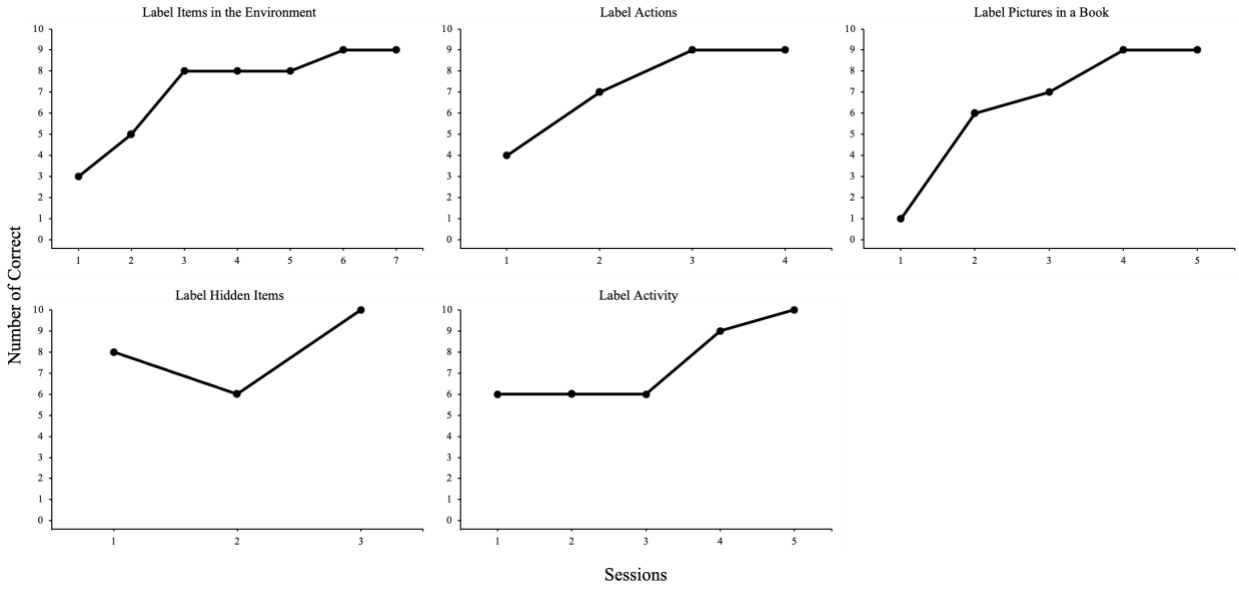


Note. 10 learn units were delivered per category making a total of 50 learn units per session.

STO=short term objective.

Figure 7

Intervention data of Anna, STO 1, Experiment 1

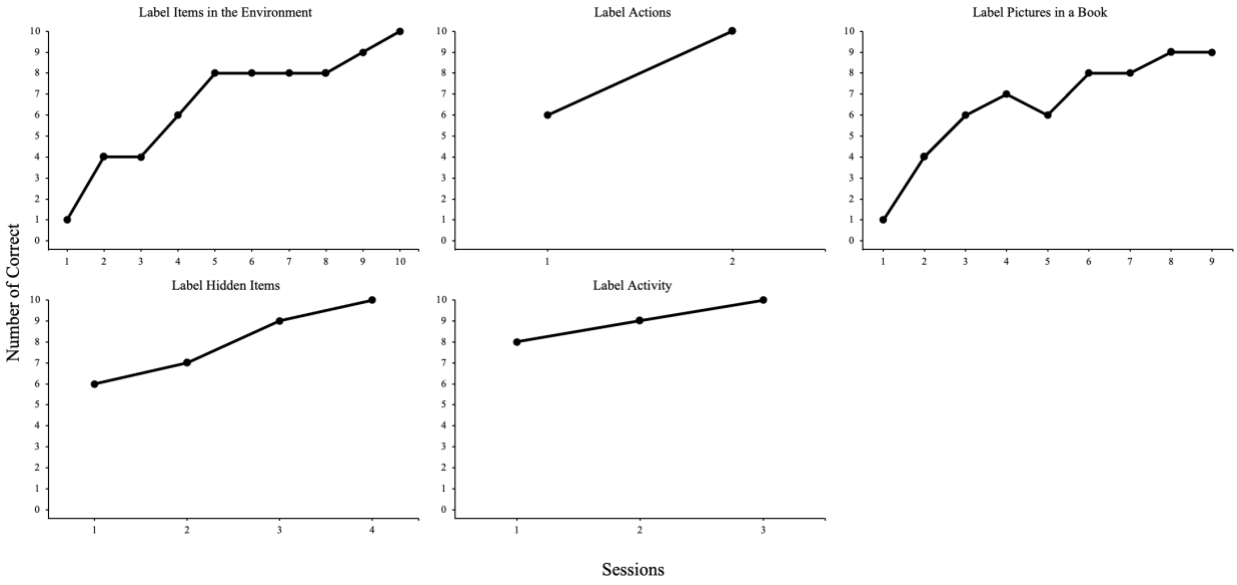


Note. 10 learn units were delivered per category making a total of 50 learn units per session.

STO=short term objective.

Figure 8

Intervention data of Anna, STO 2, Experiment 1

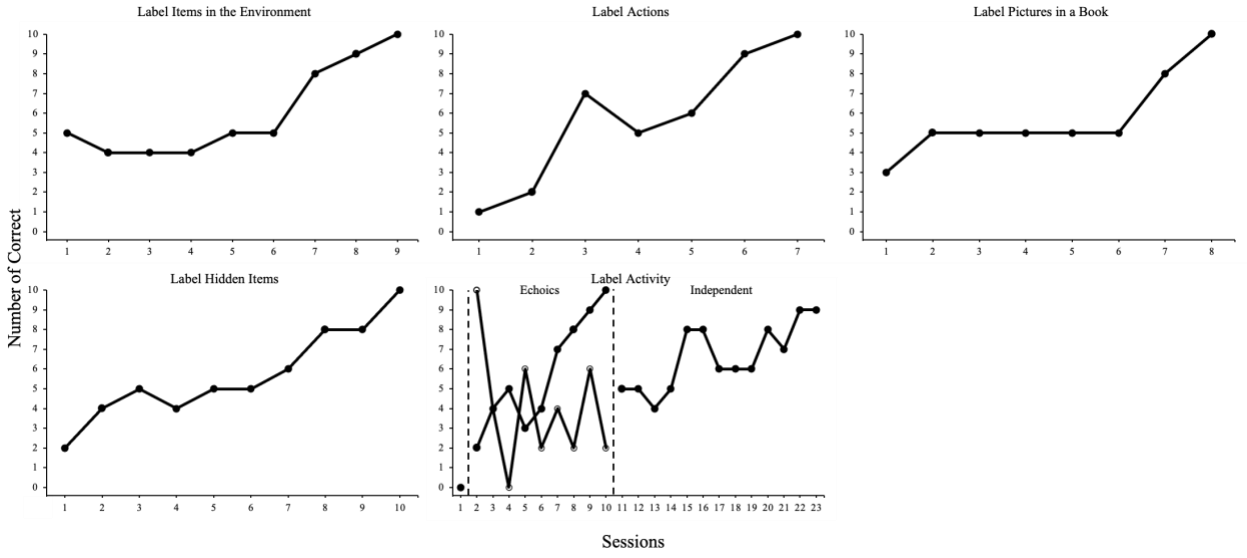


Note. 10 learn units were delivered per category making a total of 50 learn units per session.

STO=short term objective.

Figure 9

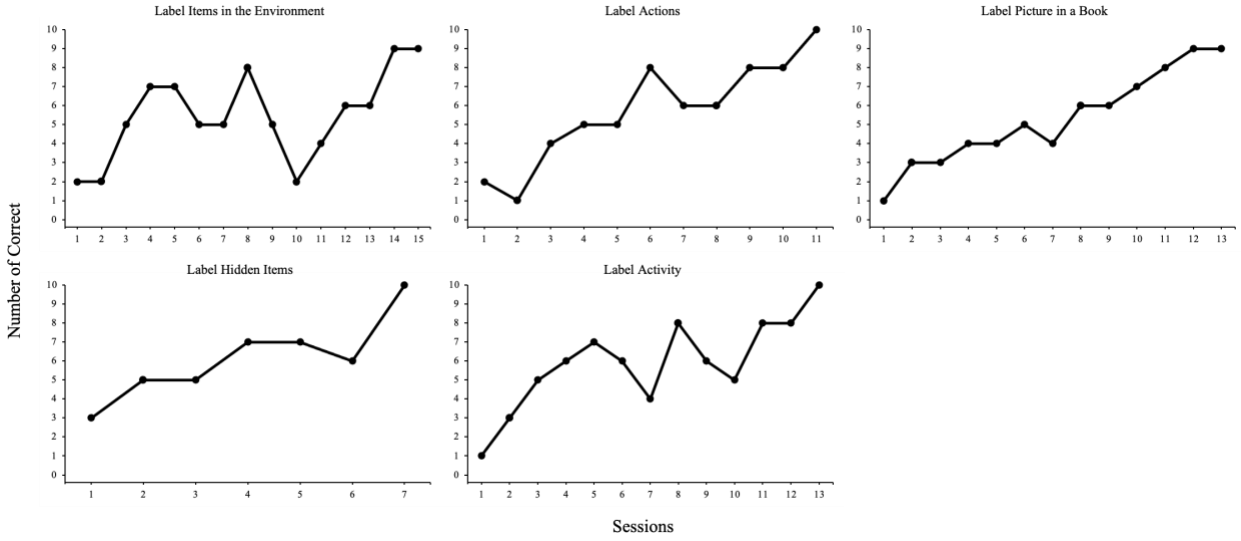
Intervention data of Sheryl, STO 1, Experiment 1



Note. 10 learn units were delivered per category making a total of 50 learn units per session. In the label activity category, Sheryl required an echoic tactic to meet criteria. STO=short term objective.

Figure 10

Intervention data of Sheryl, STO 2, Experiment 1

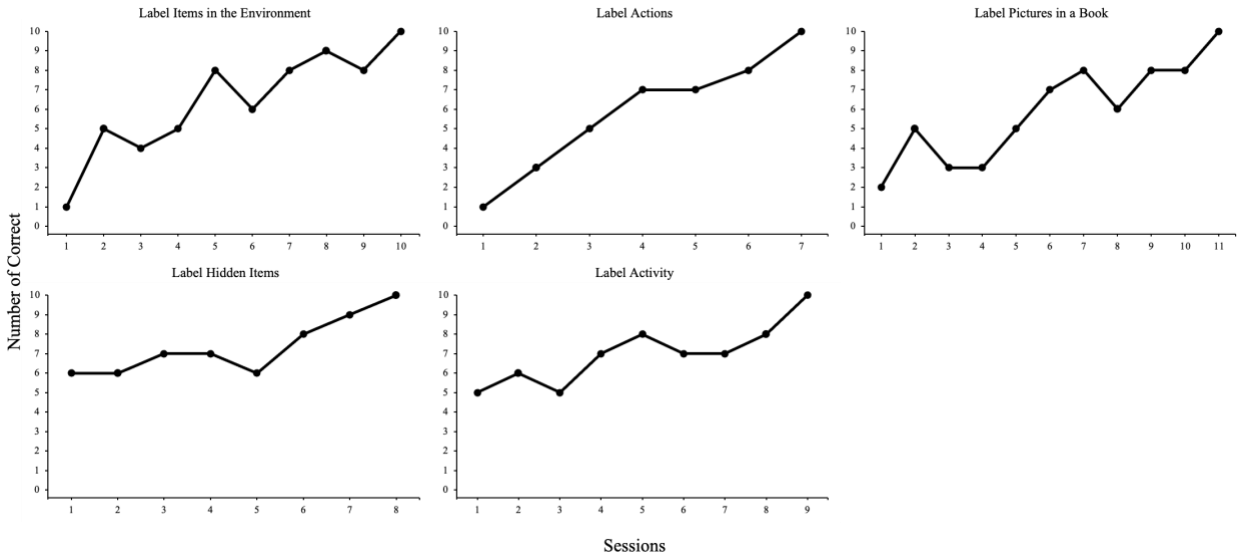


Note. 10 learn units were delivered per category making a total of 50 learn units per session.

STO=short term objective.

Figure 11

Intervention data of Sheryl, STO 3, Experiment 1

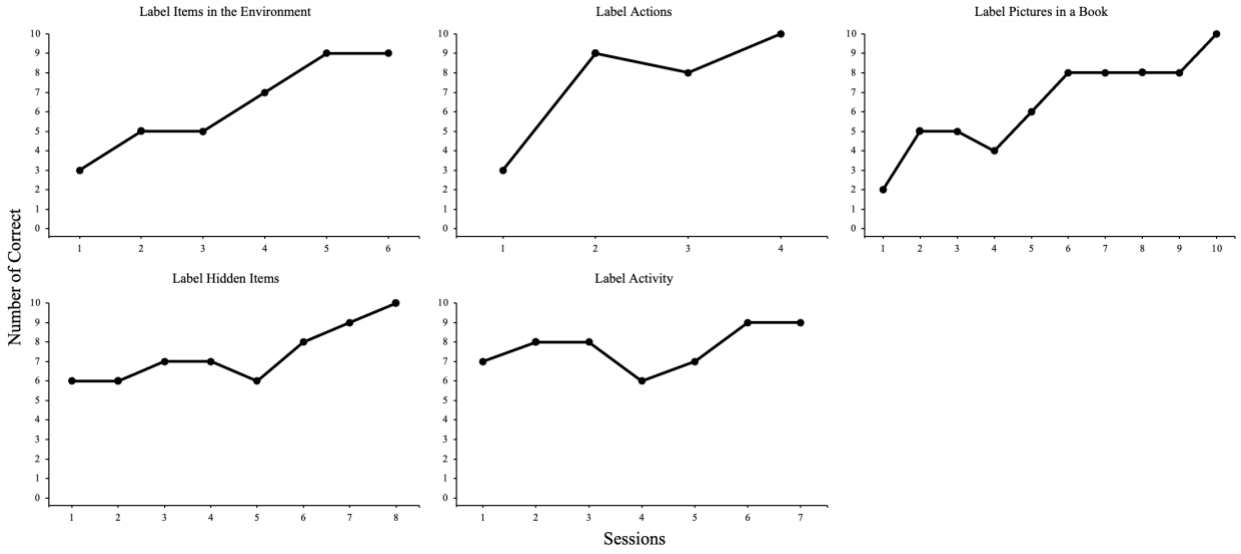


Note. 10 learn units were delivered per category making a total of 50 learn units per session.

STO=short term objective.

Figure 12

Intervention data of Sheryl, STO 4, Experiment 1



Note. 10 learn units were delivered per category making a total of 50 learn units per session.

STO=short term objective.

Summary

Experiment 1 was a systematic replication of the study by Harms (2020). The procedure was identical while the population and number of opportunities per session were different. The population in this experiment were early intervention students while the population in Harms (2020) were preschoolers. In addition, participants in this experiment received 50 total opportunities to respond per session while participants in Harms (2020) received 100 total opportunities to respond. All participants in Experiment 1 demonstrated two-point RJA during the pre-intervention assessments. Overall, there was not a replication of the effects observed in Harms (2020) study. The results indicate that Anna increased both three-point RJA and IJA to criterion-level, Vincenzo did not increase either three-point RJA or IJA at all, and Sheryl demonstrated minor increases of both three-point RJA and IJA. In the Harms (2020) study, three of the participants had moderate increases of three-point RJA and IJA where one of the participants met IJA at criterion-level. One of the participants demonstrated minor increases of joint attention similar to Sheryl, and three of the participants demonstrated no increases in joint attention similar to Vincenzo in Experiment 1. Sheryl, who had minor increases but variable data of joint attention, had an increase in joint attention based on the less stringent definition used in the literature. During the IJA pre-intervention assessments, Sheryl had shown low responses of IJA while during the post-intervention assessments, Sheryl emitted vocalizations such as, “Look, it’s lighting up” while not engaging in a coordinated look. This definition of joint attention was considered an incorrect response however it is interesting to have observed this during the post-intervention assessments. Experiment 2 will take this observation into consideration. In Experiment 1, this response did not qualify as joint attention. Sheryl was the only participant who engaged in this behavior. Therefore, future research should measure the effects of ITI on

behaviors such as language and additional communicative behaviors observed during joint attention assessments. Harms (2020) used a delayed multiple baseline design to observe the effects of the intervention on joint attention while Experiment 1 used a nonconcurrent multiple baseline design to observe the effects of the intervention on joint attention. Both designs controlled for threats to internal validity since all participants demonstrated low and steady baselines prior to the beginning of the intervention. The results of Harms (2020) and Experiment 1 show variable data amongst students which indicate that there is not a functional relation between the intensive tact instruction and the joint attention measures, three-point RJA and IJA.

There are multiple limitations seen in this experiment. Experiment 1 was unable to show a strong effect because the increased joint attention responses of Participant 1 was not replicated with the other participants. The participants who reliably emitted two-point RJA did not show improvements in three-point RJA or IJA in a consistent manner. In addition, the nonconcurrent multiple baseline design did not control for history or maturation. This design relied on between subject replications (Harvey et al., 2004; Kennedy, 2022;). However, there are no between-subject replications or effects shown in the results of Experiment 1. The design is weak based on the results shown. Additionally, the researcher recruited participants who already had some RJA in repertoire. Future research should recruit participants who show lower responses of RJA in repertoire and do not reliably emit two-point RJA, specifically. The ITI may increase certain behaviors of joint attention such as two-point RJA. In addition, subsequent research may explore measuring additional communicative behaviors that were not included in the operant definition of joint attention and consider redefining how to measure joint attention. Future research should also use a stronger design to control for history and maturation.

CHAPTER III

Experiment 2

Purpose

Experiment 2 expanded the inclusion criteria established in the previous experiment. The purpose of Experiment 2 was to determine whether the revised inclusion criterion which required that the participants did not demonstrate two-point RJA while having conditioned reinforcement for 3D and 2D objects, faces, and voices, would lead future participants to increase two-point RJA to criterion-level. The experimenter chose participants that did not demonstrate two-point RJA to examine the effects of ITI on two-point RJA behaviors. In the literature of joint attention, the most important measure is seen as responding to joint attention which consists of the child attending to the target item or event during a joint attention interaction. In the previous experiments, the focus was on responding to and initiating joint attention and had a stringent approach to joint attention. Since the most foundational measure of joint attention is seen as responding to joint attention, the purpose of Experiment 2 was to determine whether the revised inclusion criterion would lead future participants to increase two-point RJA to criterion-level (Zhang et al., 2022). The inclusion criterion for Experiment 2 required participants to have low correct responses of two-point RJA while possessing the following cusps and capabilities: attends to 3D objects, 2D objects, faces, voices, tacts, and echoes words. Independent tacts and echoics were included in the inclusion criteria for the purpose of the participants partaking in the ITI. In addition to RJA, the researcher measured secondary dependent variables such as IJA; however, participants were not required to meet criterion-level for other measures besides two-point RJA. Additional secondary dependent variables included C-JARS (a parent questionnaire measuring joint attention) and verbal operants. Experiment 2 also included additional

communicative measures during RJA and IJA to gain data on additional behaviors associated with joint attention observed during the assessments. Experiment 2 determined whether the new inclusion criteria will lead participants between the ages of two and four years old to increase two-point RJA to criterion-level after participants experienced the intensive tact instruction using a concurrent multiple baseline design. The inclusion criteria was broadened to include participants who did not demonstrate two-point RJA to demonstrate potential results. This is a stronger design than the non-concurrent multiple baseline design since it controls for history and maturation threats to internal validity.

Method

Participants

Three children between the ages of two and four years old participated in this experiment. All participants were receiving special education services at an Early Intervention (EI) center or were attending a preschool throughout the duration of the experiment. Participants were recruited through an applied behavior analysis agency located in a large metropolitan city. Researchers included these three participants in the experiment because they met the inclusion criteria of showing low correct responses of two-point RJA during pre-intervention assessments. The inclusion criteria required fewer cusps and capabilities to those in Experiment 1 and were conditioned reinforcement for 3D stimuli, 2D stimuli, faces, voices, independent tacts, and echoics in repertoire. Table 12 displays the participants' descriptions while Table 13 displays the participants' relevant cusps and capabilities.

The experimenter assessed whether a child had conditioned reinforcement for 3D stimuli in repertoire by presenting 3D stimuli. The experimenter assessed whether a child had conditioned reinforcement for 2D stimuli in repertoire by presenting non-preferred 2D pages and

collected data on whether the participant engaged in observing responses such as looking and attending to the 2D stimuli (Greer & Han, 2015). The experimenter assessed whether a child had conditioned reinforcement for faces in repertoire by sitting in front of the child and changed facial expressions without emitting any vocalizations and collected data on whether the participant visually attending to the experimenter's face (Maffei-Lewis et al., 2014). The experimenter assessed whether a child had conditioned reinforcement for voices in repertoire by presenting a button that when pressed played a sample of an adult's voice telling a story. The experimenter collected data on whether the participant pressed the switch (Maffei-Lewis et al., 2014). The experimenter assessed whether a child had independent tacts in repertoire by presenting 5 objects and 5 photos and collecting data on whether they emitted labels of the stimuli (Greer & Ross, 2008). The experimenter assessed whether a child had echoics in repertoire by presenting models (i.e., sounds and words) and seeing whether the participant would emit a correct response within 3-5 s with one-to-one correspondence (Nuzzolo-Gomez & Greer, 2004).

Raul was a 29-month-old male with an IFSP at the beginning of the experiment. Raul had been receiving services at the EI center for five months. When he began receiving services, he functioned as a listener-speaker. Raul tacted a variety of categories (i.e., vehicles, cartoon characters, fruits, vegetables, etc). Raul manded using two-word phrases. Raul's educational diagnosis was F80.2, which was a mixed receptive-expressive language disorder and was not given a medical diagnosis. Raul received occupational therapy (2x a week), speech therapy (2x a week), and physical therapy (1x a week) throughout the duration of the experiment.

Mayank was a 38-month-old male with an IEP at the beginning of the experiment. Prior to and at the beginning of the experiment he functioned as a listener-speaker. Mayank had tacting

a variety of categories (i.e., vehicles, food, body parts, clothing, animals etc) in repertoire. Mayank manded using four to six-word phrases. Mayank received occupational therapy (1x a week) and speech therapy (2x a week) throughout the duration of the experiment. Mayank had a diagnosis of autism spectrum disorder.

Zuri was a 41-month-old male with an IEP at the beginning of the experiment. Prior to and at the beginning of the experiment, he functioned as a listener-speaker. Zuri had tacting a variety of categories (i.e., vehicles, food, clothing, body parts, animals etc) in repertoire. Zuri manded using three-to-four-word phrases. Zuri received occupational therapy (2x a week) and speech therapy (2x a week) throughout the duration of the experiment. Zuri had a diagnosis of autism spectrum disorder.

Table 12

Participant Descriptions for Experiment 2

Participant	Gender	Age in mos	IFSP	Educational diagnosis	Medical diagnosis	Verbal behavior	Race
Raul	M	29	YES	Developmental Disorder of Gross Motor Coordination		Listener Speaker	Black
Mayank	M	38	YES	“”	ASD	Listener Speaker	South-east Asian
Zuri	M	41	YES	“”	ASD	Listener Speaker	South-east Asian

Table 13

Cusps in Repertoire for Participants in Experiment 2

Cusp	Participant		
	Raul	Mayank	Zuri
CR+ for Observing 3D Stimuli	√	√	√
CR+ for Observing 2D Stimuli	√	√	√
CR+ for Faces	√	√	√
CR+ for Voices	√	√	√
CR+ for See-Do	√	√	√
Parroting	√	-	-
Auditory Matching	√	√	√
Listener Literacy	IP	√	√
CR+ for Listening to Story Content	√	√	√
Unidirectional Naming (UniN)	√	√	√
Independent Mands	√	√	√
Independent Tacts	√	√	√
Echoics	√	√	√
Transformation of EOs across Mands and Tacts	-	√	√
Bidirectional Naming (BiN)	-	√	√
Conversational Units Between an Adult and a Child	-	√	√
Conversational Units between Children	-	√	√

Say-Do Correspondence	-	-	-
Self-Talk Conversational Units in Solitary Play	-	-	-
Extensions of BiN	-	-	-

Note. √ = in repertoire. IP =. In progress. - = not in repertoire..

Setting

The participants were recruited by handing out recruitment flyers to other providers in the ABA agency that the researcher was working at the time. The providers either put the flyers in the participants' backpacks or send pictures of the flyers to the parents. Parents had the opportunity to contact the researcher via call, text, or email to discuss possible participation. This experiment took place in the homes of the participants. The researcher conducted the assessments and intervention session of Raul in his living room. The living room contained a sofa, a child sized table and two chairs, a TV, and some toys. The experiment was conducted either on the floor, on the sofa, or on the child sized table. The researcher conducted the assessments and intervention sessions of Mayank in the living room and/or Mayank's bedroom. The living room contained a sofa, a child-sized trampoline, a TV, and a book rack. Mayank's bedroom contained a bed, a mirror, drawers, a toy shelf, a credenza, a child-sized table and chair, and a closet. The experiment was conducted either on the floor, on the sofa, or on the bed. The researcher conducted the assessments and intervention sessions of Zuri in the living room. The living room contained a sofa, a TV, and toys. The experiment was conducted on the floor.

Dependent Variables

Researchers measured two- and three-point RJA, IJA, C-JARS-P questionnaire, and vocal verbal operants during the assessments (Birkeneder et al., 2024). Researchers also used the ELCAR to assess the presence of having 2D, 3D, faces, and voices conditioned as reinforcers and having independent tacts and echoics in repertoire (Greer et al., 2019).

Responding to Joint Attention. Responding to joint attention assessment sessions were conducted identical to that as described in Experiment 1. The researcher added an additional antecedent based on the ESCS (Early Social Communication Scales) where the researcher pointed to a target object in a book (Greer et al., 2019). In previous experiments, the participants were given three opportunities to respond to a gesture (i.e., pointing to the clock). In Experiment 2, the participants were given two opportunities to respond to a gesture and one opportunity to respond to the researcher pointing to a picture in a book.

Additional RJA Behaviors. See Table 14 to see the raw data sheet for additional communicative behaviors during the RJA assessment. During responding to joint attention assessments, additional behaviors were measured such as tacts, mands, gestural responses (i.e., a point), and facial expressions (Watson et al., 2013; Vaughan et al., 2003). The additional communicative behaviors replicated the behaviors from the Early Social Communication Scales (ESCS) by Tomasello et al. (1995) and has been continued to be studied (Hansen et al., 2018; Mundy et al., 2003; Steiner, 2021). The assessment used to measure additional RJA behaviors were a modification of the ESCS assessment. A tact would involve a child labeling the target stimulus or event in the environment. A mand would involve a child requesting the target stimulus. A gestural response required a child to make a point with their index finger and point towards the target stimulus in the environment. A facial expression would involve a child

changing the expression on their face to either a happy, excited, surprised, or scared emotion. These measures were included to measure behaviors that were possibly related to joint attention.

Initiating Joint Attention. Initiating joint attention assessment sessions were conducted identical to that as described in Experiment 1. See Table 23 for new toys that were used during the IJA assessment. The researcher used the toys used in Experiment 1 as well.

Additional IJA Behaviors. See Table 15 to see the raw data sheet for additional communicative behaviors during the IJA assessment. During initiating joint attention assessments, additional behaviors were measured. The additional communicative behaviors replicated the behaviors from the ESCS and researchers used a modification of the assessment to collect data on these behaviors. The additional behaviors included eye contact during a mand, reaching for an object during a mand, reaching and engaging in eye contact during a mand, pointing during a mand, pointing and engaging in eye contact during a mand, vocal mands, attending to the toy presented, manding for help, manding for removal, playing with the toy, eye contact during IJA, pointing during IJA, pointing and engaging in eye contact during IJA, and showing an object during IJA. These measures were included to measure behaviors that were possibly related to joint attention. Eye contact during a mand involved the child making eye contact with the researcher while emitting a request for the target stimulus. Reaching for an object during a mand involved the child reaching with their arm for the target stimulus while emitting a request for the target stimulus. Reaching and engaging in eye contact during a mand required the participant to engage in the previous two behaviors simultaneously. Pointing during a mand involved the child making a point with their index finger and pointing towards the target stimulus to request. Pointing and engaging in eye contact during a mand involved the child pointing towards the target stimulus to request while making eye contact with the researcher.

Vocal mands involved the participant using words(s) to request the target stimulus. Attending to the presented toy involved the participant looking at the toy for at least 5 s. Manding for help involved the participant requesting vocally for help by saying, “help” or if the participant brought a non-functioning toy to the researcher. Manding for removal involved the participant giving the toy back to the participant and showing no interest in the toy or fear of the toy. Play with the toy required the participant to engage with the toy for at least 15 s. Eye contact during IJA involved the participant looking at the researcher after looking at and/or engaging with the presented toy. Pointing during IJA involved the participant making a point with their index finger at the target stimulus after looking at and/or engaging with the presented toy. Pointing and engaging in eye contact during IJA required the participant to engage in the two previous behaviors simultaneously. Lastly, showing an object during IJA involved the participant bringing the toy to the researcher with the intention of presenting the toy while having a neutral or happy facial expression.

Table 14

Raw Data Sheet of RJA

Responding to Joint Attention (RJA)							
		2-point JA (Orient)	3-point JA	Tact	Mand	Gestural Response	Facial expression
Eye gaze	1.						
	2.						
	3.						
Eye gaze and vocal	1.						
	2.						
	3.						
Gesture (point) / Point to picture in book	1.						
	2.						
	3.						
Gesture and vocal	1.						
	2.						
	3.						

Table 15

Raw Data Sheet of IJA

Initiating Joint Attention (IJA)								
1.	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy
	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy
2.	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy
	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy
	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy

3.	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy
4.	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy
	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy
5.	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy
	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy

6.	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy
	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy
7.	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy
	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy
8.	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy
	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy

9.	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy
	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy
10.	Mand	Eye contact	Reach	Reach and Eye contact	Point	Point and Eye Contact	Vocal Mand	Attend to toy
	Toy	Eye Contact	Point	Point and Eye Contact	Show	Mand for help	Mand for removal	Play with toy

C-JARS-P Questionnaire. The questionnaire was presented and completed by the parents during the pre-intervention assessments and during the final post-intervention assessments. The C-JARS assessment is a rating scale (0-4) and measures AS (asocial) and PS (prosocial) symptoms (Birkeneder et al., 2024). AS represents a lack of sharing experience with another person. An example of an AS question is, "S/he does not look at you when s/he asks you for things." PS represents verbal and nonverbal sharing of an experience with another person. An example of a PS question is, "S/he shows you things s/he is interested in." Higher AS symptoms indicate a-typical social behavior and less frequency of joint attention behavior by the child. Higher PS symptoms indicate typical social behavior and a higher frequency of joint attention behavior. The AS and PS measures are divided by the number of questions in each category. The SJAS (Summary Joint Attention Scale) is calculated by subtracting the AS measure from the PS measure. A negative score of the SJAS indicates low PS behaviors and high AS behaviors. A positive score indicates high PS behaviors and low AS behaviors.

Vocal Verbal Operants. The researcher assessed the number of vocal verbal operants emitted during 5-min intervals in the setting. The researcher did not initiate conversations, but if the participants initiated a conversation, the researcher reciprocated. The vocal verbal operants measures included mands, tacts, sequelics, conversational units, and unintelligible sounds. Mands are defined as verbal requests made to acquire something they want or need. An example of a mand is a child saying, "I want cookie" when they are hungry and want a cookie. Tacts are controlled by a nonverbal stimulus such as an object, person, picture, or event, and occur due to social reinforcement. An example of a tact is a child seeing a cookie and saying, "Look at this cookie" to come into contact with social reinforcement. Sequelics are defined as one verbal exchange between two people where one initiates a conversation and the other responds.

Sequelics are reinforced by social engagement. During the experiment, the researcher did not initiate a sequelic. Therefore, all sequelics occurred when the participant initiated the sequelic. An example of a sequelic is a greeting where two people say “Hello” to each other. Conversational units are defined as verbal exchanges between two people that occur more than once. During the conversational unit, the speaker emits a verbal response while the listener responds and the first speaker answers. They are reinforced by social engagement. If the conversation extends beyond the greeting, that would be considered a conversational unit. During the experiment, the researcher did not initiate a conversation. All conversational units occurred when the participant initiated the conversation. For example, if two children say hello to each other and the other child continues the conversation after the greeting by saying, “How are you?” and the other child says, “I’m fine, thank you, and you?” and the child says, “I’m good as well, thanks for asking” while the other child says, “Anytime,” this is considered a conversational unit. According to Greer and Ross (2008), conversational units are verbal exchanges between two people with at least three exchanges per speaker. Unintelligible sounds are defined as a noise emitted by the participants, or attempted verbalizations made by the participants. When the unintelligible sound is a noise, it is automatically reinforced. When the unintelligible sound is an attempted verbalization, it is reinforced by either social stimuli or acquisition of the preferred item or activity. Unintelligible sounds were considered to be sounds emitted by the participant that cannot be deciphered by the researcher. These sounds may be words that cannot be understood due to speech delay or noises. The vocal verbal operant assessments were conducted in either the bedroom or the living room of the participants where toys were readily available. When the participant emitted a vocal verbal operant, the researcher tallied the frequency within the 5-min assessment. At the end of each session, the researcher

counted the number of vocal verbal operants and graphed the total number after the 5-min assessment.

Independent Variable

The independent variable was the Intensive Tact Instruction which required participants to tact (i.e., label or name) a variety of stimuli such as objects in the environment, actions, the activity or action they are engaging in, items in a book, and labeling a missing item. The researcher provided participants ten opportunities to tact from five categories, totaling 50 opportunities to respond and were identical to that as described in Experiment 1. Each session lasted between 10 min to 40 min depending on the participant and based on how many categories they had to work on during the session. Sessions were conducted once a day between five to six days a week. See Table 16 for materials used during the intervention.

Procedure

The procedure of the independent variable and assessments was similar to Experiment 1. There are some differences between Experiment 1 and 2. The first difference lies in the way participants were recruited in the inclusion criteria. In addition, the post-intervention assessments were conducted at different times. In Experiment 2 post-intervention assessments were conducted after the participant's behavior met criterion for two short-term objectives. The rationale for this decision was that in Harms (2020), post-intervention assessments were conducted after every short-term objective, but the number of opportunities were twice as much (100 opportunities per session). In comparison, the number of opportunities were half in Experiment 2 (50 opportunities per session). Therefore, the researcher decided to conduct the post-intervention assessments after the same number of opportunities were presented to the

participants. See Table 17, 18, and 19 for the operants used during the ITI. See Table 20 for the new toys used as antecedents during the IJA assessment. During the pre-intervention RJA assessment, the researcher replaced one out of the three antecedents from gestural to point to picture in a book.

Table 16

Materials Used in Experiment 2

Categories	Materials
Category 1: Labeling 3D Objects in the Environment	Items and objects in the natural environment (e.g., sofa, TV, lamp, fridge, microwave, light switch, etc)
Category 2: Labeling Actions	N/A
Category 3: Labeling Pictures in a Book	Children's picture books
Category 4: Labeling Hidden Items/Answering Questions	Opaque bag, 3D stimuli, matching 3D stimuli, toys, small plastic acorn toys (can be opened and closed by participants to conceal the item)
Category 5: Labeling the Activity	Playdough, blocks, doll house, car ramp, dot paint, crayons, dress-up, doctor's set, construction worker's set, cooking toys…

Table 17

Operants during ITI Intervention for Raul: STOs 1-4, Experiment, 2

	STO 1	STO 2	STO 3	STO 4
Category 1: Labeling 3D Objects in the Environment	Pen, Bottle, Wipes, Sofa, Lamp	Pillow, Tissue, Diaper, Gloves, Blanket	Napkin, Binder, Hat, Clock, Narwhal	Car keys, Box, Lunch box, Bag, Eraser
Category 2: Labeling Actions	Dancing, Sneezing, Drinking, Eating, Clapping	Jumping, Yawning, Stomping, Spinning, Tickling	Petting, Driving, Tapping, Opening, Snapping	Shaking, Nodding, Rubbing, Rolling, Scratching
Category 3: Labeling Pictures in a Book	Bus, Ball, Xylophone, Bugs, Sun	Shark, Whale, Starfish, Lobster, Octopus	Traffic light, Wheel, Drill, Gas station, Nails	Hat, Stop sign, Bike, Hole, Hammer
Category 4: Labeling Hidden Items	Items in Repertoire	Items in Repertoire	Items in Repertoire	Items in Repertoire
Category 5: Labeling the Activity	Activities of Participants' Interests Included Puzzles, Blocks, Coloring, Playdough, Magnetiles	Activities of Participants' Interests Included Cause and effect toys, Xylophone, Catch, Kitchen toys, Doctor toys	Activities of Participants' Interests Included Playdough, Reading, Stickers, Arts and Crafts, Dress-up	Activities of Participants' Interest Included Playdough, Dot paint, Cars, Train set, Trampoline

Table 18

Operants during ITI Intervention for Mayank: STOs 1-2, Experiment, 2

	STO 1	STO 2
Category 1: Labeling 3D Objects in the Environment	Fan, Sofa, Pillow, Table, TV,	Microwave, Fridge, Trampoline, Light switch, Bookshelf
Category 2: Labeling Actions	Dancing, Driving, Laughing, Sneezing, Stomping	Snapping, Drinking, Flying, Blowing kiss, Turning off
Category 3: Labeling Pictures in a Book	Snake, Fish, Coral, Cave, Starfish	Leaf, Sun, Tree, Tractor, Corn
Category 4: Labeling Hidden Items/Answering Questions	Items in Repertoire	My birthday is, I live in, My mom's name is, I have A (sibling), My (sibling's) name is
Category 5: Labeling the Activity	Activities of Participants' Interest included Playdough, Coloring, Hide and Seek	Activities of Participants' Interest included Puzzles, Blocks, Writing, Coloring, Doctor Set

Table 19

Operants during ITI Intervention for Zuri: STOs 1-4, Experiment, 2

	STO 1	STO 2	STO 3	STO 4
Category 1: Labeling 3D Items in the Environment	Rug, Pen, Bag, Clock, Sofa	TV, Door, Window, Police car, Pillow	Fridge, Stove, Fan, Bottle, Tissue	Mat, Light switch, Lamp, Knob, Socks
Category 2: Labeling Actions	Stomping, Driving, Clapping, Eating, Sneezing	Running, Blowing kiss, Snapping, Yawning, Shaking	Rubbing, Tapping, Skipping, Opening, Smiling	Tickling, Nodding, Singing, Laughing, Crying
Category 3: Labeling Pictures in a Book	Shark, Fish, Coral, Bubble Mirror	Treasure, Octopus, Sun, Gas station, Hammer	Eggs, Fence, Barn, Farmer, Bush	Balloon, Hay, Cloud, Leaf, Tractor
Category 4: Labeling Hidden Items	Items in Repertoire	Items in Repertoire	Items in Repertoire	My birthday is, I live in, My mom's name is, I have a (sibling), My (sibling's) name is
Category 5: Labeling the Activity	Activities of Participants' Interests Included Playdough, Blocks, Coloring, Dot Paint, Writing	Activities of Participants' Interests Included Doctor Set, Construction Worker Set, Cars, Playdough, Puzzles	Activities of Participants' Interests Included Playdough, Cars, Arts and Crafts, Magnetiles, Coloring	Activities of Participants' Interest Included Arts and Crafts, Handwriting, Playdough, Catch, and Blocks

Table 20

Antecedents Presented During IJA Assessment, Experiment 2

Target Object/Toy	Description of Antecedent
1. Fan	The researcher placed the fan in front of the participant. If necessary, the researcher demonstrated that turning on the switch turned on the fan. The participant was given an opportunity to engage with the fan.
2. Pop-corn Toy	The researcher placed the pop-corn toy in front of the participant. If necessary, the researcher demonstrated that turning the knob on the side led the pop-corn to pop inside the pop-corn machine and that turning the knob top led the pop-corn to fall out of the machine. The participant was given an opportunity to engage with the pop-corn toy.
3. Grocery Basket Toy	The researcher placed the grocery basket toy in front of the participant. If necessary, the researcher demonstrated that placing the fruits and vegetables and the basket led the toy to talk about the item placed inside. The participant was given an opportunity to engage with the grocery basket toy.
4. Xylophone Ramp Toy	The researcher placed the xylophone ramp in front of the participant. If necessary, the researcher demonstrated that pushing the ball down the ramp led the ball to make music on the xylophone. The participant was given an opportunity to engage with the xylophone ramp toy.
5. Spinning Fan Toy	The researcher placed the spinning fan toy in front of the participant. If necessary, the researcher demonstrated that pressing the button led the fan to spin off of the toy. The participant was given an opportunity to engage with the spinning fan toy.
6. Whale Toy	The researcher placed the whale toy in front of the participant. If necessary, the researcher demonstrated that pressing the button led the balls to fly from one hole to another. The participant was given an opportunity to engage with the whale toy.
7. Circular Saw Toy	The researcher placed the circular saw toy in front of the

	participant. If necessary, the researcher demonstrated that pressing the button led the circular saw to spin. The participant was given an opportunity to engage with the circular saw toy.
8. Remote Control Snake	The researcher placed the remote control snake in front of the participant. If necessary, the researcher demonstrated that pressing the buttons on the remote control led the snake to move. The participant was given an opportunity to engage with the snake toy.
9. Hot wheels ® Launcher	The researcher placed the hot wheels launcher in front of the participant. If necessary, the researcher demonstrated that pressing down on the knob led the hot wheel to launch out. The participant was given an opportunity to engage with the toy.
10. Texture Book	The researcher placed the texture book in front of the participant. If necessary, the researcher opened the book so the participant could see and feel the textures on the pages. The participant was given an opportunity to engage with the book.
11. Walkie-talkie	The researcher placed one walkie-talkie in front of the participant. If necessary, the researcher pressed the button on the walkie-talkie to show that the walkie-talkies were connected. The researcher communicated with the participant using the walkie-talkie. The participant was given the opportunity to engage with the walkie-talkie.
12. Owl Music Toy	The researcher placed the owl toy in front of the participant. If necessary, the researcher touched the owl to show that it played music and lit up. The participant was given the opportunity to engage with the owl toy.

Experimental Design

A concurrent delayed multiple baseline design across participants was used in Experiment 2 to evaluate the effects of the ITI on two-point RJA. Raul was the first participant that began the assessment and the intervention. Mayank then began receiving assessments during the post-STO-2 assessments of Raul and began intervention during the one-month follow-up of Raul. Zuri began the pre-intervention assessment during the post-intervention assessment of Mayank and began intervention after Mayank completed the three-month follow-up assessment.

Interobserver Agreement

A second independent observer collected data for the purpose of assessing interobserver agreement (IOA). The second independent observers included teachers who held a minimum rank of Teacher II within the CABAS® system. The IOA was collected by watching the video tape of probe and intervention sessions. Trial-by-trial IOA was calculated by adding the number of agreements across both observers and dividing by the total number of opportunities presented to the participants and multiplying by 100%. IOA was collected for 85% of all assessment sessions and agreement was 91% (range = 82% to 100%). IOA was collected for 78% of intervention sessions and agreement was 95% (range = 92% to 100%).

Treatment Fidelity

The IOA and treatment fidelity procedures are identical to the first experiment. An independent observer recorded the accuracy of implementing baseline and intervention sessions for the purpose of calculating treatment fidelity. The observer evaluated the implementation of antecedents and consequences delivered during probe sessions and intervention sessions. To evaluate the accuracy of these components, a trained and independent observer completed a

TPRA. The treatment fidelity was calculated by the researcher and by teachers who held a minimum rank of Teacher II within the CABAS® System. The TPRA outlined the antecedents delivered and the consequences presented to the participants. Treatment fidelity was calculated by dividing the total number of correct researcher responses in a session by the total number of opportunities provided and multiplying by 100%. We collected treatment fidelity for 85% of the baseline sessions and 78% of the intervention sessions. Treatment fidelity was 98% (range 97% to 100%) for all conditions of the experiment with all participants.

Results and Discussion

Two-Point Responding to Joint Attention

Figure 13 displays pre- and post-intervention two-point and three-point RJA data. See the first panel of Figure 13. Raul demonstrated a low number of correct responses during the two-point RJA pre-intervention assessment sessions (M = 5.3, range 5 to 6). Two-point RJA increased during the first post-intervention assessment sessions (M = 7, range 5 to 9). Raul demonstrated a higher number of correct responses during the second post-intervention assessment sessions and met criterion for two-point RJA (M = 10.5, range 10 to 11). Raul maintained the high number of correct responses during the one-month follow-up assessment session (M = 11, range 11 to 11), and the three-month follow-up assessment session (M = 10, range 10 to 10). Table 21 displays the number of correct responses during the two-point RJA pre-intervention and post-intervention assessments for Raul based on the differing antecedents presented to the participants during the RJA assessment. The two-point RJA data show that the researcher's eye contact alone or eye contact with vocalization did not lead Raul to engage in RJA. The data show that he responded to things when the researcher was gesturing and gesturing while talking. He increased the number

of correct responses during the post-intervention sessions where he began following eye gaze after completing the ITI.

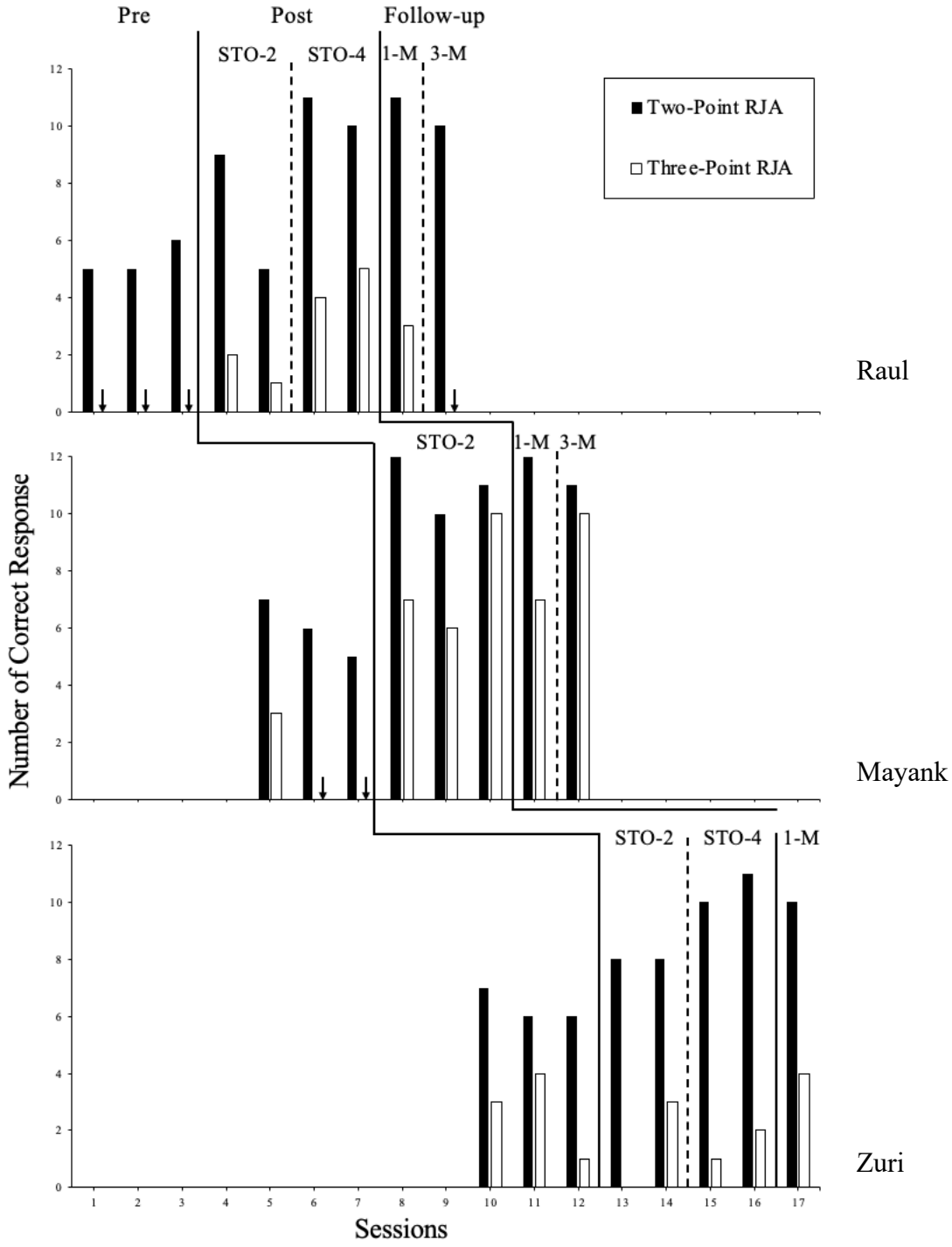
See the second panel of Figure 13. Mayank demonstrated a low number of correct responses during the two-point-RJA pre-intervention assessment sessions (M = 6, range 5 to 7). Mayank then increased the number of correct responses (M = 11, range 10 to 12) after the second short-term objective and met criterion for two-point RJA. Mayank then maintained criterion-level of two-point RJA during the one-month follow up (M = 12, range 12 to 12) and during the three-month follow up (M = 11, range 11 to 11). Table 23 and displays the number of correct responses during the two-point RJA pre-intervention and post-intervention assessments for Mayank based on the differing antecedents presented to the participants during the RJA assessment. The two-point RJA data show that the researcher's eye contact alone or eye contact with vocalization were not provocative stimuli for Mayank, especially eye contact alone. The data show that he responded to things when the researcher was gesturing and gesturing while talking. He increased the number of correct responses during the post-intervention sessions where he began following eye gaze and eye gaze with vocalization after completing the ITI.

See the fourth panel of Figure 13. Zuri demonstrated a low number of correct responses during the two-point RJA pre-intervention assessment sessions (M = 6.3, range 6 to 7). After meeting criterion on the second short-term objective, Zuri increased the number of correct responses for two-point RJA (M = 8, range 8 to 8). After meeting criterion on the fourth short-term objective, Zuri increased the number of correct responses and met criterion-level for two-point RJA (M = 10.5, range 10 to 11). During the one-month follow up assessment, Zuri maintained criterion-level of two-point RJA (M = 10, range 10 to 10). Table 25 displays the number of correct responses during the two-point RJA pre-intervention and post-intervention

assessments for Zuri based on the differing antecedents presented to the participants during the RJA assessment. The two-point RJA data show that the researcher's eye contact alone or eye contact with vocalization were not provocative stimuli for Zuri, especially eye contact alone. The data show that he responded to the antecedent when the researcher was gesturing and gesturing while talking. He increased the number of correct responses during the post-intervention sessions where he began following eye gaze with vocalization after completing the ITI. He showed fewer improvements in the eye contact alone.

Figure 13

Two-point and Three-point RJA Graph, Experiment 2



Three-Point Responding to Joint Attention

Similar to results in Experiment 1, big improvements were not shown for three-point RJA in Experiment 2. Figure 13 displays pre- and post-intervention two-point and three-point-RJA data. See the first panel of Figure 13. Raul minimally increased three-point RJA data during the post-STO-2 assessment and demonstrated higher number of correct responses during the post-STO-4 assessment. During follow-up, Raul decreased the correct number of responses for three-point RJA. Raul demonstrated an increase in two-point RJA and maintained criterion-level responding during the follow-up sessions. Although Raul demonstrated a small increase in three-point RJA, it was not to criterion-level and these small increases were not maintained during the follow-up sessions. Table 22 displays the number of correct responses during the three-point RJA pre-intervention and post-intervention assessments for Raul based on the differing antecedents presented to the participants during the RJA assessment. The three-point RJA data show that none of the antecedents led to any joint attention behavior by Raul. After the ITI instruction, he increased three-point RJA responses during the eye contact and eye contact and vocalization antecedents. The increases during the gesture and gesture and vocalization antecedents were not as great in comparison.

Raul

Mayank

Javi

See the second panel of Figure 13. Mayank increased three-point RJA data during the post-STO-2 assessment to criteria level on the third assessment session. During one-month follow-up, Mayank decreased the number of correct responses but increased back to criterion-level during three-month follow-up for three-point RJA. Mayank emitted criterion-level for two-point RJA after completing two short-term objectives and maintained criterion-level during the follow-up sessions. Mayank increased three-point RJA and met criterion after completing the intervention, but did not maintain criterion-level during both follow-up sessions. Table 24

Zuri

displays the number of correct responses during the three-point RJA pre-intervention and post-intervention assessments for Mayank based on the differing antecedents presented to the participants during the RJA assessment. The three-point RJA data show that there no significant joint attention behavior made by Mayank. After the ITI instruction, he increased three-point RJA responses during all antecedents, but not as great during the eye contact antecedent. There were fewer improvements during the eye contact antecedent.

See the fourth panel of Figure 13. Zuri demonstrated a decrease in three-point RJA data during the post-STO-2 assessment. Zuri continued to show low responses of three-point RJA during the post-STO-4 assessment and during the one-month follow-up session. Zuri met criterion for two-point RJA and maintained it during the one-month follow-up. However, Zuri did not increase three-point RJA throughout the duration of the experiment. Table 26 displays the number of correct responses during the three-point RJA pre-intervention and post-intervention assessments for Zuri based on the differing antecedents presented to the participants during the RJA assessment. The three-point RJA data show that Zuri responded to three-point RJA when the antecedent consisted of gestures and vocalizations. After the ITI instruction, he did not increase three-point RJA during any specific antecedents. He did however demonstrate fewer improvements during the eye gaze antecedent.

Raul, Mayank, and Zuri increased two-point RJA to criterion-level, but only Mayank increased three-point RJA to criterion-level.

Table 21

Two-Point-RJA Antecedent Data of Raul, Experiment 2

	Pre-Intervention			Post-Intervention				Follow-up	
	Pre-1	Pre-2	Pre-3	STO-2		STO-4		1-M	3-M
Eye contact	-	-	-	+	+	-	+	+	+
	-	-	-	-	-	+	+	-	-
	-	-	+	-	-	+	-	+	+
Eye contact	-	-	+	+	-	+	+	+	-
And	-	-	-	+	+	+	-	+	+
Vocalization	-	-	-	-	-	+	+	+	+
Gesture	-	+	+	+	-	+	+	+	+
	+	-	-	+	-	+	+	+	+
Point to Picture	+	+	+	+	+	+	+	+	+
Gesture and	+	+	-	+	+	+	+	+	+
Vocal	+	+	+	+	+	+	+	+	+
	+	+	+	+	-	+	+	+	+

Table 22

Three-Point-RJA Antecedent Data of Raul, Experiment 2

	Pre-Intervention			Post-Intervention				Follow-up	
	Pre-1	Pre-2	Pre-3	STO-2		STO-4		1-M	3-M
Eye contact	-	-	-	-	-	-	-	+	-
	-	-	-	-	-	-	+	-	-
	-	-	-	-	-	+	+	-	-
Eye contact	-	-	-	-	-	+	-	-	-
And	-	-	-	+	+	-	+	-	-
Vocalization	-	-	-	-	-	-	+	+	-
Gesture	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	+	-	-	-
Point to Picture	-	-	-	-	-	+	-	-	-
Gesture and	-	-	-	+	-	-	-	-	-
Vocal	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	+	+	-

Table 23

Two-Point-RJA Antecedent Data of Mayank, Experiment 2

	Pre-Intervention			Post-Intervention			Follow-up	
	Pre-1	Pre-2	Pre-3	STO-2			1-M	3-M
Eye contact	-	-	-	+	+	+	+	+
	-	-	-	+	+	+	+	-
	-	-	-	+	+	+	+	+
Eye contact	+	+	+	+	+	+	+	+
And	+	-	-	+	+	+	+	+
Vocalization	-	-	-	+	+	+	+	+
Gesture	+	+	+	+	-	+	+	+
	-	-	-	+	+	+	+	+
Point to Picture	+	+	+	+	+	+	+	+
Gesture and	+	+	+	+	+	-	+	+
Vocal	+	+	-	+	+	+	+	+
	+	+	+	+	-	+	+	+

Table 24

Three-Point-RJA Antecedent Data of Mayank, Experiment 2

	Pre-Intervention			Post-Intervention			Follow-up	
	Pre-1	Pre-2	Pre-3	STO-2			1-M	3-M
Eye contact	-	-	-	-	+	-	+	+
	-	-	-	-	-	+	-	-
	-	-	-	-	-	-	+	+
Eye contact	-	-	-	+	-	+	+	-
And	+	-	-	+	+	+	+	+
Vocalization	-	-	-	+	+	+	+	+
Gesture	-	-	-	-	-	+	+	+
	-	-	-	+	+	+	-	+
Point to Picture	+	-	-	-	+	+	-	+
Gesture and	-	-	-	+	+	+	+	+
Vocal	-	-	-	+	-	+	-	+
	+	-	-	+	-	+	-	+

Table 25

Two-Point-RJA Antecedent Data of Zuri, Experiment 2

	Pre-Intervention			Post-Intervention				Follow-up
	Pre-1	Pre-2	Pre-3	STO-2		STO-4		1-M
Eye contact	-	+	-	-	-	+	+	+
	-	-	-	-	-	-	-	-
	-	-	-	-	-	+	+	+
Eye contact	+	+	-	+	+	+	+	-
And	-	-	-	+	-	-	+	+
Vocalization	-	-	-	-	+	+	+	+
Gesture	+	-	+	+	+	+	+	+
	+	+	+	+	+	+	+	+
Point to Picture	+	-	+	+	+	+	+	+
Gesture and	+	+	+	+	+	+	+	+
Vocal	+	+	+	+	+	+	+	+
	+	+	+	+	+	+	+	+

Table 26

Three-Point-RJA Antecedent Data of Zuri, Experiment 2

	Pre-Intervention			Post-Intervention				Follow-up
	Pre-1	Pre-2	Pre-3	STO-2		STO-4		1-M
Eye contact	-	+	-	-	-	-	-	+
	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
Eye contact	-	+	-	-	+	+	-	-
And	-	-	-	-	-	-	-	-
Vocalization	-	-	-	-	+	-	+	+
Gesture	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	+
Point to Picture	+	-	-	-	-	-	-	-
Gesture and	+	+	-	-	-	-	-	-
Vocal	+	+	-	-	+	-	+	-
	-	-	+	-	-	-	-	+

Communicative Behaviors during Responding to Joint Attention Assessments

During the RJA assessments, the researcher collected data on additional behaviors which included tacts, mands, gestural responses, and facial expressions. Figure 17 displays pre- and post-intervention RJA communicative behavior data for Raul, Mayank, and Zuri. Raul demonstrated low number of correct responses for additional RJA behaviors (M = 0.7, range 0 to 2). Raul increased the number of additional behaviors during the post-STO-4 assessments (M = 8.5, range 5 to 12), but did not maintain these high responses during the one-month follow-up (M = 1, range 1 to 1) or during the three-month follow-up (M = 4, range 4 to 4). Mayank demonstrated no additional RJA responses during the pre-intervention assessment. Mayank increased the number of additional behaviors during the one-month (M = 6, range 6 to 6) and three-month follow-up (M = 8, range 8 to 8), but emitted a low number of additional behaviors during the pre- and post-STO-2 assessments. Zuri emitted a low frequency of additional behaviors during the RJA assessment (M = 1, range 0 to 3). Zuri increased the number of additional behaviors during the post-STO-4 assessments (M = 7, range 4 to 10), and maintained a similar number of additional behaviors during the one-month follow up (M = 8, range 8 to 8). Raul had tacts and facial expressions increase from the pre-intervention RJA sessions to the follow-up RJA sessions. Mayank had tacts and facial expressions increase from the pre-intervention RJA sessions to the follow-up RJA sessions. Zuri did not make any increases for the additional RJA measures during his assessments.

The additional communicative behaviors measured during RJA showed that although participants may not have emitted three-point RJA under the operant definition of the experiment (i.e., the participant orients towards the target stimulus and looks back at the researcher), participants engaged in other joint attention behaviors such as tacts, mands, gestural responses,

and facial expressions. See Figure 14 for additional communicative behaviors of Raul. Raul emitted three-point RJA (under the operant definition of the experiment, with eye contact) 0 times during the pre-intervention assessments while emitting two total tacts. Others may argue that these instances of tact are a representation of three-point RJA. During the post second short-term objective assessments, Raul emitted 3 instances of three-point RJA with eye contact while one of those instances included a tact response. During the post fourth short-term objective assessments, Raul emitted 9 instances of three-point RJA with eye contact while also emitting 17 tacts. During the one-month follow-up, Raul emitted 3 instances of three-point RJA while emitting one tact and during the three-month follow-up, Raul emitted 0 instances of three-point RJA, but emitted 3 total tacts. See Figure 15 for additional communicative behaviors of Mayank. Mayank emitted 3 instances of three-point RJA during the pre-intervention assessments. During the post second short-term objective assessments, he emitted 23 instances of three-point RJA while emitting 2 tacts and 2 mands. During the one-month follow-up, Mayank emitted 7 instances of three-point RJA while emitting 5 tacts and 1 mand. During the three-month follow-up, Mayank emitted 10 instances of three-point RJA while emitting 5 tacts, 2 mands, and 1 facial expression. See Figure 16 for additional communicative behaviors of Zuri. Zuri emitted 8 instances of three-point RJA during the pre-intervention assessments while emitting 3 tacts. During the post second short-term objective assessments, he emitted 3 instances of three-point RJA while emitting 4 tacts, 2 mands, and 1 facial expression. During the post fourth short-term objective assessments, he emitted 3 instances of three-point RJA along with 10 tacts, 3 mands, and 1 facial expression. During the one-month follow-up, he emitted 4 instances of three-point RJA while also emitting 7 tacts and 1 facial expression. These additional communicative behaviors suggest that instances in which the researcher marked three-point RJA as negative may

have misrepresented whether joint attention actually occurred. A participant may not have engaged in eye contact during RJA but may have engaged in joint attention by emitting tacts, mands, gestural responses, and facial expressions.

Figure 14

Additional Communicative Behaviors of Raul in Experiment 2

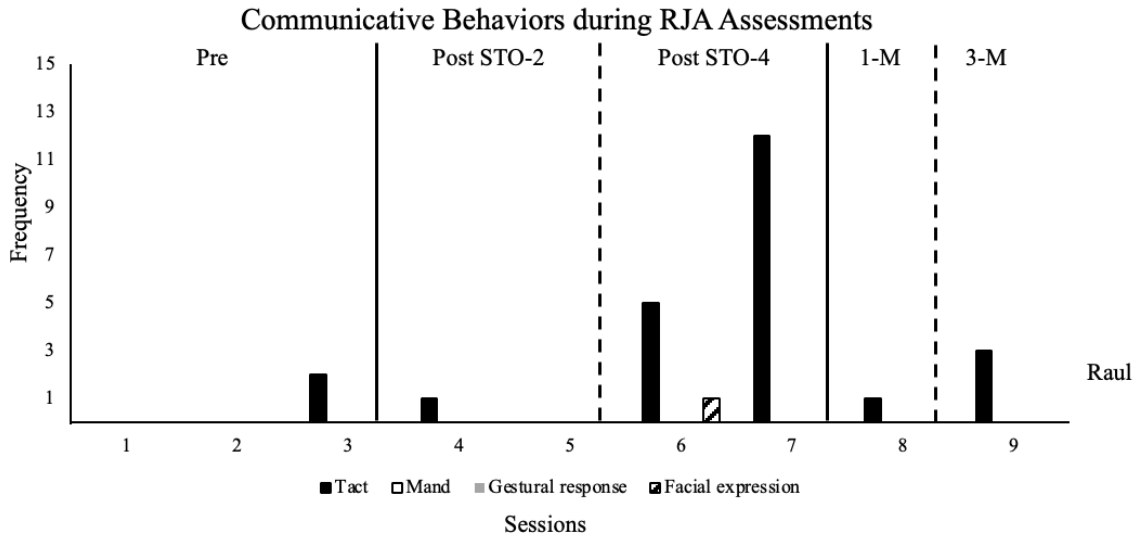


Figure 15

Additional Communicative Behaviors of Mayank in Experiment 2

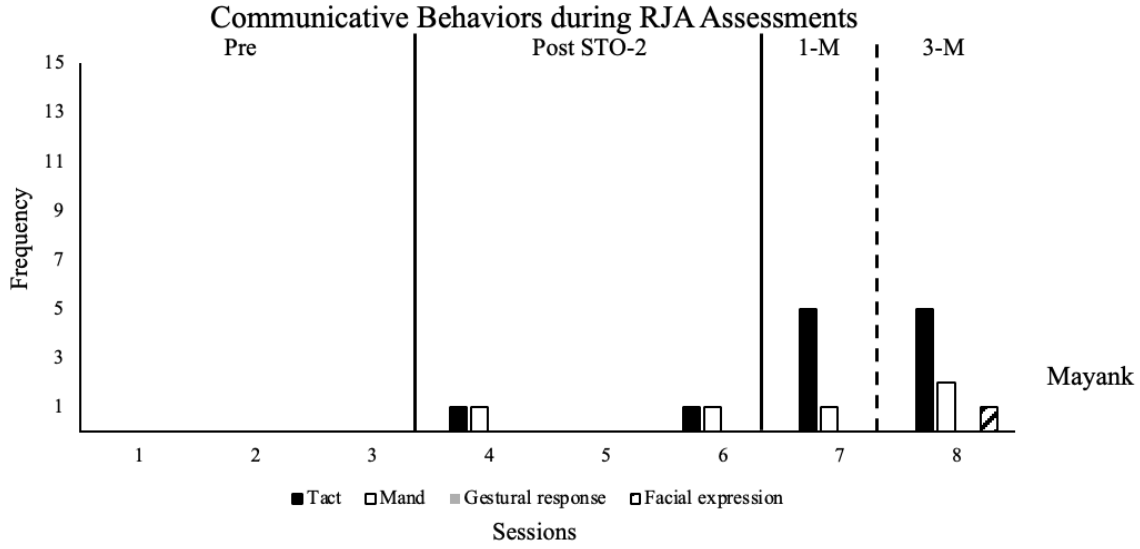
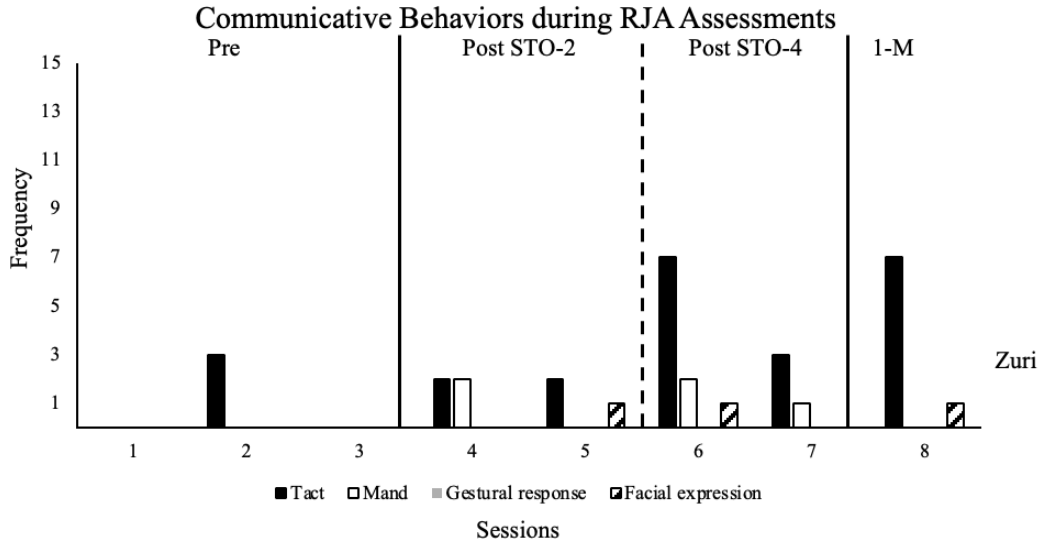


Figure 16

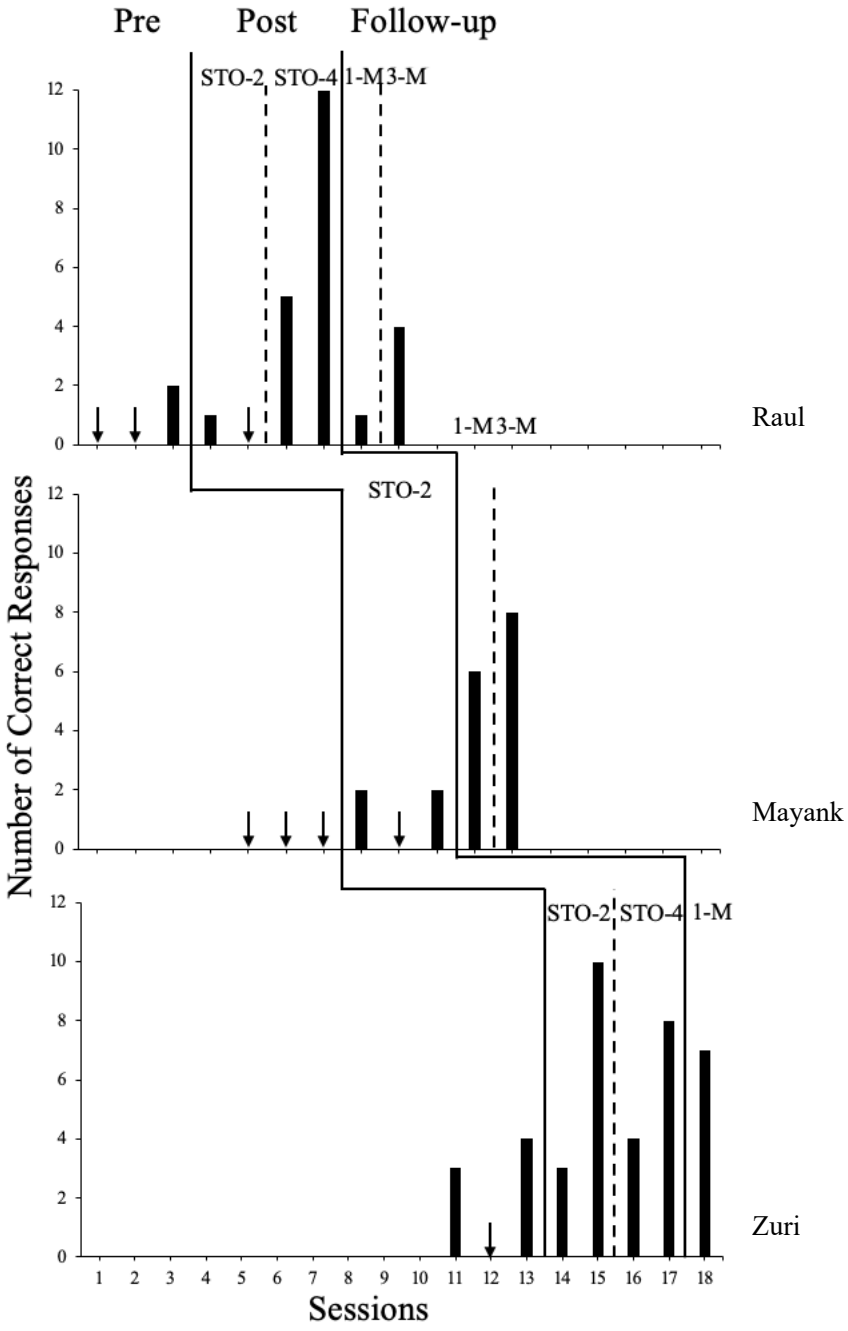
Additional Communicative Behaviors of Zuri in Experiment 2



Broader Implications of the Findings on RJA. During RJA assessments, all participants demonstrated criterion-level responding for two-point RJA while Mayank was the only participant who demonstrated criterion-level of three-point RJA during the last post-STO-2 assessment and during three-month follow-up. A correct two-point RJA response required the participant to orient towards the target object or event while a correct three-point RJA response required the participant to orient towards the target object or event and look back at the researcher. The operant definition of RJA required the participant to engage in a specific form of eye contact. However, other joint attention responses occurred that did not fit the operant definition. For example, when analyzing the communicative behaviors that occurred during the RJA assessment, we can see that Raul, Mayank, and Zuri increased additional behaviors during the post-intervention assessments. Raul increased communicative behaviors such as tacts and one instance of facial expression. These communicative behaviors show that the participant increased behaviors that align with the function of joint attention. Mayank also increased tacts and mands during the post-intervention assessments. Lastly, Zuri increased only tacts. These additional communicative behaviors illustrate a more comprehensive description of the results of IJA and what behaviors were occurring during the assessment.

Figure 17

Communicative Behaviors During RJA Graph, Experiment 2



Initiating Joint Attention

Figure 18 displays pre- and post-intervention IJA data for Raul, Mayank, and Zuri. Raul demonstrated a low number of correct responses during the pre-intervention assessment sessions (M = 0.3, range 0 to 1). Raul increased IJA after both the second short-term objective (M = 4.5, range 4 to 5), and during the fourth short-term objective (M = 4.5, range 3 to 6). Raul had similar number of correct responses during the one-month follow-up (M = 5, range 5 to 5) and the three-month follow-up (M = 4, range 4 to 4). Raul demonstrated an increase in IJA across the experiment but did not show criterion-level. Mayank demonstrated a low number of correct responses during the pre-intervention assessment sessions (M = 2.3 range 2 to 3). Mayank increased the number of correct responses (M = 5.6, range 5 to 6) after the second short-term objective. Mayank then increased his number of correct responses during the one-month follow-up (M = 7, range 7 to 7) and the second-month follow-up (M = 8, range 8 to 8). Mayank did not show criterion-level for IJA throughout the experiment. Zuri demonstrated a low number of correct responses during the pre-intervention assessment sessions (M = 2.6, range 2 to 3). After meeting criterion on the second short-term objective, Zuri increased the number of correct responses (M = 7.5, range 7 to 8) and met criterion on the first post-STO-2 assessment. After meeting criterion on the fourth short-term objective, Zuri's number of correct responses decreased (M = 4.5, range 3 to 6). During the one-month follow up assessment, Zuri demonstrated criterion-level of IJA (M = 8, range 8 to 8). The data cannot show that Raul, Mayank, and Zuri met criterion on IJA measures due to variable data points during the post-STO-4 assessment, however, Zuri did increase IJA to criterion-level during the experiment while Mayank increased IJA to criterion-level during the three-month follow-up.

During the IJA assessments, the researcher collected data on additional behaviors, which included mand with eye contact, mand by reaching, mand by reaching and with eye contact, mand by pointing, mand by pointing with eye contact, vocal mand, mand for help, mand for removal, play with toy, attend to toy, IJA with eye contact, IJA by pointing, IJA by pointing and with eye contact, and IJA by showing. Figure 19 displays pre- and post-intervention IJA additional behavior data for Raul, Mayank, and Zuri. See Figure 20 for pre- and post-intervention IJA additional behavior data for Raul. Raul increased the number of additional behaviors during the post-STO-2 assessments (M = 28.5 range 27 to 30), but did not maintain these high responses during post-STO-4 assessments (M = 25.5, range 23 to 28), one-month follow-up (M = 23, range 23 to 23) or during three-month follow-up (M = 23, range 23 to 23). See Figure 21 for pre- and post-intervention IJA additional behavior data for Mayank. He gradually increased the number of additional behaviors during post-STO-2 assessments (M = 26.6, range 25 to 29). Mayank had increased the number of additional behaviors during one-month follow-up (M = 35, range 35 to 35) and during three-month follow-up (M = 32, range 32 to 32). See Figure 22 for pre- and post-intervention IJA additional behavior data for Zuri who did not change the number of correct responses for additional measures for IJA throughout the experiment.

Figure 19 displays pre- and post-intervention IJA additional behavior data that increased during the experiment for participants Raul, Mayank, and Zuri. The additional measures of IJA that increased most for Raul was mand by reaching, vocal mands, play with toy, IJA by showing, mand with eye contact, and attend to toy. The greatest increase was seen in mand by reaching during post-STO-2 and post-STO-4 assessments. However, Raul did not maintain the high responses during follow-up. Mayank increased mand by reaching, vocal mands, play with toy,

IJA show, mand with eye contact, IJA by pointing and with eye contact, mand for help, mand by pointing and with eye contact, and mand by reaching and with eye contact. Mayank increased IJA by showing the most during the experiment. Zuri increased mand by reaching, vocal mands, IJA show, and IJA point and with eye contact. Overall, Zuri's additional behavior data of IJA did not increase by much. The results are variable, and we cannot determine which additional measures increased the most across participants in the IJA assessment.

Broader Implications of the Findings on IJA. During IJA assessments, Mayank and Zuri demonstrated criterion-level responding. Mayank showed criterion-level of IJA during the three-month follow-up while Zuri showed criterion-level of IJA during the first post-intervention assessment after completing two short-term objectives and during the one-month follow-up. A correct two-point IJA response required the participant to orient towards the toy and look back at the researcher. The operant definition of IJA required the participant to engage in a specific form of eye contact. However, other joint attention responses occurred that did not fit the operant definition. For example, when analyzing the communicative behaviors that occurred during the IJA assessment, we can see that Raul and Mayank increased these additional measures while Zuri showed steady state responding. Raul increased communicative behaviors such as reaching for the toy, vocal mands, and showed little but some instances of showing a toy and making eye contact during a mand. These communicative behaviors show that the participant increased behaviors that align with the function of joint attention. Mayank also increased reaching during a mand, showing objects, and had small increases of vocal mands, eye contact with mands, point and eye contact during IJA, mand for help, point and eye contact during a mand, and reach and eye contact during a mand. Lastly, Zuri increased small instances of vocal mands, showing during IJA, and pointing and eye contact during IJA. These communicative behaviors illustrate a

more comprehensive description of the results of IJA and what behaviors were occurring during the assessment.

Figure 18

IJA Graph, Experiment 2

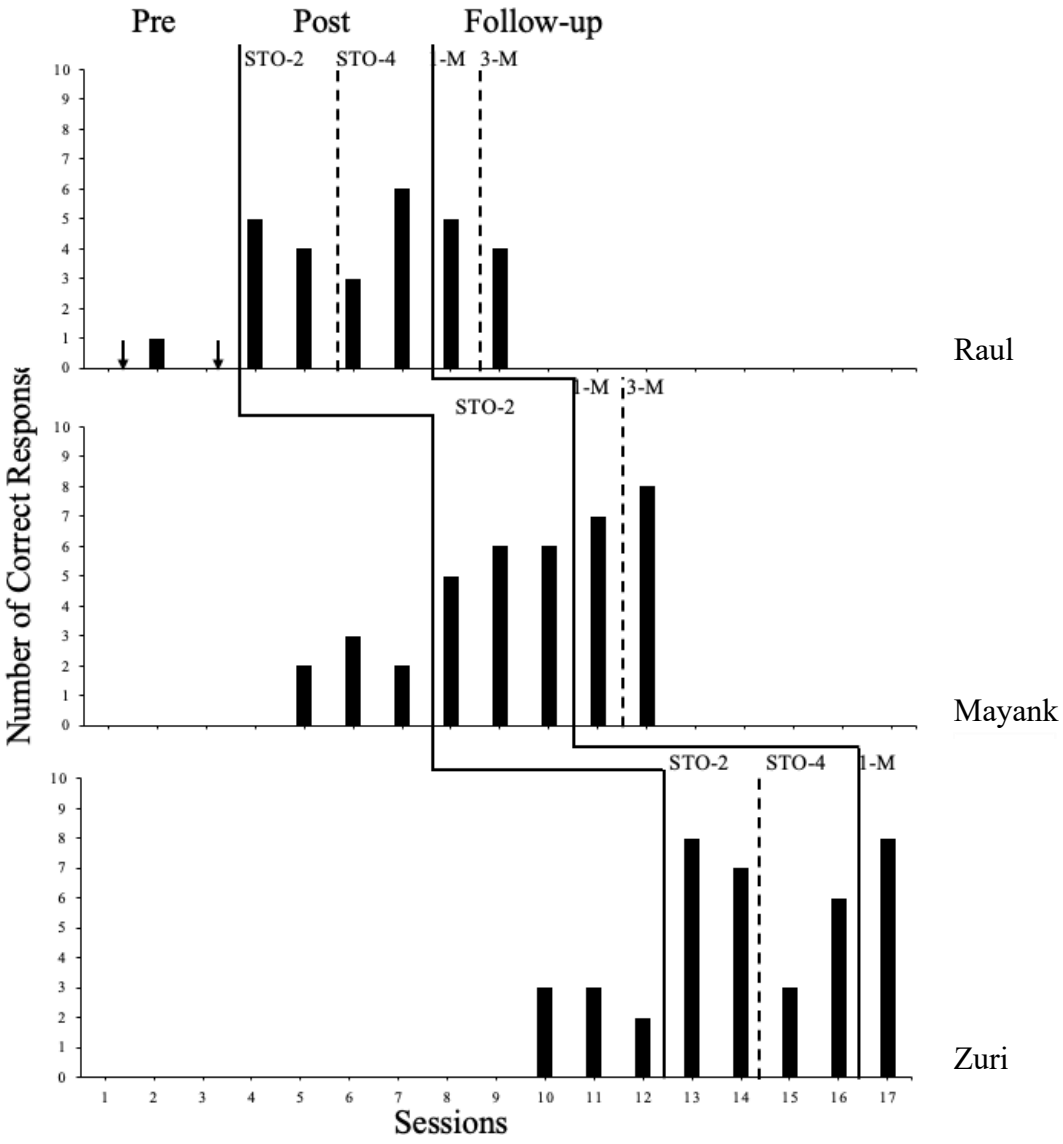


Figure 19

IJA Additional Measures Graph, Experiment 2

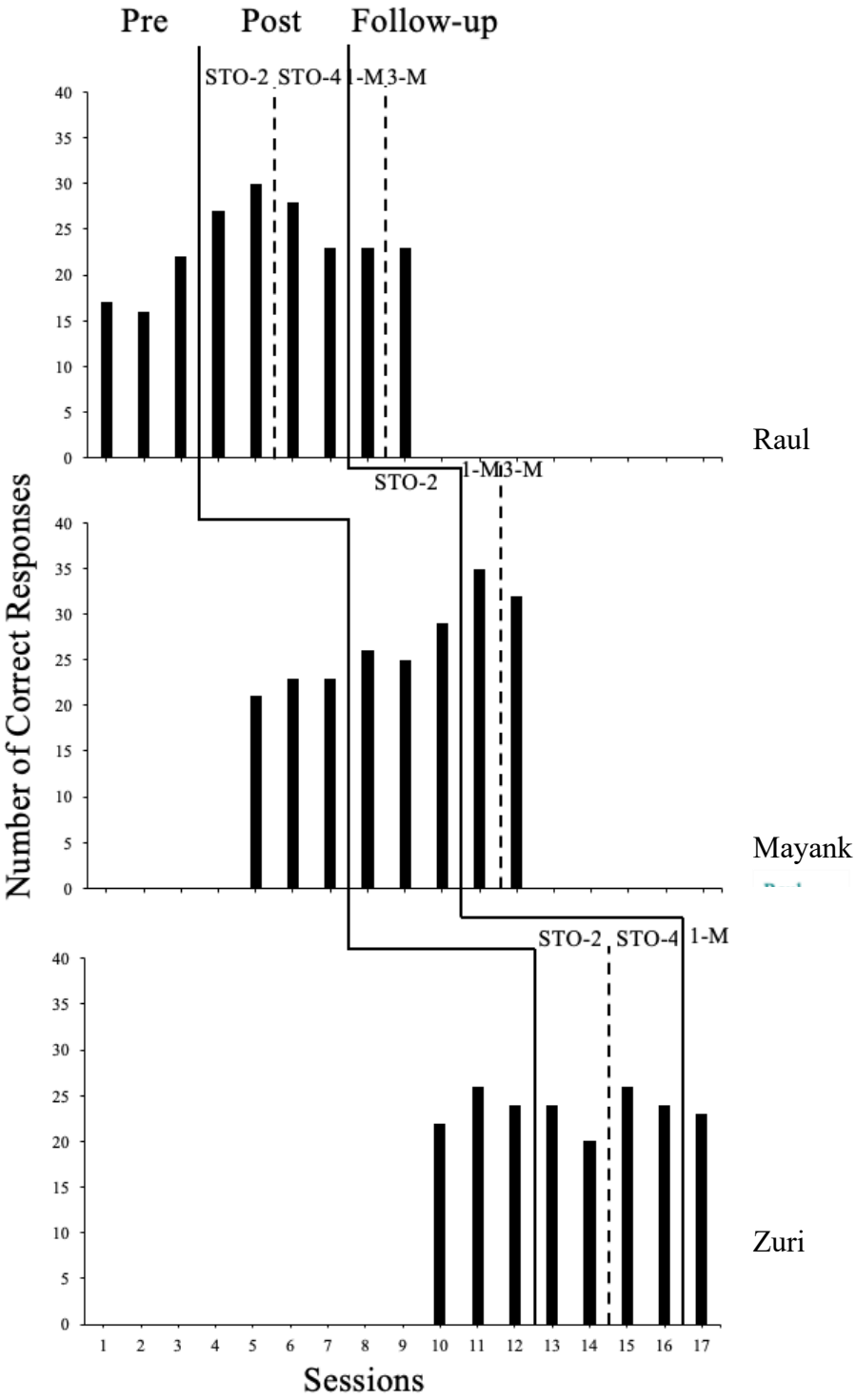


Figure 20

IJA Additional Measures of Raul, Experiment 2

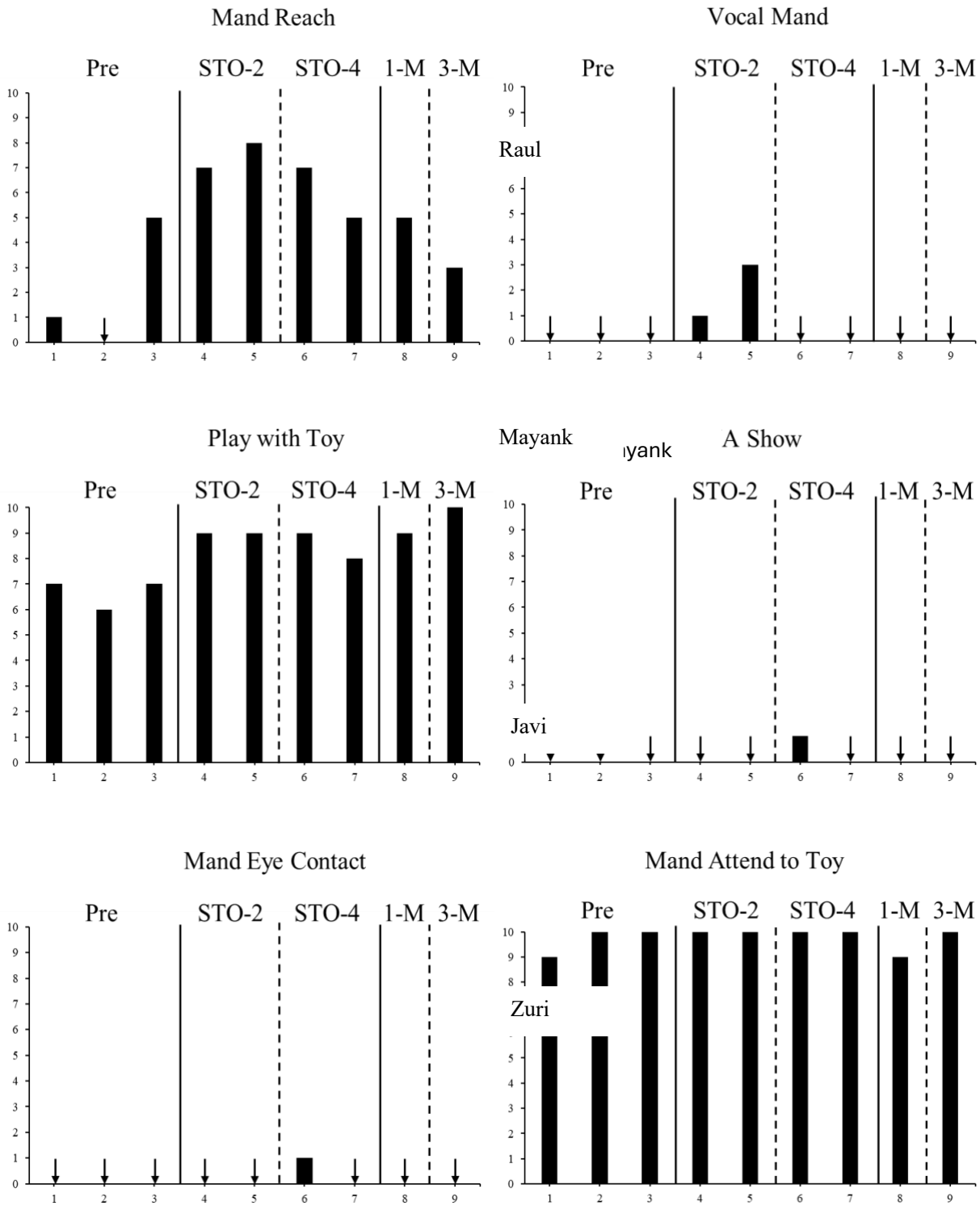
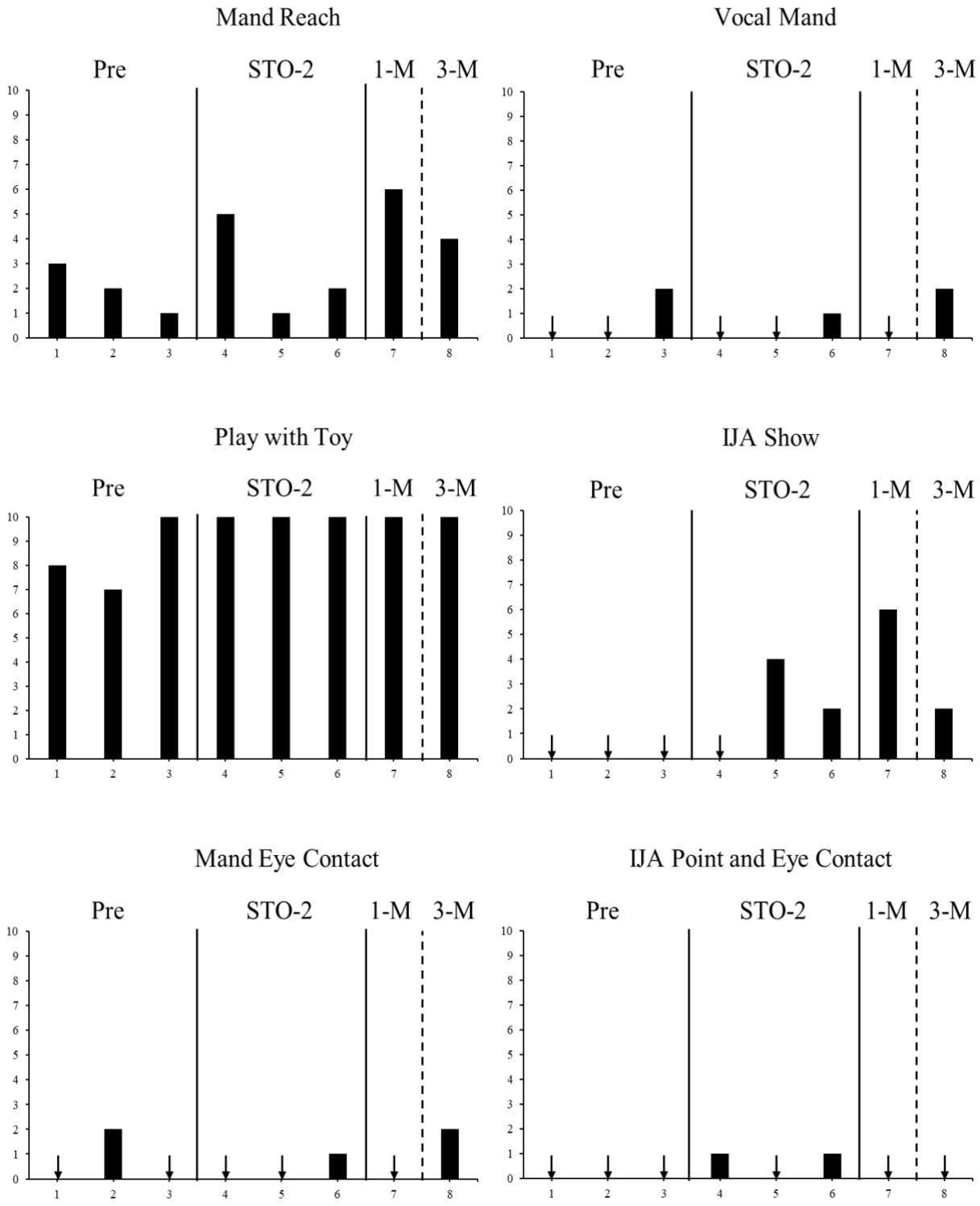
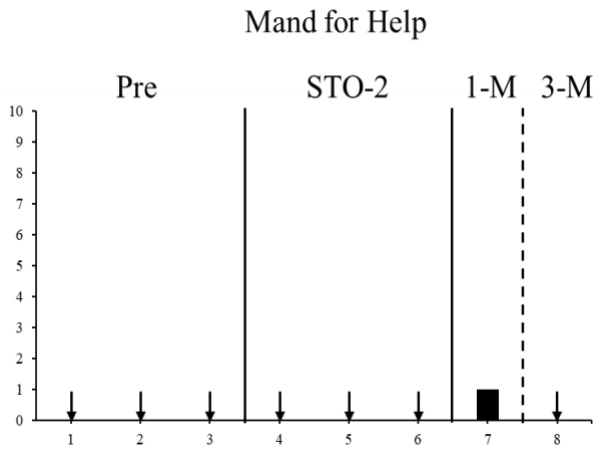
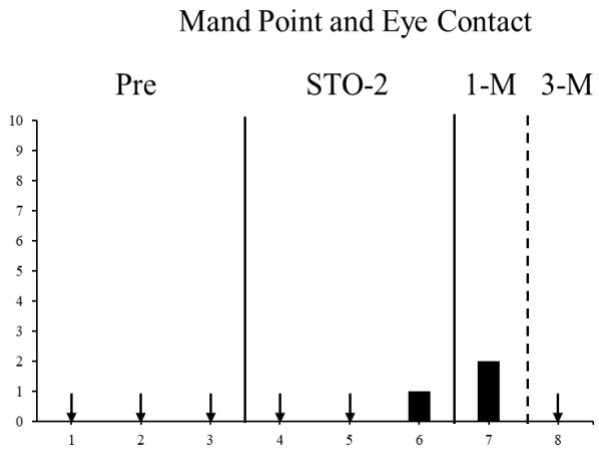


Figure 21

IJA Additional Measures of Mayank, Experiment 2




Mand for Help
Pre
STO-2
1-M
3-M
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8


Mand Point and Eye Contact
Pre
STO-2
1-M
3-M
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8

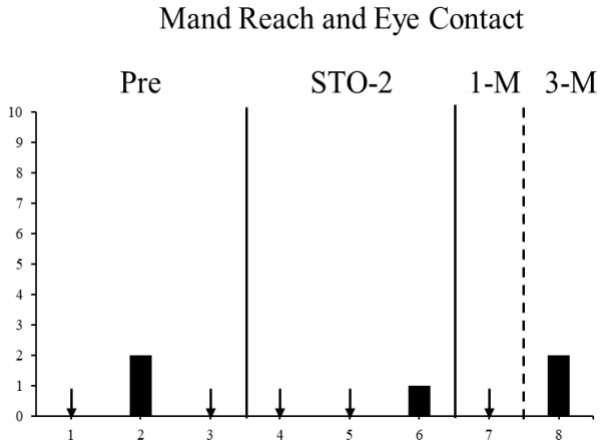
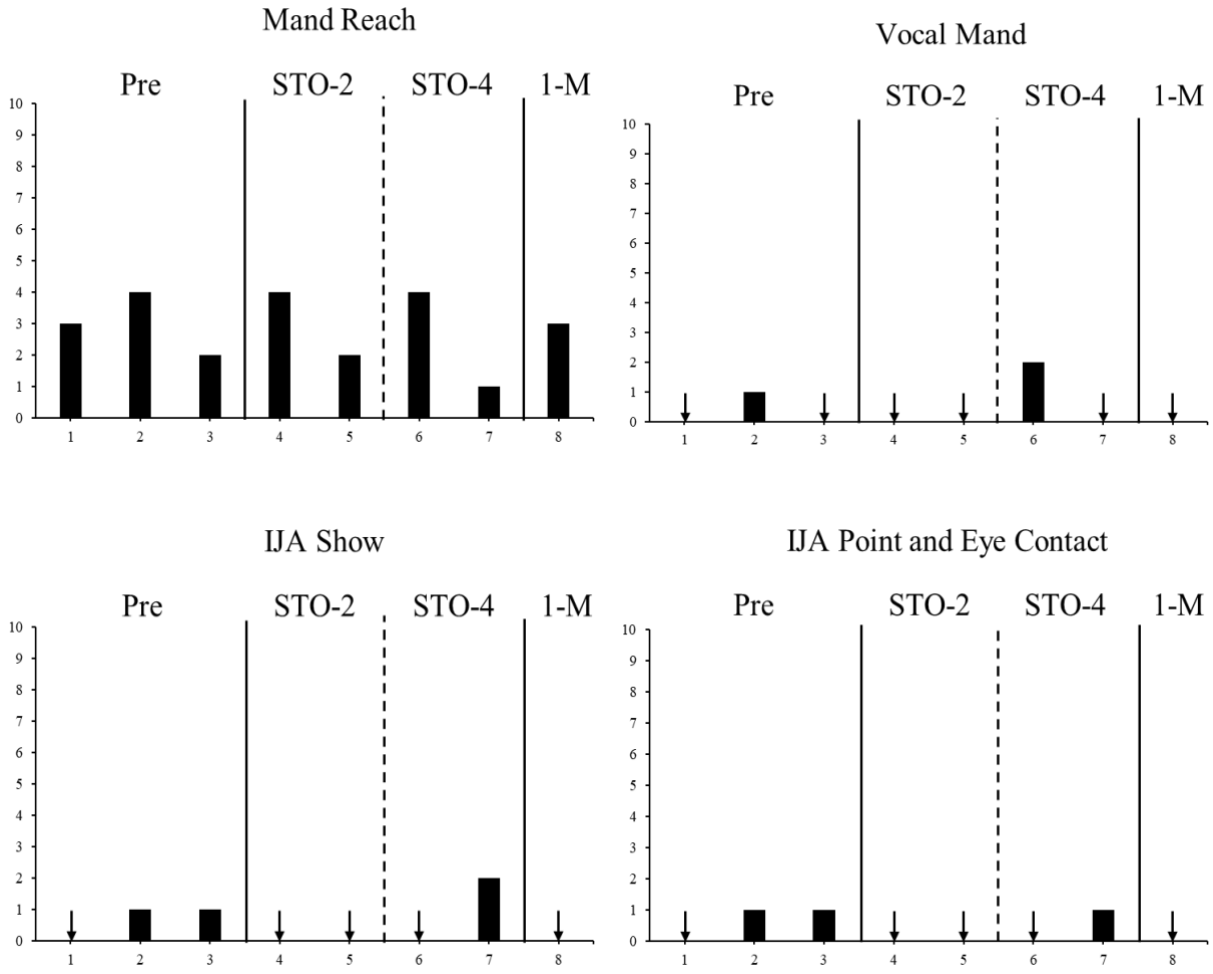

Mand Reach and Eye Contact
Pre
STO-2
1-M
3-M
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8

Figure 22

IJA Additional Measures of Zuri, Experiment 2



C-JARS

Table 27 displays pre- and post-intervention C-JARS data for Raul, Mayank, and Zuri. Raul demonstrated minimal changes from the pre-intervention data to the post-intervention data. He demonstrated some decrease in the SJAS where he went from -1.11 to -1.20. Mayank demonstrated minimal changes as well where he demonstrated some decrease in the SJAS from -1.46 to -1.50. Zuri was the only participant that increased the SJAS from -0.40 to -0.11. The data indicate that Zuri increased prosocial joint attention behavior.

Table 27

C-JARS, Experiment 2

	AS	PS	aAS	aPS	SJAS
Raul					
Pre	36	60	2.57	1.46	-1.11
Post	38	62	2.71	1.51	-1.20
Mayank					
Pre	42	63	3.00	1.54	-1.46
Post	38	50	2.71	1.21	-1.50
Zuri					
Pre	28	90	2.00	1.61	-0.40
Post	26	98	1.86	1.75	-0.11

Note. ASC = asocial scale score . PSC = prosocial scale score . aASC = average ASC score. aPSC= average PSC scale. SJAS = Summary Joint Attention Scale.

Vocal Verbal Operant

Figure 23 displays pre- and post-intervention data of vocal verbal operants for Raul, Mayank, and Zuri. Table 28 displays the frequency of different verbal operants during the assessment. Raul increased the number of verbal operants from 1 to 16 by the three-month follow-up. Mayank increased the number of verbal operants from 5 to 32 by the three-month follow-up. Zuri increased the number of verbal operants from 16 to 26 by the one-month follow-up and to 25 by the three-month follow-up. Table 28 displays a table that includes the specific verbal operants emitted by Raul, Mayank, and Zuri across different phases. Raul increased the number of mands, tacts, sequelics, conversational units, and unintelligible vocalizations. Mayank increased the number of mands tacts, sequelics, conversational units, and IJA. Zuri increased the number of sequelics, conversational units, unintelligible vocalizations, and IJA.

Figure 23

Total Vocal Verbal Operant Assessment, Experiment 2

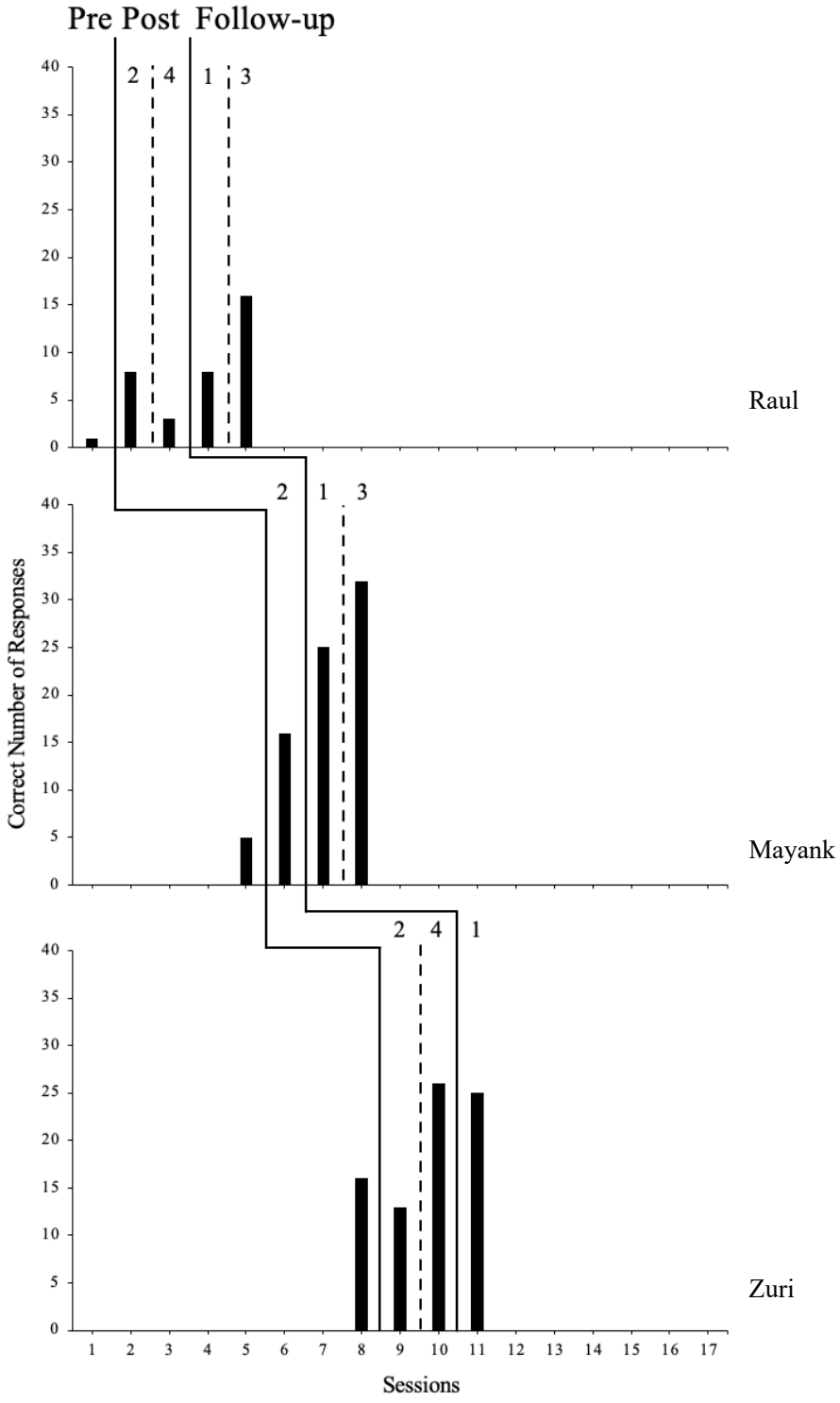


Table 28

Vocal Verbal Operant Assessment Frequency, Experiment 2

		Mands	Tacts	Sequelics	CUs	Unintelligible	IJA
Raul							
	Pre	0	1	0	0	0	0
	STO-2	0	7	0	0	6	1
	STO-4	0	3	0	0	0	0
	M-1	1	9	5	1	9	0
	M-3	0	6	2	0	3	0
Mayank							
	Pre	0	4	1	0	0	0
	STO-2	1	9	5	0	0	1
	M-1	5	15	4	1	0	0
	M-3	7	18	4	2	0	1
Zuri							
	Pre	0	12	4	0	0	0
	STO-2	0	5	8	0	15	0
	STO-4	0	7	2	1	5	2
	M-1	0	5	7	0	0	1

Intensive Tact Instruction

Figure 24 displays STO 1 data of Raul during the ITI. Raul contacted 80 learn units to meet criterion on labeling objects in the environment, 140 learn unit to meet criterion on labeling actions, 100 learn units to meet criterion on labeling pictures in a book, 80 learn units to meet criterion on labeling hidden items, and 161 learn units to meet criterion on labeling the activity. On average, Raul had the largest learn units to criterion during the fifth category where he was required to label the activity he was engaging in. Figure 25 displays STO 2 data of Raul during the ITI. Raul contacted 120 learn units to meet criterion on labeling objects in the environment, 170 learn unit to meet criterion on labeling actions, 50 learn units to meet criterion on labeling pictures in a book, 60 learn units to meet criterion on labeling hidden items, and 150 learn units

to meet criterion on labeling the activity. On average, Raul had the largest learn units to criterion during the second category where he was required to label actions. Figure 26 displays STO 3 data of Raul during the ITI. Raul contacted 90 learn units to meet criterion on labeling objects in the environment, 140 learn unit to meet criterion on labeling actions, 70 learn units to meet criterion on labeling pictures in a book, 60 learn units to meet criterion on labeling hidden items, and 239 learn units to meet criterion on labeling the activity. On average, Raul had the largest learn units to criterion during the fifth category where he was required to label the activity he was engaging in. Figure 27 displays STO 4 data of Raul during the ITI. Raul contacted 60 learn units to meet criterion on labeling objects in the environment, 90 learn unit to meet criterion on labeling actions, 70 learn units to meet criterion on labeling pictures in a book, 80 learn units to meet criterion on labeling hidden items, and 110 learn units to meet criterion on labeling the activity. On average, Raul had the largest learn units to criterion during the fifth category where he was required to label the activity he was engaging in.

Figure 28 displays STO 1 data of Mayank during the ITI. Raul contacted 70 learn units to meet criterion on labeling objects in the environment, 90 learn unit to meet criterion on labeling actions, 80 learn units to meet criterion on labeling pictures in a book, 60 learn units to meet criterion on labeling hidden items, and 80 learn units to meet criterion on labeling the activity. Mayank had the largest learn units to criterion during the second category where he was required to label actions. Figure 29 displays STO 2 data of Mayank during the ITI. Mayank contacted 70 learn units to meet criterion on labeling objects in the environment, 60 learn unit to meet criterion on labeling actions, 50 learn units to meet criterion on labeling pictures in a book, 60 learn units to meet criterion on labeling hidden items, and 70 learn units to meet criterion on labeling the activity. Mayank had the largest learn units to criterion during the first and fifth

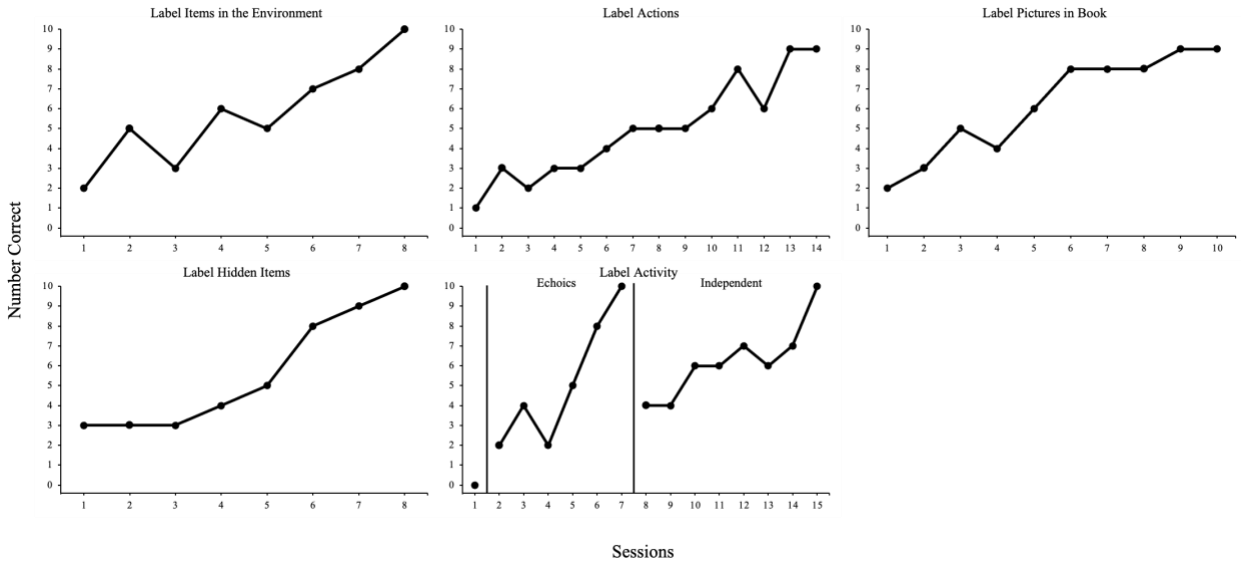
category where he was required to label objects in the environment and the activity he was engaging in.

Figure 30 displays STO 1 data of Zuri during the ITI. Zuri contacted 100 learn units to meet criterion on labeling objects in the environment, 70 learn unit to meet criterion on labeling actions, 90 learn units to meet criterion on labeling pictures in a book, 60 learn units to meet criterion on labeling hidden items, and 90 learn units to meet criterion on labeling the activity. Zuri had the largest learn units to criterion during the first category where he was required to label objects in the environment. Figure 31 displays STO 2 data of Zuri during the ITI. Zuri contacted 60 learn units to meet criterion on labeling objects in the environment, 120 learn unit to meet criterion on labeling actions, 90 learn units to meet criterion on labeling pictures in a book, 70 learn units to meet criterion on labeling hidden items, and 110 learn units to meet criterion on labeling the activity. Zuri had the largest learn units to criterion during the second category where he was required to label actions. Figure 32 displays STO 3 data of Zuri during the ITI. Zuri contacted 40 learn units to meet criterion on labeling objects in the environment, 90 learn unit to meet criterion on labeling actions, 80 learn units to meet criterion on labeling pictures in a book, 50 learn units to meet criterion on labeling hidden items, and 120 learn units to meet criterion on labeling the activity. Zuri had the largest learn units to criterion during the fifth category where he was required to label the activity he was engaging in. Figure 33 displays STO 4 data of Zuri during the ITI. Zuri contacted 100 learn units to meet criterion on labeling objects in the environment, 70 learn unit to meet criterion on labeling actions, 90 learn units to meet criterion on labeling pictures in a book, 90 learn units to meet criterion on labeling hidden items, and 90 learn units to meet criterion on labeling the activity. Zuri had the largest learn units

to criterion during the fifth category where he was required to label the activity he was engaging in.

Figure 24

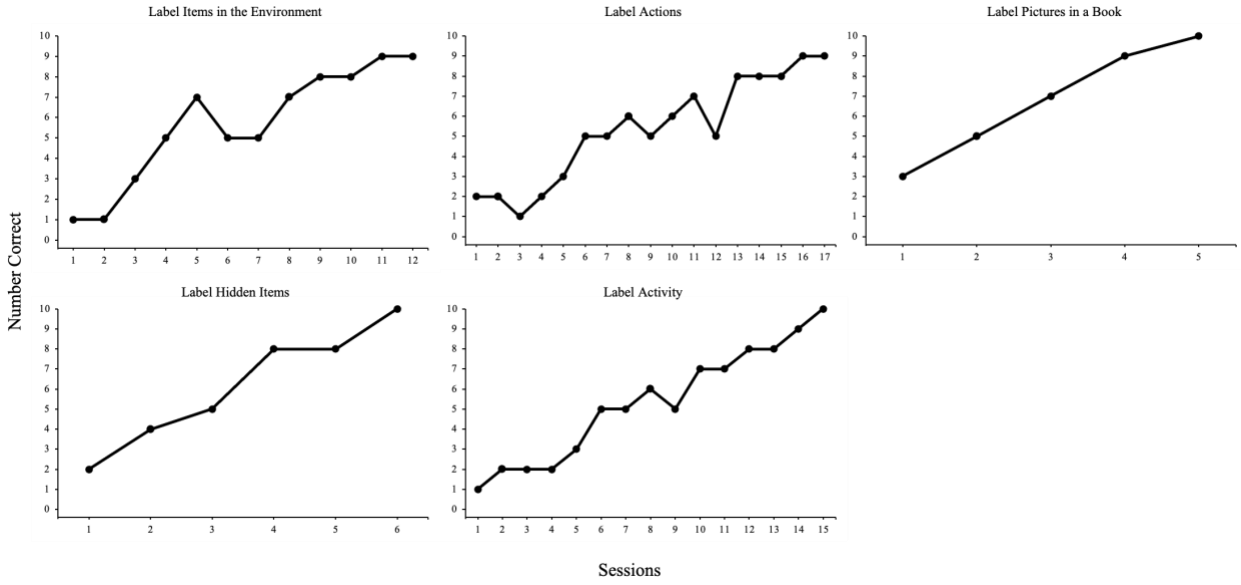
Intervention Graph of Raul STO 1, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. In the label activity category, Raul required an echoic tactic to meet criteria. STO=short term objective.

Figure 25

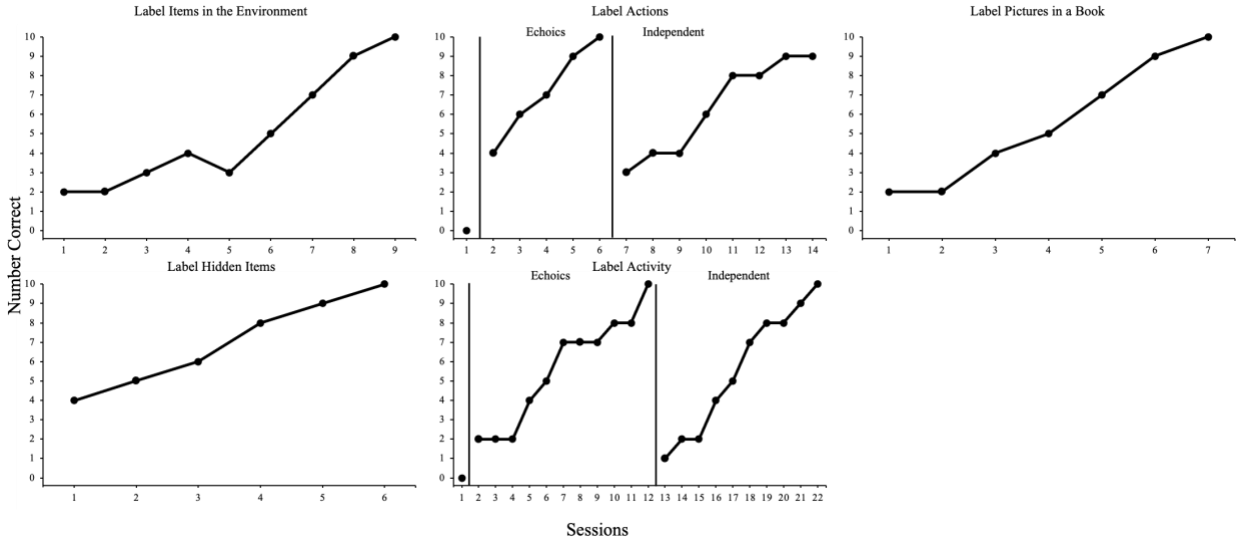
Intervention Graph of Raul STO 2, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. STO=short term objective.

Figure 26

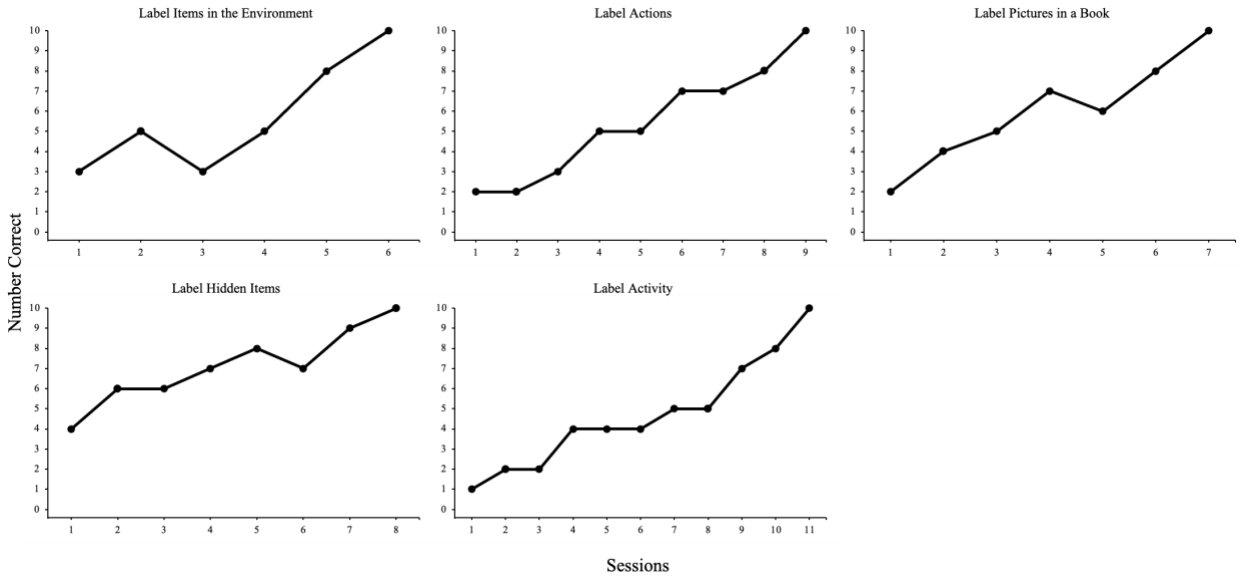
Intervention Graph of Raul STO 3, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. In the label activity category, Raul required an echoic tactic to meet criteria. STO=short term objective.

Figure 27

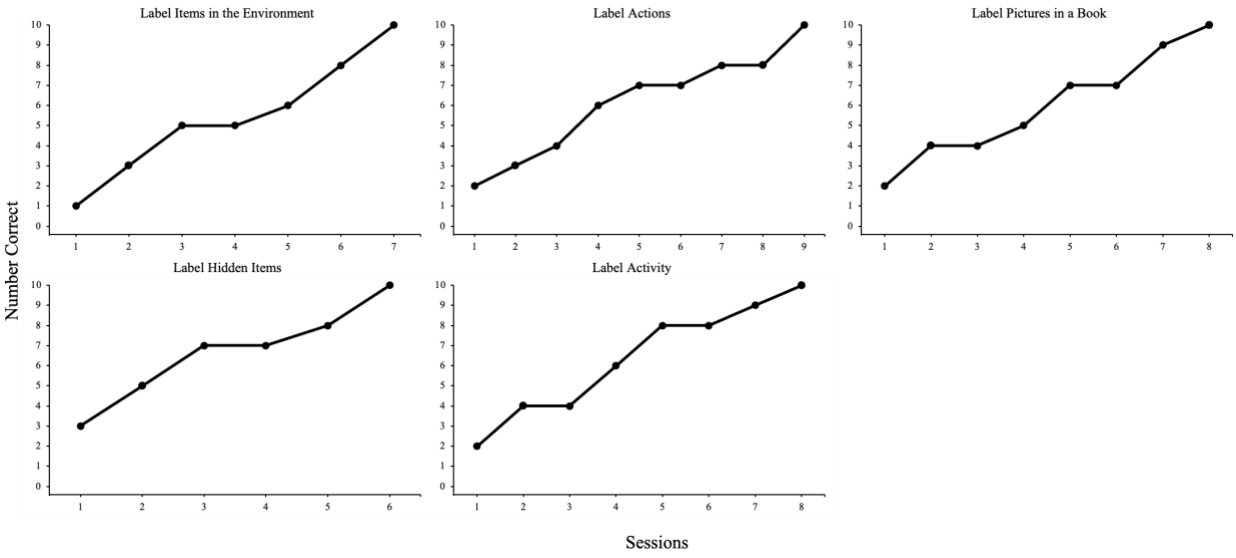
Intervention Graph of Raul STO 4, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. STO=short term objective.

Figure 28

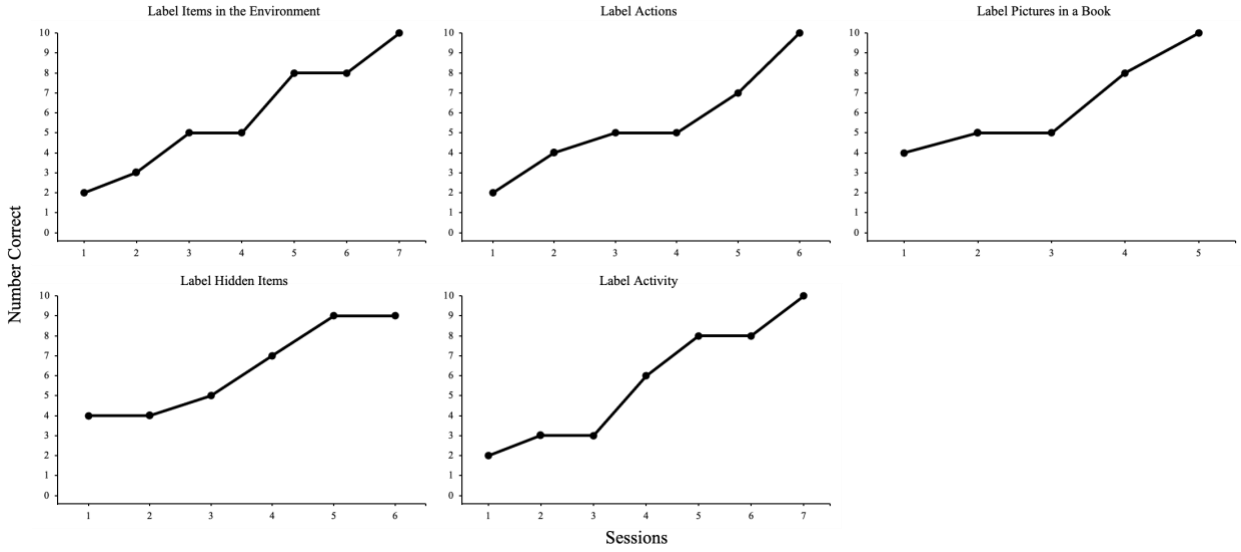
Intervention Graph of Mayank STO 1, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. STO=short term objective.

Figure 29

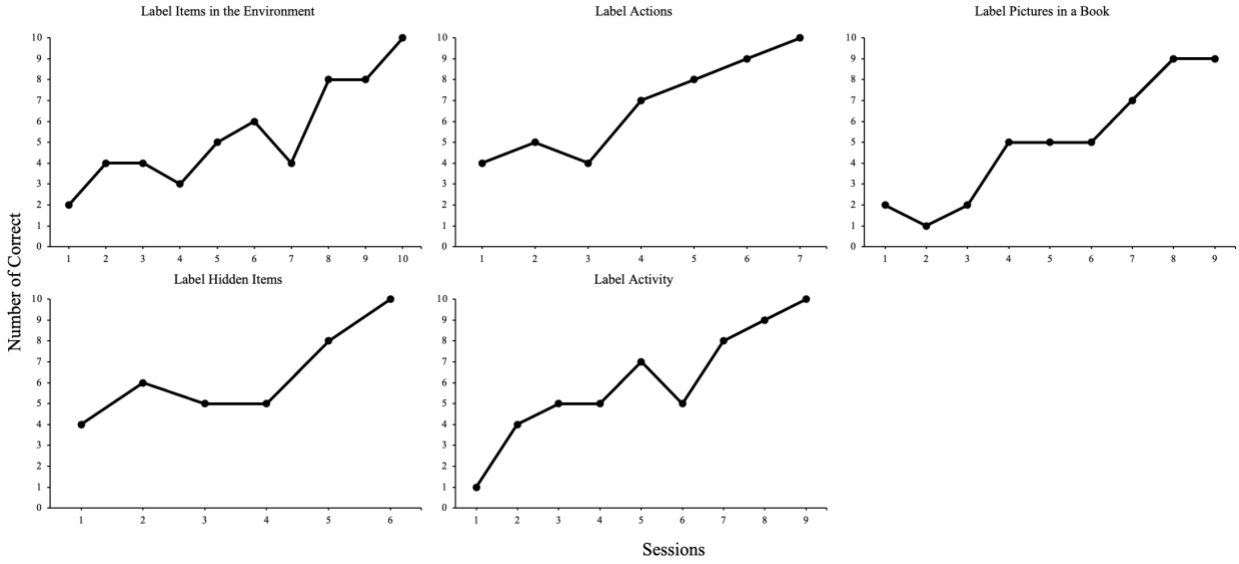
Intervention Graph of Mayank STO 2, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. STO=short term objective.

Figure 30

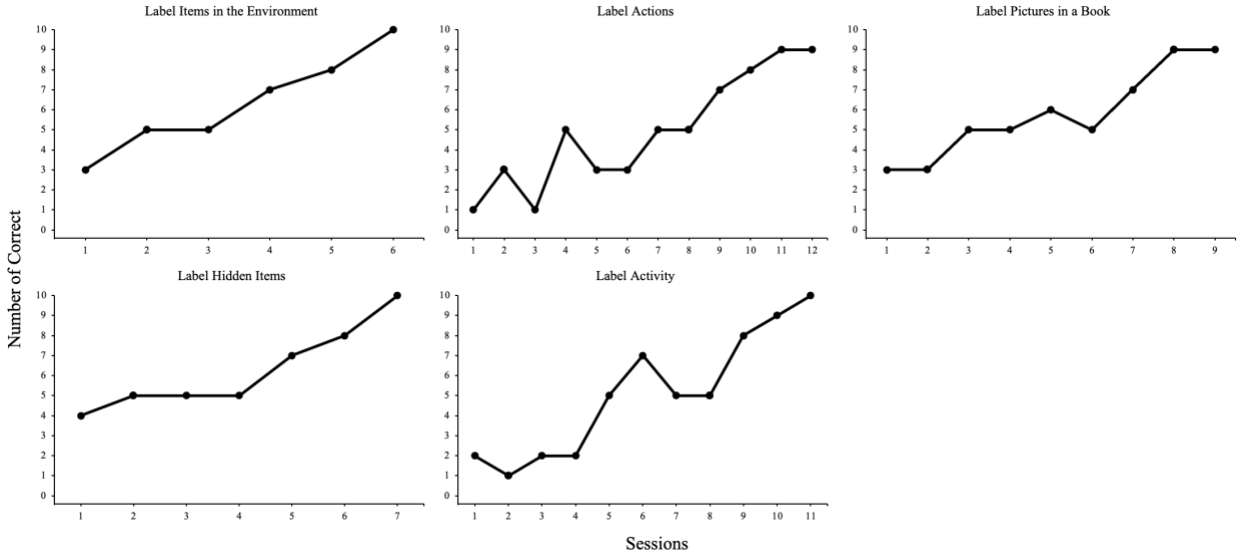
Intervention Graph of Zuri STO 1, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. STO=short term objective.

Figure 31

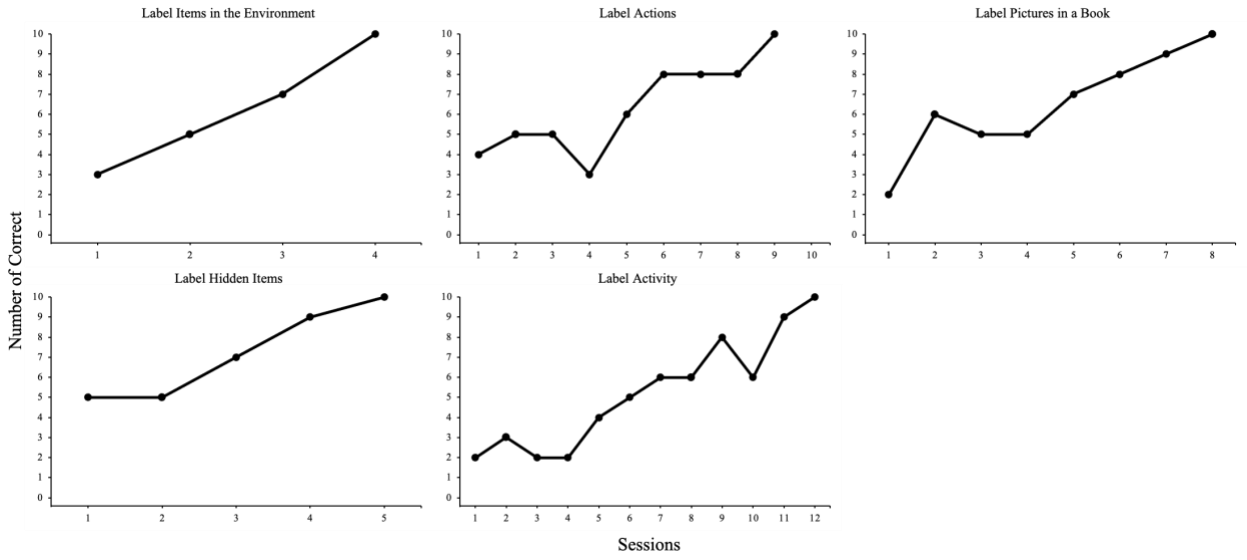
Intervention Graph of Zuri STO 2, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. STO=short term objective.

Figure 32

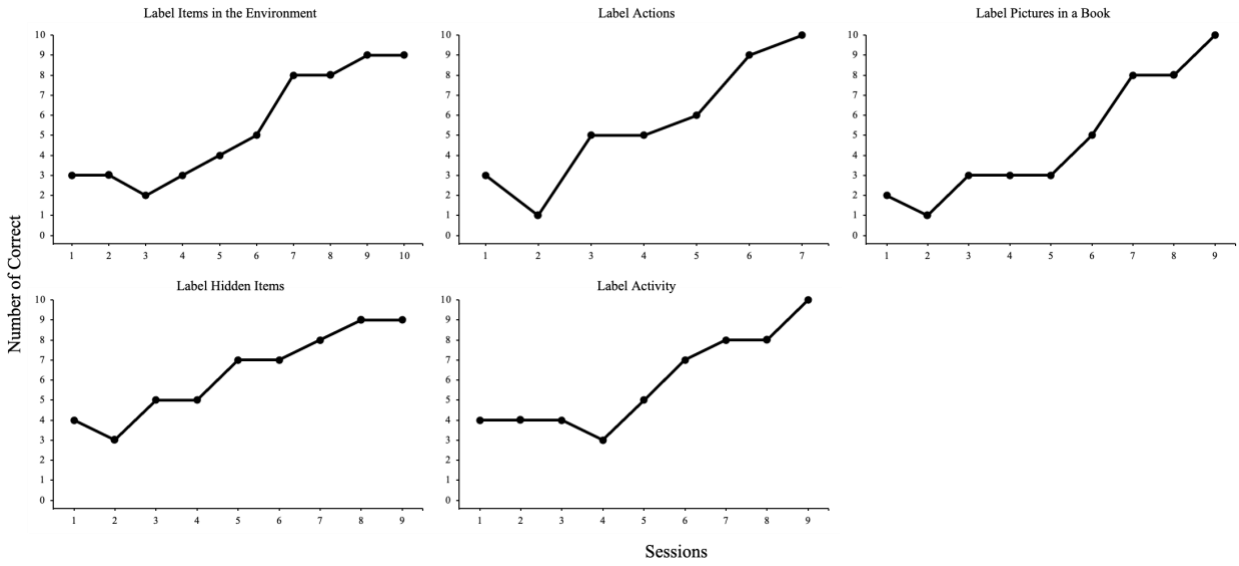
Intervention Graph of Zuri STO 3, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. STO=short term objective.

Figure 33

Intervention Graph of Zuri STO 4, Experiment 2



Note. 10 learn units were delivered per category making a total of 50 learn units. STO=short term objective.

Summary of Findings

The results of Experiment 2 indicate that completing ITI led to criterion-level improvements of behaviors associated with joint attention across the dependent variables. The three participants improved two-point RJA. Specifically, three participants met criterion for two-point RJA, one participant showed criterion-level for three-point RJA, and two participants showed criterion-level for IJA. Participants who completed the experiment also increased vocal verbal operants. Overall, the results of the experiment indicate that the inclusion criterion for the cusps and capabilities and low responses of two-point RJA were appropriate since the participants who met the inclusion criteria increased joint attention responses after experiencing the ITI. Those cusps and capabilities included conditioned reinforcement for 3D stimuli, 2D stimuli, faces, voices, echoics, and independent tacts in repertoire. The results of Experiment 2 suggest that the ITI led the participants to increase two-point RJA. The ITI experience required participants to come in contact with sharing social experiences, additional exposure to behavior-specific-praise and playful physical contact. These experiences may have led to the increases of two-point RJA. The results indicate that the ITI successfully taught reinforcers that led to increases in behaviors associated with joint attention.

Intensive Tact Instruction

The ITI was successful in increasing two-point RJA across all three participants. ITI was not successful in increasing three-point RJA and IJA consistently across all participants in Experiment 2. During ITI, researchers required participants to emit tacts of various stimuli such as objects in the environment, actions, pictures in a book, hidden items, and the activity they were engaging in. The researchers presented a stimulus, and it evoked a tact from the participants. This process indicates that the participants' tacts are controlled by the social

reinforcers presented by the researcher and are occasioned by the presence of a listener. The ITI procedure required the researcher to initiate the tact by presenting the stimuli and the participants were required to respond by labeling the target item to come into contact with the social reinforcer. This may be the rationale behind why participants emitted RJA rather than IJA.

The ITI required the researcher to elongate the social reinforcer for each correct tact response by continuing the joint experience. For example, if a participant tacted a broom correctly, the researcher would provide the participant with social reinforcement and engage with the participant by sweeping with the broom and take turns with the participant. There were instances during the ITI where participants enjoyed these reinforcing activities and would mand for the researcher to engage in these experiences outside of the intervention. These observations indicate that the elongated social experiences were reinforcing for the participants.

Limitations

The setting in which the experiment was conducted was not contrived. The researcher conducted the experiment at each of the participants' homes. Each participant had different furniture, different rooms, different people, and different items and toys present in the environment. This may have affected the assessment results and the process of the ITI. Future research should attempt to control these environments to ensure that participants are experiencing the assessments and ITI in similar environments.

Previous research has used different terminology and operationalization of joint attention. The different terminologies and operationalization have led to confusion within the joint attention literature. It is vital that researchers use the same terminology to describe joint attention to better understand and conduct joint attention. Children with ASD often times show a lack of joint attention and therefore it is important that additional research is conducted. Gabouer and

Bortfeld (2021) discussed the necessity of a coding system due to the complexity of parent-child interactions. The researchers stressed the importance of having a coding system to collect data more accurately. Joint attention is a difficult behavior to measure and operationalizing the behavior and including a description of how to code the behaviors are extremely important when conducting research.

CHAPTER IV:

GENERAL DISCUSSION

Summary of Findings

Experiment 1 was a systematic replication of the study conducted by Harms (2020). Among the three participants, Anna increased both three-point RJA and IJA to criterion-level. Out of the two participants whose behavior did not meet criterion, Sheryl demonstrated minor increases of joint attention. Harms' (2020) participants showed moderate increases of three-point RJA and IJA where one of six participants met criterion for IJA. Another participant demonstrated minor increases of joint attention, similar to Sheryl in experiment 1, while three participants did not show any increases in joint attention, similar to Vincenzo in experiment 1. None of the participants in Harms' (2020) study met criterion-level of three-point RJA.

The results of Experiment 1, when compared to Harms (2020), demonstrated variable data and did not indicate a functional relation between the ITI and joint attention. Harms (2020) required participants to receive 20 opportunities to respond per category while Experiment 1 required participants to receive 10 opportunities per category. Therefore, participants in Harms (2020) received an assessment after each short-term objective while participants in Experiment 1 required an assessment after the completion of two short-term objectives. Both studies required participants to emit 200 total responses before the conclusion of the experiment.

The primary research question examined whether ITI will lead to an increase in behaviors associated with RJA and/or IJA. The secondary research question was whether a correlation existed between language and joint attention in the results. The findings of the experiments demonstrated that ITI resulted in participants meeting criterion for two-point RJA in Experiment 2. Some participants in both Experiment 1 and 2 increased other joint attention responses such as

3-point RJA and IJA but was not consistent across all participants and was unable to demonstrate a functional relation. In Experiment 2, the results demonstrated that there was a correlation between language, through vocal verbal operant assessments, and joint attention behaviors.

The purpose of Experiment 2 was to determine whether the new inclusion criterion would lead to improved two-point RJA outcomes after participants experienced ITI. The results demonstrated that all three participants who completed the experiment increased two-point RJA to criterion-level.

Overall, the results of Experiment 1 demonstrated that ITI alone did not lead to an increase in joint attention topographies or functions. Conversely, the results of Experiment 2 demonstrated that the function needs to be taught to increase two-point RJA. Much previous research has largely focused on teaching the form of joint attention by using interventions such as prompting and modeling and by consequating correct behaviors with non-social reinforcers such as edibles or access to preferred items. In contrast, this experiment implemented ITI to teach the reinforcing consequences of social interactions such as joint attention. Once social stimuli functioned as a reinforcer, topographies of behaviors such as joint attention and tacts increased for participants.

During the ITI, each correct response was followed by an elongated reinforcer where the participant and the researcher continued to interact with the target stimulus. The researcher followed the participants' lead to sustain shared engagement before moving on to the next ITI opportunity. This procedure was used across all five categories. For instance, when the participant correctly tacted "broom," the researcher delivered behavior-specific praise (e.g., "That is a broom, great job!") and modeled how to use the broom while saying, "We can use the broom to clean!" If the participant showed interest, the researcher handed the broom to them and

cleaned with them, extending shared engagement through natural social reinforcement. The researcher may have made a game out of it by saying, “Look over there! Let’s clean up that mess.” The researcher would attempt to share the experience with the participant before moving onto the next ITI opportunity. This experience led to an increased amount of time participants spent sharing experiences, transforming tacting opportunities into meaningful social exchanges supported by behavior-specific-praise and playful interaction.

In summary, Experiment 2 demonstrated that the ITI conditioned social experiences as reinforcers and led to increase in joint-attention behaviors, specifically two-point RJA. Although the ITI did not consistently produce an increase in three-point RJA or IJA, the findings demonstrate the importance of establishing social reinforcers to increase social behaviors. the results provide further analysis and information on how social stimuli functioning as a conditioned reinforcer can contribute to the increase of joint attention behaviors.

Implications

Current experiments did not teach the form of joint attention through physical prompts but instead conditioned social experiences as reinforcers through the consequence portion of the ITI. The ITI used an elongated reinforcing experience which became the key to sustaining joint engagement and promoting naturalistic social interactions during the intervention. These extended responses to tact was a variable that led to the increase in joint attention behaviors. These elongated reinforcing experiences gave access to richer reinforcers that sustained joint engagement (i.e., continued social contact). Maintaining the attention are important when conditioning social interactions as reinforcers (Ruff & Capazzoli, 2003; Ruff et al., 1990; Schmelzkopf et al., 2017). These experiences required active engagement and intentional sharing of social experiences between the researcher and the participant.

From a behavior analytic perspective, establishing a reinforcer resulted in a class of responses that all produced the same social reinforcer. Once the reinforcer for having social experiences was established, the joint attention behaviors expanded naturally. Therefore, the operant definition of joint attention (i.e., requiring eye contact for the behavior to be considered jont attention), seen in Table 1, may have been too restrictive in these experiments. The additional communicative behaviors measured during the RJA and IJA assessments likely provided richer insight into whether joint attention actually occurred during the assessments. Joint attention can be viewed as a behavior that a child engages in when appropriate social reinforcement is in place. Therefore, it is important that educators focus on teaching the reinforcer of joint attention rather than its topography.

An important question for future research is whether there are different levels or types to having social reinforcers and experiences conditioned as reinforcers. For instance, research in SLR (social listener reinforcement) focuses on social skills such as finding listening socially reinforcing since it can lead to speaker behaviors (Tsai & Greer, 2006). It is worth exploring the various forms of social stimuli function and the types of stimuli that function as reinforcers based on the participant. Depending on the child, one may find behavior-specific-praise reinforcing while another may find playful physical contact more motivating. In these experiments, behavior-specific-praise, playful physical contact, and elongated reinforcers are included in the ITI experience. Future studies may benefit from isolating each type of social reinforcer to determine what effectively produced increases in joint attention responses.

From a developmental perspective, the ITI functioned to teach the reinforcer through both supported and coordinated joint engagement following a correct tact response. The researcher ensured to follow the lead of the participants after the correct tact response was

emitted (Yoder et al., 1993). Therefore, when the child was receptive to sharing a social experience with the adult, the researcher initiated coordinated joint engagement, where both the adult and the participant actively shared attention toward the stimulus. When a child was less receptive to sharing a social experience with the adult, the researcher encouraged supported joint engagement where the adult maintained shared focus. The duration of each interaction was determined by the participants' responsiveness and nonverbal cues. The experimenter extended the joint attention experience only as long as the child remained engaged and receptive so that the extended joint attention experienced remained natural and reinforcing.

Fidings from Experiment 1 suggested the need to measure additional behaviors that occurred during the IJA such as vocalizations and gestures. These measures paralleled the data collected for two-point and three-point RJA and the additional measures recorded during the RJA assessment. The additional measures during IJA were included in this experiment because there were participants in previous experiments that were engaging in IJA without engaging in eye contact and these measures were not explicitly recorded. The additional communicative behaviors during the RJA and IJA assessments provided a broader picture of how participants engaged in joint attention behaviors. There are many joint attention-related behaviors and they were included in the joint attention assessments in Experiment 2 (Goodhart & Baron-Cohen, 1993).

The operant definitions for correct three-point RJA and IJA required the participant to make eye contact with the researcher. During three-point RJA the participant was required to orient towards the target stimulus and look back at the researcher while IJA required the participant to look and/or engage with the given toy and look back at the researcher. However, the additional communicative behaviors revealed that there were instances where participants

attended to the target stimulus and commented about it without looking back at the researcher. The operant definitions of joint attention, as stated in Table 1, disregard these additional communicative behaviors. Much of the joint attention literature considers these behaviors as valid instances of joint attention since eye contact is not always necessary for sharing an experience (Goodhart & Baron-Cohen, 1993). If a participant is attending to the target stimulus and talking about the stimulus without looking back at the researcher, the participant is still sharing the experience with the researcher. For example, a child may look toward the target stimulus and say, "What's that?" without looking back at the researcher but that may be considered three-point RJA even when it doesn't meet the definition provided in the operant definition.

Therefore, it is possible to yoke an experience with another person without engaging in eye contact. Our findings indicate that additional communicative behaviors are also representative of joint attention. The two-point and three-point RJA graphs only represent joint attention based on the operant definition of the two experiments. The inclusion of these additional measures allowed for a more comprehensive understanding of joint attention as a whole instead of focusing on the eye contact component of the form of joint attention. Experiment 1 measured joint attention from a stringent perspective where participants were required to reciprocate eye contact and initiate joint attention. Experiment 2 was conducted to measure the less stringent component of joint attention, two-point RJA. However, our findings indicate that the operant behaviors of joint attention behaviors for Experiment 2 were still stringent. Ultimately, it was valuable and important that the additional communication behaviors were included in the joint attention assessments in Experiment 2. The results demonstrated a more accurate depiction of participants' behaviors related to joint attention.

The purpose of Experiment 2 was to determine whether two-point RJA would increase after experiencing the ITI. Much of the previous joint attention studies required the participants to respond to joint attention by solely attending to the event or object of interest. Therefore, in Experiment 2, joint attention was described as two-point RJA while also measuring the more stringent measures of joint attention: three-point RJA and IJA. Two-point RJA was the target dependent variable for this experiment. Participants in Experiment 2 began with low levels of two-point RJA during the pre-intervention assessments due to the inclusion criterion. The current experiment used an ITI to attempt to increase two-point RJA. After experiencing the ITI, all participants who completed the study reached criterion level for two-point RJA, demonstrating that conditioning social experiences led to increases in joint attention behaviors. Mayank was the only participant that increased three-point RJA to criterion-level. Raul and Zuri also showed improvements in three-point RJA, but did not reach criterion level. Raul and Zuri required four short-term objectives to increase two-point RJA to criterion while Mayank only required two short-term objectives. These results highlight individual variability in acquisition rates and demonstrate that ITI reliably increased two-point RJA. Additionally, the results do indicate that more complex joint attention behaviors such as three-point RJA and IJA developed more gradually.

Additional measures were collected during the RJA assessments to capture a broader range of joint attention behaviors. Raul increased additional RJA measures during the post-STO-4 assessment sessions but did not maintain these responses during the follow-up sessions. Mayank increased additional RJA measures after completing the experiment during the one and three-month follow-up. Zuri gradually increased additional RJA measures throughout the

experiment. He showed the highest number of additional RJA measures during the post-STO-4 assessment session and during the one-month follow-up.

Across participants, tacts and facial expressions increased after completing the ITI which indicate that the intervention led to increases in behaviors beyond the primary RJA measures. The results demonstrated that two-point RJA increased while tacts and facial expressions increased as well. Tacts and changes in facial expressions are common behaviors seen during joint attention experiences (Moll, 2024; Yu & Smith, 2013). For example, a child may initiate joint attention by saying, “That car is going fast!” while making a surprised face. Gestural responses were an additional behavior that was measured during RJA assessments, but the researcher did not see as great of an increase. Mayank and Zuri increased gestural responses, but only one to two times during the post-intervention assessments. These results are interesting since gestural responses are often observed during a joint attention experience as well (Hurwitz et al., 2015). This limited increase may reflect the higher physical effort required for gestures compared to verbal or facial responses. Overall, these findings suggest that the ITI facilitated a variety of joint attention behaviors.

During the post-intervention IJA assessments, all participants increased manding-by-reaching the most consistently. The additional measures data during the IJA assessments further revealed increases across behaviors such as vocal mands, IJA by showing, and playing with the toy. Manding by reaching is not considered to be a social behavior since this describes a child who is reaching for a toy because they want access to it. This measure was included based on the topographies measured during the ESCS. Vocal mands are also not considered to be a social behavior since the child emits verbal behavior to access an item. In contrast, IJA-by- showing is described as a child gesturally presenting or bringing the item towards the researcher. This

behavior represents a clear form of social engagement and has correspondence with the definition of IJA in experiment 1 and 2. This behavior reflects the participant's intention to share the experience instead of gaining access to the object.

The RJA assessment presented participants with different gestural and eye gaze antecedents to the participants, allowing data collection on which cues most effectively elicited joint attention responses. The data demonstrated patterns across sessions. During the pre-intervention assessments, Raul and Zuri emitted correct responses mainly during the gesture and vocalization antecedent for two-point RJA. Mayank emitted correct responses mainly during the gesture, and gesture and vocalization antecedent with occasional correct responses during the eye contact and vocalization antecedent. Raul, Mayank, and Zuri emitted close to zero correct responses for three-point RJA during the pre-intervention assessments except for Zuri who occasionally emitted correct responses during the gesture and vocalization antecedent. Participants produced the fewest correct responses to eye contact only and eye contact plus vocalization antecedents prior to intervention. Following the ITI, however, all participants demonstrated improvements in emitting correct responses during the eye contact, and eye contact and vocalization antecedents during the post-intervention assessments.

Among the antecedent types, the gesture and vocalization antecedent was the most overt. In contrast, eye contact only was considered the least overt antecedent in the assessment. The researcher also presumed from the data that when the antecedent included a vocalization in addition to the eye contact or gesture, this made it more overt. During the gesture with vocalization antecedent, there are two stimuli to attend to: the gestural response and the vocalization. Although the eye contact with vocalization antecedent also has two stimuli to attend to, the shift in eye gaze is less obvious than the gesture. The gesture controlled the participants'

behavior during the pre-intervention assessments and continued after intervention. The ITI may have led participants to become more aware of environmental stimuli and became more sensitive to less obvious social cues such as eye gaze. The continued dominance of gesture-controlled behavior after the ITI may reflect the salience of visual cues but after participants experienced the ITI, the more nuanced social stimuli seemed to have become more salient. This interpretation aligns with Cilia et al (2020) who found that the different antecedents presented prior to joint attention and whether the target object or event was in the visual field of the child changed the RJA behavior in children. In autistic children, presenting a gesture, such as a point, led to increase the duration of the joint attention experience (Benjamin et al., 2014). Interestingly, researchers did find that verbalizations in combination with other joint attention bids did not increase the frequency or duration of joint attention in autistic children. Cilia et al. (2020) states that when different antecedent types, such as gesturing and eye contact are combined, this increases the probability of RJA in children with ASD. This pattern is consistent with the results of the present study.

The ITI consisted of five instructional categories: 3D objects in the environment, actions performed by the experimenter, pictures in a book, hidden objects in a bag, and the activity that the participant was engaging in. Out of all 5 categories, the participants required the greatest number of learn units to meet criterion in the categories involving hidden objects in a bag, the activity that the participants were engaging in, and the actions of the experimenter. In regard to the elongated reinforcing experiences, though the duration was not measured during both experiments, the participants did not engage in longer elongated reinforcing experiences based on category. This measure should be included in future research to observe whether some categories are more critical than others.

Implications indicate that the category for tacting the activity that the participant was engaging in may have been critical in increasing joint attention behaviors since this was the only category that requires the participant to initiate a tact. Other categories are an interverbal tact since the experimenter is presenting a contrived setting to the participant (e.g., pointing to a picture in the book, pointing to an object in the environment, engaging in an action, and presenting a bag full of objects). This distinction suggests that spontaneous self-initiated verbal behavior may create more authentic opportunities for joint attention. Future research may consider adding a different type of joint attention assessment where the participant walks in a designated area for 5 min with the experimenter and the experimenter keeps track of the frequency of vocalizations and joint attention behaviors that the participant emits. Natural observation tasks such as these could demonstrate data on how joint attention occurs and the different types of joint attention behaviors.

The experiment successfully increased two-point RJA responses but did not increase 3-point RJA consistently across all participants. This finding may be attributed to the idea that conditioning social reinforcers take longer to be established. Further research is necessary to understand how we can increase 3-point RJA in children who are showing low joint attention responses. Future research requires us to isolate the feature of the ITI and determine what exactly led to the increase in two-point RJA responses. It is hypothesized that the elongated reinforcer was the critical variable that led to conditioning social experiences as a reinforcer which led to the increase of two-point RJA. Further research is necessary to determine if the elongated reinforcer alone is sufficient to establish social experiences as a reinforcer.

Across the two experiments, there were participants who had speaker repertoire but did not have social reinforcers conditioned. This statement is made with the assumption that

participants that engage in joint attention behaviors do have social reinforcers conditioned. A participant may be emitting tacts but there was no social component. This finding supports the assumption that engaging in joint attention behaviors requires social stimuli to function as reinforcers. The results of these experiments found that a child can demonstrate speaker behavior, but they are not always functional. Therefore, the participants in these experiments only appeared to have tacts in repertoire, but the proper social function was not put in place. Tact can be defined as a mand for attention and therefore, requires the social component to function as the reinforcer. Many of the protocols that are conducted to induce cusps and capabilities are what many typically-developing children are accessing developmentally and for some kids they do not contact it at all or in the intensity that they require. The current findings therefore emphasize the importance of establishing social stimuli as reinforcers for increasing inherently social behaviors such as joint attention.

Research shows the strong correlations between joint attention and language. The function of joint attention is the same as a tact according to the definition of a tact by Skinner (1957). From the behavioral perspective, RJA is similar to listener skills and IJA is similar to speaker skills. RJA requires the child to attend to the target stimulus based on what is pointed out by another person. In comparison, IJA requires the child to initiate and point out the target stimulus to another person. The ITI, although requiring a speaker response (tact), is similar to the function of RJA where the researcher initiates an interaction/bids for joint attention by presenting the target stimulus to the participant, and they are expected to emit a response to share the experience. Therefore, from a social perspective, the ITI is requiring the participant to emit speaker responses where another person initiates a social interaction and the child is given an opportunity to respond. During ITI, the participant responds because a stimulus is present and

has stimulus control. Stimulus control transferred to social stimuli which increased behaviors consistent with joint attention.

The ITI successfully taught the function of joint attention, and the findings suggest that joint attention is not a skill, but a behavior that occurs when sharing social experiences function as a conditioned reinforcer and produce joint attention behaviors. We argue that joint attention is a social behavior that occurs when a child has social stimuli function as reinforcers and has stimulus control. Joint attention is a behavior that emerges based on the presence of the social listener reinforcement cusp. In conclusion, the social stimulus of sharing an experience with another person becomes a conditioned reinforcer and as a result leads to joint attention behaviors. Based on our findings, we can state that joint attention itself may not be a developmental milestone but having social stimuli such as sharing experiences function as a reinforcer is a developmental milestone. This approach is similar to the verbal behavior developmental trajectory of CABAS® where the reinforcer is observed and analyzed, not the behavior.

The current findings support prior research since it shows a correlation between joint attention and language. To explore these results, Experiment 2 included verbal operant assessments to determine the frequency of verbal operants emitted during the assessments. The results indicated an increase in language after participants met criterion on two-point RJA. Therefore, the data suggests that increasing two-point RJA after experiencing the ITI led to more advanced verbal behavior. Joint attention requires there to be a social interaction between the child and another person similar to sequelics and conversational units. During a joint attention experience, there is an object or event that the two people are attending to. In comparison during a sequelic or conversational unit, the two people are exchanging vocal verbal operants and

communicating. The results suggest that establishing two-point RJA may also increase the frequency and complexity of verbal behavior or vice versa. These findings suggest the interdependence between language and social behaviors.

In addition, during the verbal operant assessments conducted in Experiment 2, the experimenter measured the occurrence of joint attention behaviors. Joint attention behaviors were measured in frequency, but only those that included eye contact topography were considered joint attention. This measure was not a dependent variable for Experiment 2 but should be added in the future. Future research should systematically measure joint attention behaviors during verbal operant assessments by defining and coding all relevant topographies rather than limiting the definition of joint attention behaviors. The full range of joint attention responses such as vocalizations, gestures, and facial expressions would provide a comprehensive picture of how joint attention appears. This approach would help experimenters capture joint attention behaviors in non-contrived contexts.

Meindl and Cannella-Malone (2011) found results that children require explicit instruction to gain IJA and RJA separately because they are not the same behavior. Although our findings show that IJA and RJA are not the same behavior, there were participants in both Experiment 1 and 2 who showed increases in both RJA and IJA after experiencing the same intervention. This finding supports our theory that having social stimuli functioning as reinforcers leads to an increase in social behaviors such as RJA and IJA. These findings support the idea that when social stimuli function as conditioned reinforcers, it can strengthen the broad class of socially maintained behaviors such as RJA and IJA and therefore many not need to necessarily be taught separately.

Limitations

While the findings of the present experiments provide interesting results into the effects of the ITI on joint attention, several limitations should be acknowledged. These limitations help contextualize the results and help better direct future research in the field of joint attention. The experimenter measured participants' presence of relevant cusps and capabilities during pre-intervention assessments; however, they were not assessed during the conclusion of the experiment which is a key limitation of the study. A post-intervention re-assessment could have potentially provided valuable findings into whether the ITI led to the emergence of cusps and capabilities.

Gabouer and Bortfeld (2021) introduced a different perspective on joint attention and stated that there is a perspective of joint attention that occurs when the person who's gaze the child is following did not intentionally shift their gaze for the child to follow their gaze. If there were truth to this, the experiments would not have measured joint attention accurately because the researcher contrived the gaze shifts and gestural antecedents during the assessments. Therefore, it is important to distinguish between contrived and non-contrived coordination during joint attention. Future research should operationalize the type of coordination that the experiment is measuring. Researchers should explicitly identify both the definition of joint attention and how and what they are measuring specifically. Gabouer and Bortfeld (2021) also state that active coordination is necessary in joint attention while coordinated looking at the target object or event may not be considered a social behavior since the person may be orienting towards the target object or event without an intention to share the experience. Therefore, future research should understand what population benefits most from what procedure to increase three-point RJA and IJA.

Another limitation of the current experiments is that during the ITI, the researcher initiated the majority of the joint attention interactions during the assessment and the intervention, requiring participants to respond rather than independently initiate an interaction. As a result, the procedure showed parallel similarities with RJA behaviors and may not have fully captured or paralleled IJA. Future research should explore implementing an intervention that requires the participants to initiate the interaction and observe whether this type of intervention can lead to an increase in IJA behaviors.

Future Implications

The environment that the assessments and intervention sessions were conducted in may have largely impacted the results of the experiment. In Experiment 1, participants experienced the ITI in a structured school setting where the environment was controlled. In Experiment 2, the experiment was conducted in the natural home setting where there were familiar people such as family members and in-home therapists that were present during assessment or intervention sessions. This setting may have led to higher generalization skills since assessments such as the vocal verbal operant assessment was conducted in the presence of familiar people. This finding highlights the importance of the differences between contrived and non-contrived environments and what types of behaviors occur based on the setting. Future research should examine how the environment can affect behaviors related to joint attention.

The primary dependent variable of Experiment 2 was two-point RJA. Although two-point RJA is seen as the most common measure of joint attention according to the literature, future research should assess what type of instruction would lead to an increase in more complex forms of joint attention such as three-point RJA and IJA. In addition, researchers should explore what type of participants would benefit from different social reinforcers to determine which are most

effective for establishing and maintaining behaviors associated to joint attention. Understanding differences such as these may help identify specific components of an intervention that leads to increases in RJA and IJA across a heterogeneous sample.

Future research should consider conducting the ESCS (Mundy et al. 2003) as an additional assessment or in conjunction with the two-point and three-point RJA and IJA assessments used in this experiment. The ESCS has been widely used in many joint attention studies. The researcher should also conduct a study that compares ESCS assessment versus the joint attention assessments used for this experiment since the researcher used a modified ESCS when collecting RJA and IJA responses. The experiment will involve comparing the results of the two types of experiments. Conducting the two-point and three-point RJA and IJA assessments with typically developing children and children with IEPs or IFSPs should also be considered to determine if the assessment is valid. This method will help determine the validity and generalizability of the assessment procedures.

Future Research

Building upon on the findings of the two experiments, future research should focus on explicitly defining joint attention as a class of related responses rather than treating it as a single topography. Therefore, future research should include behaviors such as vocalizations, gestures, and gaze shifts as a response in the class of joint attention behaviors instead of strictly focusing on the eye contact component of joint attention. This approach would broaden the lens of joint attention research since it allows for a more precise and accurate capture of the behavior. In order for this to occur, future research must identify the behaviors within the response class that constitutes joint attention. While the present research identified some of these behaviors, additional topographies may exist that needs to be explored.

Joint attention is a common area of difficulty for autistic children. There may be instances where an autistic child has interest in a partner but is not sure how to engage in social interactions appropriately. Increasing opportunities for joint engagement can lead to increasing positive experiences with others and observing models of appropriate social behavior. During joint engagement and joint attention, the child can begin learning new words, language, responding, and making coordinated looks. In addition, future research may consider seeing the relation between joint attention behaviors and empathy. A child must observe others' behaviors and facial expressions to understand if another person is feeling sad or upset. This area of research may be of potential interest in the future since it may deepen our understanding of the affective aspect of joint attention.

Gabouer and Bortfeld (2021) also discusses the multiple modalities that joint attention can occur in such as touch which we did not measure in these experiments. Future research should include touch, such as gentle touch or hand-pulling as a measure to determine whether participants engage in joint attention through touch during RJA and IJA. Touch may be considered an additional communicative measure especially since many autistic children engage in behaviors such as hand pulling to initiate interactions with adults.

Future research should aim to identify the specific components of ITI that led to conditioning sharing experiences with others. Future research may analyze whether a tact experience is necessary to increase joint attention through establishing social stimuli as a reinforcer. Future research may focus on finding out what part of the ITI led to social stimuli become a conditioned reinforcer. The social reinforcer presented after the participant emitted a correct tact response consisted of behavior-specific-praise, playful physical contact, and an elongated reinforcer that sustained joint engagement. Based on the data collected, it remains

unclear which of these reinforcers or combination of these reinforcers was the critical piece that produced increases in joint attention behaviors. Subsequent studies could systematically isolate each component of the ITI to determine which helped contribute to conditioning social stimuli as reinforcers. This method will give researchers the opportunity to explore whether a tact is necessary for the conditioning to occur as well. Not only this, but it also provides the opportunity to explore whether nonverbal procedures can also lead to similar results as what we saw in Experiment 2. Future research should focus on using the effective features of the ITI to condition social stimuli as reinforcers.

Future research of joint attention must find ways to code and measure joint attention objectively and reliably (Gabouer and Bortfeld, 2021) in order to further the knowledge of children with ASD and joint attention. Cilia et al. (2020) stated the importance of where the target object or event is located in the context of the child's visual field. These factors can potentially influence the occurrence of joint attention behaviors. Future research may also consider how to operationally define behaviors associated with joint attention so that it includes behaviors that are observed in measures such as additional communicative measures seen in Experiment 2. This will help future researchers from having a restrictive topographical criteria for joint attention as these experiments did.

Gabouer and Bortfeld (2021) states that much of the joint attention research is conducted with white, upper-middle class families. Given the diverse participant pool in the current experiments, it is essential for future research to uphold this inclusivity, fostering a bigger picture of understanding joint attention associated behaviors in autistic children (Dunlap & Mertig, 1995; Hart & Risley, 1996). Maintaining and expanding the inclusivity and diversity in future

research is extremely important for developing an accurate and representative understanding of joint attention and to ensure that interventions are effective across diverse populations.

Last, but not least, we must consider how participant selection criteria may have shaped the results of current experiments. The second experiment recruited participants that did not demonstrate two-point RJA and defined this as emitting below 80% accuracy for two-point RJA during assessments. This inclusion criteria helped find results on how ITI strengthened existing inconsistent RJA responses. Next steps should include finding participants that have 0% correct responses of two-point RJA, though these participants may not have faces and/or voices conditioned as reinforcers. This would help show us whether the ITI can establish RJA rather than solely enhance it. This indicates that Experiment 2 purely strengthened the joint attention responses by establishing the reinforcer and did not establish two-point RJA in these participants. Having social stimuli as reinforcers is a spectrum and not determined by presence or lack thereof. Future research should continue to study how different levels of conditioned social reinforcement impact joint attention behaviors.

Conclusions

In conclusion, the current experiments examined the effect of the ITI on two-point RJA in autistic children. The findings demonstrate that establishing social stimuli as conditioned reinforcers with elongated reinforcement experiences led to increases in two-point RJA and in some cases, three-point RJA and IJA. This behavior-analytic approach views joint attention not as a skill that is taught through prompts, but as an operant class of responses maintained by social reinforcement.

Measuring additional communicative behaviors in Experiment 2 demonstrated different measures and forms of joint attention, which showed that a variety of topographies can be

considered indicators of shared attention. Future research should explore different types of procedures that include the elongated reinforcing experience without necessarily having to conduct the ITI to see its effects on joint attention behaviors. During these instances, the experimenter should measure the duration and quality of the elongated reinforcers for each participant.

This experiment measured spontaneous instances of joint attention that occurred during non-contrived vocal verbal operant assessments. This data collection was not originally planned since the primary focus was language during the assessment; however, the researcher recorded data whenever participants engaged in joint attention behaviors during the vocal verbl operant assessments. Though this data was not included, future research should include this type of measurement as a requirement since it captures naturally occurring joint attention behaviors.

We must also recognize that social reinforcement encompasses a variety of social stimuli rather than a single social stimulus. These can include behavior-specific praise, eye contact, playful physical contact, gestures of approval, sharing an experience together, etc. Each of these social stimuli may function as a conditioned reinforcer depending on each child and their instructional history and preference. It is important that instructors individualize the different social stimulus presented as a reinforcer based on each child. Lastly, in the present experiments, the elongated reinforcing experience was one of many different types of social reinforcement. The elongated reinforcing experience looked different for each child. Depending on the child there may have been an exchange of surprised looks, cleaning with a broom together, or singing with a karaoke mic during the elongated reinforcers. All of these social stimuli reflected meaningful exchanges and moments. Ultimately, the number of possible social stimuli that exist are infinite.

Moreover, subsequent studies should include target participants with fewer developmental skills and conduct interventions that do not require a tact response to have the opportunity for different populations to increase joint attention responses. The most undeniably important component in the recipe to the success of the ITI was the participants contacting the natural reinforcers.

The current experiments extend the literature by broadening the definition of what counts as joint attention and what does not. These findings contribute to a growing body of research in social behaviors such as joint attention, demonstrating that function-based reinforcement strategies can lead to social behaviors such as joint attention. The results highlight that the true developmental milestone may not be joint attention behaviors, but the conditioning of social stimuli as reinforcers, specifically the social stimulus of sharing the experience with another person. Future research should continue exploring how function-based reinforcers can lead to increases in a class of behaviors.

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