TEACHING JOINT ATTENTION SKILLS TO AUTISTIC CHILDREN:

A SYSTEMATIC REVIEW AND SINGLE-CASE STUDY

A Dissertation

by

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ABSTRACT

Joint attention (JA) is a pivotal prelinguistic skill critical to developing language and social repertoires. This behavior is often absent or delayed in children with autism spectrum disorder, commonly resulting in problematic communicative consequences. Behavior-based interventions have been used to teach autistic children to initiate and respond to JA, with mixed results. My two dissertation studies focused on reviewing and evaluating research on teaching JA to children with autism, and a single-case research design to investigate the use of a behavior analytic intervention to teach three autistic children to initiate JA.

The systematic review intended to identify which type of JA was being taught, using which methods, and further, what type of consequence was being used to shape and maintain this behavior. A quality indicator analysis is conducted to evaluate studies that meet the criteria for high-quality, methodologically sound research.

The single case study featured the analysis of a behavioral-based intervention comprised of a differential reinforcement and time delay procedure to teach three autistic children to initiate joint attention through remote training and supervision. Joint attention behavior as a socially valid goal and the intervention as a socially valid intervention was evaluated through the assent behavior of participants.

Collectively, these two studies supported the critical need for more research in this area and highlighted the importance of this essential skill for children with autism in the home, school, and community settings. Future research is needed to assess the generality of joint attention behaviors, both generalization outside of intervention conditions and maintenance post-treatment as well as evaluate the quality of contemporary research in this field of inquiry.

DEDICATION

Dedicated to my father for instilling in me the wonder of inquiry.

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I would like to thank my mother for being a model of strength and perseverance, my husband, Billy, for being my solid ground and always knowing when and how to make me laugh, and Ikey who spent his days studying by my side; you would have looked so handsome in a tam. I owe gratitude to my committee, especially my co-chairs Drs. Thompson and Ganz, for the support and lessons learned under their tutelage. Finally, thank you to my village; you know who you are. I couldn't have done it without you.

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NOMENCLATURE

ABA	Applied Behavior Analysis
ASD	Autism Spectrum Disorder
AW	Assent Withdrawal
BCBA	Board Certified Behavior Analyst®
BC-SMD	Between-Case Standardized Mean Difference
CEC	Council for Exceptional Children
EA-ES	Early Achievements for Education Settings
I	Independent
IJA	Initiating Joint Attention
IOA	Interobserver Agreement
JA	Joint Attention
JASPER	Joint Attention Symbolic Play Engagement Regulation
P	Prompted
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
QI	Quality Indicator
RJA	Responding to Joint Attention
SCRD	Single Case Research Design
WWC	What Works Clearinghouse

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1. INTRODUCTION

Autism spectrum disorder (ASD) is a construct used to describe a particular combination of difficulties in social communication, restricted interests, and repetitive behaviors beginning early in an individual's life (Lord et al., 2020). These characteristics can vary in severity within and between individuals (Charman, 2003). The Centers for Disease Control and Prevention's Autism and Developmental Disabilities Monitoring Network estimates that about 1 in 36 children have been identified with ASD (Maenner et al., 2023).

People with ASD often experience challenges with language; about 25% to 30% of autistic children either fail to develop functional language or are minimally verbal (Brignell et al., 2018; Tager-Flusberg & Kasari, 2013). Functional communication is an essential life skill, deficits of which can lead to adverse outcomes, including behavioral and social challenges, reduced academic performance, and ultimately reduced quality of life (Mancil, 2006).

Joint attention (JA) is the ability to initiate social interaction with others and respond to bids for social interaction from others (Mundy & Newell, 2007). Initiating Joint Attention (IJA) and Responding to Joint Attention (RJA) may take on several forms: coordinated eye gaze, verbal engagement, and pointing (Gulsrud et al., 2014). This coordination of attention with a social partner is fundamental to developing language, learning abilities, and social competency (Mundy & Newell, 2007). JA skills impact language development in children with ASD; studies have found that JA is predictive of later language abilities (Charman, 2003). According to Carpenter et al. (1998), joint engagement interactions are social processes that facilitate language acquisition by creating a shared referential network between the child and adult. The link

between social meaning and language is the mechanism by which infants come to understand their social world (Racine & Carpendale, 2007).

Given the critical nature of JA skills, special educators, behavior analyst researchers, and practitioners have begun to use the science of behavior analysis to teach autistic children to initiate and respond to bids for JA. Using reinforcement and naturalistic learning procedures, autistic children can learn these pivotal behaviors, greatly enhancing their social competence, language and learning abilities and mitigating the development of problematic behaviors often inherent in children with minimal language (Carr & Durand, 1985).

This dissertation discusses gaps in the literature regarding social-communication interventions to improve JA skills for children with ASD. The two studies in this dissertation will extend the literature on JA interventions for children with ASD. The first study (Chapter II) is a systematic review of behavioral-based JA interventions identified in the current literature and assessed based on the Council for Exceptional Children's (CEC) standards for determining evidence-based practices in special education (Cook et al., 2014). The second study (Chapter III) is a single-case research design (SCRD) conducted to evaluate the effects of an intervention treatment package to teach autistic children to initiate eye contact. This study identified how educators and clinicians could use a language-based approach featuring a treatment package of differential reinforcement and time delay prompt procedure to teach this critical skill.

Throughout this manuscript, I will use identity-first (e.g., "autistic") and person-first language (e.g., "child with autism") interchangeably, given that many autistic self-advocates have demonstrated a preference for the former while respecting the alternative; acknowledging that there is no universally accepted terminology (Bottema-Beutel et al., 2021; Keating et al., 2022; Monk et al., 2022).

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2. TEACHING JOINT ATTENTION TO CHILDREN WITH AUTISM SPECTRUM DISORDER: A SYSTEMATIC REVIEW OF THE INTERVENTION LITERATURE

2.1 Joint Attention

Joint attention (JA) is the shared focus of two people on an object or "interesting event" (Dube et al., 2004) called the referent (Brim et al., 2009). JA is achieved when one individual directs the other to the object to gain, maintain, or shift the attention of the social partner. More specifically, JA requires social orientation and the coordination of attention between a social partner and objects in the social environment, entering a "shared-attention episode" (Stephenson et al., 2021). JA is recognized as one of the earliest forms of communication in young children (Mundy et al., 1994; Scaife & Bruner, 1975; Taylor & Hoch, 2008); the coordination of visual attention between two individuals serves as a referencing tool that uses shared gaze and gesture for communication. JA is a pre-linguistic skill critical for social or language acquisition, and cognitive development. JA behaviors emerge in the first six months of life and solidify around 18 months. Whereas neurotypical children develop verbal and nonverbal socio-communicative skills within the first two years, children with autism spectrum disorder (ASD) demonstrate impairments in social cognition (Tomasello, 1996) and development (Paparella & Freeman, 2015).

JA behavior is found to be atypical in autistic individuals. The absence of JA before the first year of age is one of the earliest indicators of ASD; compromised JA is a primary feature of this developmental disorder (Bruinsma et al., 2004). JA behaviors are one of the most noticeable and vital indicators of ASD (Baron-Cohen, 1991). Children screened positive for ASD demonstrate weak JA skills, engagement, and expressive language (Adamson et al., 2019).

According to the Diagnostic and Statistical Manual of Mental Disorders – V criteria for ASD, a child must have persistent deficits in three areas of social communication and social interaction: 1) deficits in social-emotional reciprocity, including reduced sharing of interests, emotions, or affect and failure to initiate or respond to social interactions; 2) deficits in nonverbal communicative behaviors used for social interaction, including abnormalities in eye contact and body language or deficits in understanding and use of gestures; and 3) deficits in developing, maintaining, and understanding relationships (American Psychiatric Association, 2013). The profound social deficits associated with ASD potentially originate with the atypical development of early JA behaviors (Baron-Cohen, 1991; McArthur & Adamson, 1996; Sigman & Kasari, 1995). JA impairments often result in missed experiences and opportunities to learn that are detrimental to social interactions (Mundy & Newell, 2007), empathy (Whalen & Schreibman, 2003), imitation (Bottema-Beutel, 2016), social coordination (Jording et al., 2019), social orientation (Dawson et al., 1998), learning (Jording et al., 2019), cognition (Tomasello, 1996), and survival (Jording et al., 2019).

Triadic coordination of attention (Charman, 2003) between the infant, social partner, and an object or event (Bakeman & Adamson, 1984) includes multiple behavioral topographies, including gaze, pointing and point following, and using vocal verbal behavior such as “look.” JA skills are associated with the development of language in autistic children (Brignell et al., 2018), including early spontaneous speech (Whalen & Schreibman, 2003) and subsequent complex language (Carpenter et al., 1998; Charman, 2003), as well as perspective taking and Theory of Mind (Baron-Cohen, 1991; Charman, 2003; Shaw et al., 2017). According to Bakeman and Adamson (1984), complex or symbolic language develops from early caregiver attention-sharing experiences. Approximately 25% to 30% of children with ASD either fail to develop functional

language or remain minimally verbal, highlighting the importance of teaching children to engage in this pivotal behavior (Brignell et al., 2018; Charman, 2003).

2.2 Responding to and Initiating Joint Attention

JA behaviors can be divided into two classes: responding to joint attention (RJA) bids and skills in initiating joint attention (IJA). RJA is the ability to follow the direction of other people's attention (sometimes referred to as "gaze following"), and IJA is the ability to spontaneously seek to direct the attention of others to share their experience of an object or event. Several studies have reported that children with ASD are impaireded in both RJA and IJA (Gillespie-Lynch, 2013; Meindl & Cannella-Malone, 2011; Shillingsburg et al., 2022). A distinction has been made between the functions of these two topographically similar behaviors. From a behavioral perspective, RJA functions as the social partner's request for the child's attention. IJA functions as the child's request for the social partner's attention or access to the referent. In this case, RJA is maintained by generalized reinforcement, meaning that these behaviors produce social approval. In contrast, IJA is maintained by specific reinforcement (Sundberg & Michael, 2001), meaning that the learner requests the specific object or activity they want. In this way, IJA benefits the speakers by producing access to desired reinforcers falling under the control of the establishing operation (Taylor & Hoch, 2008). The establishing operation, driven by the speaker's motivation, increases the reinforcing value of consequences (e.g., the listener directing their attention toward the referent), and the frequency of behaviors associated with consequences (Michael, 1993; Naoi et al., 2008). An example of IJA under the control of the establishing operation is a hungry child who sees a cookie on the table. Hunger has created motivation for the food, resulting in the child being more likely to request the cookie by IJA using words, gestures, or eye gaze.

2.3 Behavior Analytic Approach to Teaching Joint Attention

Using a language-based functional analytic approach grounded in the principles of behavioral analysis (Skinner, 1957), researchers have taught both RJA and IJA behaviors. RJA and IJA are socially mediated; language is a learned behavior under the functional control of environmental variables. The significance of teaching this prelinguistic skill through language training has far-reaching benefits for learners with ASD (Gulsrud et al., 2014; Jones et al., 2006); therefore, instructional procedures based on operant procedures to increase these behaviors should be included as part of children's behavioral interventions (Jones et al., 2006; Novak & Pelaez, 2011; Sigafoos et al., 2007; Taylor & Hoch, 2008).

Initially, JA research was influenced by psychological theories derived from developmental psychology literature (Dube et al., 2004). JA is believed to be a cognitive skill acquired along the developmental trajectory of early communication skills (Beuker et al., 2013). From a behavioral standpoint, developmental theories do not account for establishing and maintaining JA behaviors. Behavioral accounts consider the role of reinforcement and punishment in an individual's learning history (Skinner, 1966). The operant behaviors of IJA and RJA develop through the repeated presentation of specific consequences; behaviors paired with reinforcement are more likely to occur in the future, while behaviors paired with punishment are more likely to be avoided (Holth, 2005; Skinner, 1969). Operant behaviors are controlled by consequential events and are evoked by antecedent stimulus events (Pierce & Cheney, 2017; Staddon & Cerutti, 2003).

Dube et al. (2004) offered a contingency analysis of joint-attentional behaviors, including antecedent and consequent events, to determine the controlling variables of JA. Dube et al.'s (2004) analysis specified that IJA and RJA are behaviors shaped by social reinforcers in the form

of attention or access to the "interesting event" (Taylor & Hoch, 2008). Operant conditioning is the learning process that occurs through reinforcement and punishment; behaviors are strengthened or weakened based on the consequences of that behavior. Reinforcing stimuli that closely follow a behavior will increase the likelihood of that behavior occurring again. Reinforcement can further be classified as social, contrived, or characteristic. Social reinforcement is mediated through another individual (e.g., praise, high fives). Contrived contingencies are designed and implemented by practitioners to achieve the acquisition, maintenance, and generalization of a targeted behavior change (e.g., tokens; Cooper et al., 2019). With characteristic reinforcement, the specific stimulus identified by the child is delivered (Skinner, 1957).

Behavioral research that followed Dube et al.'s (2004) foundational work included play-based interventions (Goods et al., 2013; Kasari et al., 2006; Zercher et al., 2001), imitation training interventions (Ingersoll & Schreibman, 2006; Tiegerman & Primavera, 1984); discrete trial training (Rocha et al., 2007; Whalen & Schreibman, 2003), peer-led training (Pierce & Schreibman, 1995; Zercher et al., 2001), and pivotal response training (Koegel & Frea, 1993; Vismara & Lyons, 2007), or a combination of these technologies. Other researchers used contrived prompts, including scripts (Pollard et al., 2012; Taylor & Hoch, 2008), modeling (Jones, 2009; Naoi et al., 2008), physical (Martins & Harris, 2006; Taylor & Hoch, 2008), and echoic prompts (Taylor & Hoch, 2008).

Meindl and Cannella-Malone (2011) conducted a literature review on IJA and RJA in children with ASD to identify interventions to teach autistic children these skills. The review described the behavioral principles used to teach JA, how the researched measured JA, and which procedures were used. In addition, they sought to understand if IJA and RJA were taught

simultaneously or separately and to determine the relative study outcomes and whether the programmed consequences were social, characteristic, or contrived.

There were several primary findings in this systematic review. Meindl and Cannella-Malone (2011) identified that although IJA and RJA are two separate skills that develop differently and have distinct functions; RJA is maintained by social attention and IJA is maintained by access to tangible consequences. Although these skills function differently, many of the studies that they analyzed did not specify whether the consequent stimuli delivered were social or nonsocial, a critical consideration due to the nature of operant learning, which asserts that all behaviors are controlled by consequences. The authors also reported that because RJA and IJA are distinct skills, they may require separate interventions. Future research teaching RJA and IJA through natural interventions maintained by their respective functions. Research that featured social attention as the maintaining consequence should ensure that the function of the participant's JA behavior is to coordinate attention to the attending stimulus, or referent. Teaching RJA alone was not found to increase IJA, but there is some evidence that IJA instruction can increase RJA without explicit training. Additional findings on RJA intervention assert that this skill can be developed as a collateral benefit of imitation training, a typical early intervention procedure for autistic children. Limitations reported by Meindl and Cannella-Malone (2011) included publication bias, which often favors studies that demonstrate positive results (Scheel et al., 2021); therefore, the systematic review may not represent studies resulting in negative or null findings.

2.4 Purpose of this Review

Given the essential role that JA plays in the development and language of children with ASD and the relative dearth of research in the behavior analytic literature, the purpose of the

current study was to extend the systematic review by Meindl and Cannella-Malone (2011) to include studies from 2011 to the present. This systematic literature review and quality indicator (QI) analysis aimed to identify how contemporary researchers have developed and implemented interventions to teach JA to children with autism. Specifically, this review sought to determine which form(s) of JA were taught and with which strategies and the effectiveness of the intervention procedures. White et al. (2011) recommended that the topography of JA skills selected for intervention must be supported in the child's natural environment(s) and should consider developmental and cultural norms. The reviewers also wanted to investigate the types of reinforcements or consequences used in the study: if the JA behavior was reinforced by social (e.g., praise, high fives) or contrived (e.g., a stimulus deliberately arranged to modify a behavior) stimuli, or if the reinforcement was characteristic (e.g., the stimulus reinforcer delivered was specified by the child; Brady et al., 1995; Skinner, 1957).

2.4.1 Research Questions

This review aims to answer the following research questions:

Research Question 1: What interventions are used to teach JA?

Research Question 2: What are the context and characteristics of autistic children included in these studies?

Research Question 3: Are researchers teaching RJA and IJA in isolation or conjunction?

Research Question 4: How are researchers measuring the dependent variable(s)?

Research Question 5: Are reinforcement contingencies social, contrived, or characteristic?

Research Question 6: What are the results of these JA interventions?

Research Question 7: Are collateral, unplanned behavior change gains reported and measured?

Research Question 8: Do any instructional strategies meet the criteria for an evidence-based practice using the Council for Exceptional Children (CEC) standards for evidence-based practices in special education (Cook et al., 2014)?

2.5 Method

Guidelines for special education systematic reviews, as described by Talbott et al. (2017), were followed to conduct this review. The PRISMA (Page et al., 2021) flow diagram was used to report how studies were selected. See Figure 2.1 for the PRISMA flow chart of the search at each stage.

2.5.1 Eligibility criteria

To be included in this review, all articles needed to meet the following criteria:
1) An intervention was implemented in the study. The intervention was behavioral in nature and based on the principles of behavior analysis. Studies that included only descriptions, analyses, or assessments of JA interventions were excluded; 2) interventions must have included JA as a dependent variable. If initiating and responding to JA were measured as the independent variable and was manipulated by the researchers (e.g., Cooper et al., 2019), the article was included; 3) interventions were implemented in a way that allowed for the demonstration of experimental control (i.e., experimental, quasi-experimental, or single-subject research designs). Studies that used a case study solely were excluded; 4) studies included at least one autistic individual; 5) articles were published in peer-reviewed journals between January 2010 and February 2023; 6) articles were assessed according to CEC's standards for evidence-based practices in special education.

Articles that met the following exclusionary criteria were not included in this review:

1) non-experimental: single case research design (SCRD), quantitative, quasi-experimental, SMART, regression discontinuity design with experimental control; 2) was published before January 2010; 3) did not include at least one individual with autism spectrum disorder; 4) was not in English; 5) did not include JA as the primary dependent variable.

2.5.2 Search Procedures

This literature review is an extension of "Initiating and responding to joint attention bids in children with autism: A review of the literature" by Meindl and Cannella-Malone (2011), a review of articles published between 2000 and 2009. Therefore, the search from all databases for the current study was limited to documents in English and published in peer-reviewed journals between January 2010 and 2023. See Table 2.1 for a comparison of the Meindl and Cannella-Malone (2011) review and the current study.

I conducted systematic searches in four electronic databases: Education Resources Information Center (ERIC), PsycINFO, Proquest Dissertations and Theses Global, Education Source, and Academic Search Ultimate. The terms ‘‘joint attention’’ and ‘‘autism’’ were inserted into the search fields. All papers were screened through the full-text stage, followed by an ancestral and progeny search of all remaining documents. The abstracts of the resulting studies were reviewed to identify studies that meet the inclusion criteria.

Using the search engine, for concept one, I searched under subject headings using the following keywords: "autism," "autism spectrum disorder." Under title/abstract, I used the following keywords: "Autism spectrum disorder*" OR "autism." For concept two, I searched under subject headings using the following keywords: "joint attention." Under title/abstract, I used the following keywords: "joint attention". For concept three, I searched under subject headings using the following keywords: "behavioral interventions," "applied behavior analysis,"

OR “behavior modification.” Under title/abstract, I used the following keywords: “applied behavior analysis” OR “behavior modification” OR “behavioral intervention*”

2.5.3 Screening

All articles were screened through Covidence (https://www.covidence.org/), an online tool that assesses references at the title/abstract and full-text level. Following Covidence screening, ancestral and progeny searches were conducted to identify relevant studies. An ancestral search was conducted by hand screening the reference lists of all articles that met the inclusion criteria (Cumming et al., 2023). Finally, a progeny search was conducted by identifying the original articles (i.e., parent studies) and then retrieving all articles that referenced the parent articles (i.e., child studies; Jones et al., 2010; Therrien et al., 2016). This resulted in the inclusion of a total of 15 studies.

2.5.4 Variables under study

I collected information on and investigated the following variables: participants, interventionists, setting descriptions, dependent and independent variables, research designs, measurement, type of reinforcement, results, and ancillary gains measured.

2.5.5 Data Extraction and Coding

Articles were coded for the following variables: participant (e.g., child with ASD receiving behavior analytic intervention) including the number of participants and ages, interventionist (e.g., researcher, parent, behavior clinician, peer, educator, etc.), and setting descriptions (e.g., school, home, clinic, community). I also coded for research design (e.g., SCRD, group design), independent variable(s) (e.g., intervention(s)), dependent variable (e.g., type of JA measured), results, and findings. Finally, I coded the type of reinforcement delivered for the target responses; social, contrived, or characteristic. Results were coded as positive,

mixed, or negative according to guidelines created in the systematic review by White et al. (2011). For SCRD studies, "positive" was coded when all the participants demonstrated increases in JA behavior, "mixed" indicated that some of the participants demonstrated increases in JA, and "negative" represented studies that found no positive changes in JA. For group designs, "positive" indicated positive statistically significant differences in treatment effect, and "no difference" denoted no differences reported between treatments or between treatment and control. Only the treatment that yielded positive results was listed in studies comparing treatments. Ancillary gains measured represented collateral effects of teaching JA that were measured and reported by researchers. See Table 2.2 for the definitions of the variables coded for this study.

2.5.6 Quality Indicators Analysis

The researcher used the CEC Standards for Evidence-Based Practices in Special Education Quality Indicator (QI) criteria (Cook et al., 2014) to determine the quality of research and whether a practice was deemed evidence-based (Gersten et al., 2005; Horner et al., 2005). In 2014, the CEC published specific guidelines for identifying evidence-based practices, including Qis for determining methodological rigor and whether there was sufficient support to deem the practices evidence-based (Cook et al., 2014). The CEC Evidence-Based Practices Standards include 28 total Qis that evaluate (a) context and setting, (b) participants, (c) intervention agents, (d) description of practice, € implementation fidelity, (f) internal validity, (g) outcome measures/dependent variables, and (h) data analysis.

2.6 Results

2.6.1 Research Participants

All studies included autistic children (number of children ranged from 3-179; ages 20 months-14 years). Shih and colleagues (2021) also included five children with diagnoses in addition to autism spectrum disorder, including cerebral atrophy, language delays, and global developmental delays. Across all studies, the children's genders appeared to be predominantly male (M= 302; F=98), and four studies did not specify the gender breakdown.

2.6.2 Interventionists

The interventionists in the studies included teachers (Engelstad et al., 2020; Kaale et al., 2012; Kryzak & Jones, 2015; Lawton & Kasari, 2012; Shih et al., 2021; Spjut Janson et al., 2022); instructional assistants (Engelstad et al., 2020; Shih et al., 2021); parents (Frolli et al., 2021; Kryzak & Jones, 2015), ABA front-line workers (Jones, 2022), therapists (Kourassanis-Velasquez & Jones, 2018; Shillingsburg et al., 2022), licensed clinical psychologists and licensed dance/movement interventionist (Chiang et al., 2015), intervention coordinators (Schertz et al., 2013), trained supervisors (Spjut Janson et al., 2022), and researchers (Ferraioli & Harris, 2011; Hansen et al., 2022; Kourassanis-Velasquez & Jones, 2018; Kryzak et al., 2013; Kryzak & Jones, 2015).

2.6.3 Setting Description

The interventions took place in a variety of settings, including: schools (Chiang et al., 2015; Engelstad et al., 2020; Frolli et al., 2021; Hansen et al., 2022; Kaale et al., 2012; Kryzak et al., 2013; Kryzak & Jones, 2015; Lawton & Kasari, 2012; Shih et al., 2021; Shillingsburg et al., 2022; Spjut Janson et al., 2022), homes (Ferraioli & Harris, 2011; Frolli et al., 2021; Kourassanis-Velasquez & Jones, 2018; Kryzak et al., 2013; Schertz et al., 2013), community

(Shih et al., 2021), hospital-based program (Chiang et al., 2015), private service (Chiang et al., 2015), ABA centers (Kourassanis-Velasquez & Jones, 2018), and a therapeutic farm (Jones, 2022).

2.6.4 Dependent variables

IJA was the dependent variable in studies by Engelstad et al. (2020), Hansen et al. (2022), Kaale et al. (2012), Kourassanis-Velasquez and Jones (2018), Kryzak and Jones (2015), Lawton and Kasari (2012), Shih et al. (2021), Shillingsburg et al. (2022), and Spjut Janson et al. (2022). Kryzak et al. (2013) taught children RJA behaviors, and both IJA and RJA were targeted for behavior change in studies by Ferraioli and Harris (2011), Frolli et al. (2021), and Schertz et al. (2013). The specific topographies taught by researchers Chiang et al. (2015) and Jones (2022) were not specified.

2.6.5 Research design

Several studies included SCRD, including multiple probe designs across participants (Ferraioli & Harris, 2011; Kourassanis-Velasquez & Jones, 2018; Kryzak et al., 2013; Kryzak & Jones, 2015). Research by Shillingsburg et al. (2022) featured a non-concurrent multiple baseline across participants design, and Hansen et al. (2022) a multiple baseline across child-peer dyads.

Engelstad et al. (2020), Kaale et al. (2012), Lawton and Kasari (2012), Schertz et al. (2013), Shih et al. (2021), and Spjut Janson et al. (2022) used randomized control trials. Frolli et al. (2021) featured a quasi-experimental design, and a random crossover experimental design was used by Jones (2022).

2.6.6 Independent variables

Interventions used in the included studies were Early Achievements for Education Settings a teacher-implemented naturalistic socio-communicative focused intervention for

preschool autistic children (Engelstad et al., 2020). Several family-mediated interventions were featured, including the Joint Attention Mediated Learning Intervention (Schertz et al., 2013), a parent-guided intervention designed to teach socio-communication skills to pre-verbal toddlers; Frolli et al. (2021) implemented applied behavior analysis (ABA) combined with parental training focused on Parental Reflexive Functions. The Parental Reflexive Functions is an intervention that focuses on the teaching the caregiver to reflect on their and their child's internal mental experiences, an intervention aimed at developing social cognition in their children. Chiang et al. (2015) used caregiver-mediated intervention with body movement play while Hansen et al. (2022).

Several studies used interventions based on ABA; Ferraioli and Harris (2011) taught participants RJA and IJA behaviors using pivotal response training and discrete trial training. Pivotal response training is a play-based behavioral treatment for autism, the goals of which are the increase of positive social behaviors and language skills (Koegel & Frea, 1993). Discrete trial training, a structured ABA technique breaks down skills into small "discrete" components, and systematically teaches the components using reinforcement. Three researchers used the Joint Attention Symbolic Play Engagement Regulation (JASPER; Kasari, 2022) protocol (Kaale et al., 2012; Lawton & Kasari, 2012; Shih et al., 2021), a play-based intervention that teaches JA, symbolic play, engagement, and regulation (Kasari, 2022).

Kourassanis-Velasquez and Jones (2018) taught peers to facilitate an intervention package including instructions, modeling, role play, and feedback to children with ASD. Two studies featured researchers teaching JA through circumscribed interest activities (Kryzak et al., 2013; Kryzak & Jones, 2015); incorporating restricted interests inherent in autism to increase JA with participants. Shillingsburg et al., (2022) taught IJA using a treatment package of script

fading, graduated guidance, and echoic prompting, in which researchers physically guided the child to approach their peer and repeat a verbal script such as “Hey, [Name], look at my toy!”. Spjut Janson and colleagues (2022) taught JA through the Be Imitated strategy. The “Being Imitated” procedure is a strategy in which the child’s actions are imitated by a social partner as a strategy to increase social engagement (Contaldo et al., 2016). Jones (2022) taught JA through Equine Assisted Therapy in conjunction with Applied Behavior Analysis (Jones, 2022). Equine Assisted Therapy entails children riding trained horses, a practice with reported benefits including improved cognitive skills, emotional regulation, and behavioral skills, including socio-communiction for children with ASD.

2.6.7 Measurement

Engelstad et al. (2020) and Shih et al. (2021) recorded JA behavior through frequency measures. Ferraioli and Harris (2011), Hansen et al. (2022), Kourassanis-Velasquez and Jones (2018), Kryzak et al. (2013), Kryzak and Jones (2015), and Shillingsburg et al. (2022) measured percentage of correct JA responses. Jones (2022) measured responses to six prompts throughout the session, and Shih et al. (2021) took whole interval recording data of joint engagement.

Scores to standardized tests and questionnaires were recorded and analyzed by several researchers to measure the effects of the IV on JA behaviors. Frolli et al. (2021) measured IJA behavior by the Early Social-Communication Scales (ESCS; Mundy et al., 2003), Parental Reflective Function Questionnaire (PRFQ; Luyten et al., 2017), and Vineland Adaptive Behavior Scales -III pre/post-test scores (Sparrow et al., 2016). The Mullen Scales of Early Learning Scores (Mullen, 1995) was used by Shih and colleagues (2021). Jones (2022) used the Assessment of Basic Learning and Language Skills (ABLLS-R; Partington, 2010) and the Assessment of Joint Attention in school-age children and adolescents (Bean & Eigsti, 2012). The

Early Achievements for Education Settings (EA-ES; Engelstad et al., 2020) was used by researchers Chiang et al. (2015), Kaale et al. (2012), Lawton and Kasari (2012), Schertz et al. (2013), and Spjut Janson et al. (2022) used the Precursors of Joint Attention Measure (Schertz, 2005).

2.6.8 Reinforcement

JA behavior was reinforced by social consequences in studies by Hansen et al. (2022), Kaale et al. (2012), Kourassanis-Velasquez and Jones (2018), Kryzak et al. (2013), and Kryzak and Jones (2015). Characteristic reinforcement was delivered by Shillingsburg et al. (2022). Engelstad et al. (2020) provided both social and characteristic reinforcement. Ferraioli and Harris (2011) provided both social and contrived reinforcement. Studies by Chiang et al. (2015), Frolli et al. (2021), Jones (2022), Lawton and Kasari (2012), Schertz et al. (2013), Shih et al. (2021) and Spjut Janson et al. (2022) did not specify the stimulus consequence delivered to children in their studies.

2.6.9 Individual Study Outcomes

Thirteen out of the 15 studies reported positive results (Engelstad et al., 2020; Chiang et al., 2015; Frolli et al., 2021; Hansen et al., 2022; Kaale et al., 2012; Kourassanis-Velasquez & Jones, 2018; Kryzak et al., 2013; Kryzak & Jones, 2015; Lawton & Kasari, 2012; Schertz et al., 2013; Shih et al., 2021; Shillingsburg et al., 2022; Spjut Janson et al., 2022) demonstrating that interventions based on behavior analysis can successfully teach JA skills to autistic children. Ferraioli and Harris (2011) reported mixed results, and Jones (2022) found no differences between treatments.

2.6.10 Ancillary Gains Measured

A variety of collateral or ancillary behaviors were reported by researchers, including directed gestures, spontaneous verbalizations, decrease in unengaged states, imitation, social functioning, social interaction, and expressive and receptive language studied by Engelstad et al. (2020), Chiang et al. (2015), Ferraioli and Harris (2011), Jones (2022), Kryzak et al. (2013), Shih et al. (2021), respectively. RJA behavior was reported to have been acquired without direct training in several studies (Kourassanis-Velasquez & Jones, 2018; Kryzak & Jones, 2015; Shillingsburg et al., 2022). Several other studies did not report or measure any additional untrained behaviors gained (Frolli et al., 2021; Hansen et al., 2022; Kaale et al., 2012; Lawton & Kasari, 2012; Schertz et al., 2013; Spjut Janson et al., 2022). See Table 2.3 for a Summary of JA Interventions from 2010-2023

2.7 Intercoder Agreement for Study Identification and Coding

Intercoder agreement was calculated by dividing the number of agreements by the number of disagreements plus agreements and multiplying by 100. Interrater agreement indices assess the extent to which the responses of two or more independent raters concur (Gisev et al., 2013). A sample of approximately 5% of studies at each stage of the coding was initially compared between the two coders to detect coding disagreement early on. Because the agreement was high (i.e., 90% or greater), we continued with the remaining studies planned for intercoder reliability. If coding was below 90%, we continued with an additional 5% of studies before completing the remaining coding. This was needed during the title and abstract review, with one additional 5% coded. Intercoder reliability was conducted at each stage of study identification and variable coding: 1) title/abstract review of 33% (n = 16) of all studies retrieved from database resulting in 80% agreement followed by 100% agreement after discussion of the

title and abstracts, 2) full text review of 27% (n = 3) of potentially relevant studies resulted in 100% initial agreement, 3) intercoder reliability of the CEC coding for 27% (n = 4; this number is higher due to the additional studies identified through the ancestry and progeny searches) of all relevant studies (i.e., meeting all inclusion criteria except CEC review) resulting in 87% agreement of an item by item analysis within the codes, and 4) variable coding of all included studies 27% (n = 4) resulted in 90% agreement followed by 100% agreement after discussion of the variables identified through disagreement.

2.8 Quality Indicator Analysis

To assess the quality of the reviewed studies, they were each coded as "meeting" or "not meeting" each of the eight QI categories based on the CEC Standards for Evidence-Based Practices in Special Education (Cook et al., 2014). The categories assessed included context and setting, participants, intervention agent, description of practice, implementation fidelity, internal validity, outcome measures/dependent variables, and data analysis (Council for Exceptional Children; Cook et al., 2014).

Seven of the 15 articles analyzed met all 28 of the CEC Qis for methodologically sound research in group and SCRDs. Thirteen of the articles met the criteria for QI critical features of the context or setting described. Ten met the QI criteria for describing participant demographics, and 14 for disability or risk status adequately described. Fourteen studies met the QI for describing the role of the intervention agent described, and 11 described specific training for interventionists. Detailed intervention procedures were sufficiently described in 11 studies; all 15 met the criteria for describing study materials as required by CEC standards. Twelve met QI for reporting and assessing the adherence to protocol, and all but one met the QI for evaluating and reporting adequate dosage or exposure to the intervention.

Assessment and reporting of fidelity of intervention implementation were met by 11 studies as required by the CEC standards. All studies controlled and systematically manipulated the independent variable, and 13 sufficiently described baseline or control/comparison conditions. In every study, participants had limited access to the intervention in comparison or baseline condition. Outcomes were socially important in all studies, as reported, and all but one clearly defined and described the measurement of the dependent variables. However, one study reported all effects of the intervention, not just those for which a positive result was found. The frequency and timing of outcome measures were appropriate in all studies, and 12 studies provided evidence of adequate internal reliability.

Some criteria were only applicable to group designs, while others were only for single-case research designs. In all nine group designs, the study clearly described assignments to groups, and attrition was low across groups and was controlled for by adjusting for non-completers. The QI that described the study providing adequate evidence of validity, such as content, construct, and criterion, were met by six. All met the requirements for analysis techniques appropriate for comparing the change in performance of two or more groups. Eight studies reported one or more appropriate effect-size statistics or provided data from which appropriate Ess can be calculated.

All six SCRD studies provided at least three demonstrations of experimental effects at three different times. In five studies, controls for common threats to internal validity were implemented, and the design controlled for common threats to internal validity criteria. All SCRD studies met the following criteria: Graph clearly represented outcome data across all study phases for each unit of analysis met by all SCRDs. See Table 2.4 for CEC QI Analysis and the

Council for Exceptional Children (Cook et al., 2014) Standards for Evidence-Based Practices in Special Education for a complete description of each QI category.

2.9 Discussion

JA plays an important role in the development of foundational social and language skills and is thought to be a critical prerequisite to the development of social cusps (Pelaez & Novak, 2013). Early assessment and detection of JA weakness can promote behavioral interventions to increase JA in children with autism, leading to gains in functional language and social skills. RJA and IJA skills are shaped through social contact; the behavior is established and maintained by the attention of others in the form of sharing an experience or a verbal exchange (Greer & Du, 2015). Understanding the stimulus change following a JA exchange is critical for creating function-based interventions that use the naturally occurring reinforcers to shape and maintain the specific topography of JA.

The purpose of this review was to extend and address the limitations of efforts by prior researchers Meindl and Cannella-Malone (2011) to review contemporary research on behavioral practices for teaching JA skills to autistic children by examining high-quality research. Of the 15 studies that featured strategies for teaching IJA and RJA published between January 2010 and February 2023 (n = 15) seven met all Qis to meet criteria as methodologically sound research.

This underdeveloped body of research that facilitates identifying cogent interventions for teaching JA to autistic children signals the need for more rigorous, high-quality research in this area. JA is a requisite skill that engenders language, social, and behavioral development, the lack of which has been correlated with deficits in language, social aptitude, and ultimately quality of life (Montagut-Asunción et al., 2022). The implications for promoting JA for children with ASD are vast. Given the critical nature of these behavioral deficits, researchers, behavior analysts and

teachers must continue identifying effective procedures for JA interventions by replicating current literature, strengthening the evidence for such systems, and identifying new approaches.

2.10 Limitations and Future Research

Through the analysis of behavioral-based interventions with scientific evidence of improving JA outcomes of children with ASD, researchers can continue developing evidence-based rigorous technologies to increase these skills with far-reaching benefits to autistic children. As analyzed in this review, researchers should be mindful of using natural contingencies of reinforcement for JA interventions; social and characteristic reinforcement should be provided following target responses in lieu of delivering contrived stimuli.

A limitation of this review is that the search terms may have been too narrow, searching for interventions that were "behavioral in nature" may have limited appropriate articles for review. Expanding the search terms to "educational in nature" could result in a wider scope of contemporary research for analysis. Another limitation of note is that the researcher excluded papers in which JA was not the primary variable. An analysis of interventions in which JA was taught in conjunction with other skills, such as imitation, eye contact, social referencing, play, turn-taking, and visual-perception may yield more results for investigation.

Future research is needed to assess for generality of JA to the child's natural environments with natural behavior change agents. A major goal of behavioral intervention is to ensure that taught behaviors are durable and demonstrated outside training conditions. The extent to which generalization was exhibited and if the skills are maintained post-intervention by research participants was not examined by either Meindl and Cannella-Malone (2011), nor the current researchers.

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Table 2.1 Comparison of Coding Variables

Study	
Meindl and Cannella-Malone, 2011	Georgio et al., 2023
Authors	Authors
Year	Year
Participants (n)	Participants (n)
Participant ages	Participant ages
N/A	Participant(gender)
Participant diagnosis	N/A
N/A	Setting descriptions
Dependent variable: Joint attention behavior	Dependent variable: Joint attention behavior
N/A	Research design
Independent variable: Procedures	Independent variable: Procedures
Measurement	Measurement
Reinforcement (social, nonsocial)	Reinforcement (characteristic, social, contrived)
Results: Outcomes/PND per participant	Results: Outcomes (Positive, Mixed, or Negative)
N/A	Findings
N/A	Ancillary Gains Measured

Table 2.2 Definitions of coding variables.

Variable	Definition
Participant	These variables examined the age, gender, and number of participants who received the joint attention intervention(s)
Interventionist	This variable examined who worked directly with the students to implement the intervention and were coded as teachers, researchers, behavior clinicians, parents, or others
Setting Descriptions	This variable examined the setting which the intervention was conducted. The setting descriptions were coded as home, school, clinic, community, or others
Dependent Variable	This variable examined the behaviors targeted for change
Research Design	This variable examined whether the research design was a group or single-case experimental design (SCRD). If the study was a SCRD, the variable was further broken down as to the type of or combination of SCRDs
Independent Variable	This variable examined the intervention(s) that were used to make a change on the target behavior (dependent variable)
Measurement	This variable examined the dimension of behavior measurement scale used to measure the target dependent variable
Reinforcement	This variable examined whether reinforcement for the targeted JA behavior(s) were characteristic (reinforced by the specific item or referent, social (praise or other socially mediated stimulus delivered or removed), or contrived (an additional stimulus added or removed)
Results	This variable examined whether the intervention(s) had a positive or negative effect on the dependent variable
Ancillary Gains Measured	This variable describes the measurement of additional or collateral behaviors resulting from the JA interventions applied

Table 2.3 Summary of Joint Attention Interventions (2010-2023).

	Study				
Authors	n	Age(s)	Gender	Interventionist	Setting
Engelstad et al., 2020	43	36-60 months	9 male, 6 female	Teachers, instructional assistants	Classrooms
Chiang et al., 2016	34	2-4 years	Not specified	Licensed clinical psychologists, licensed dance movement interventionist	Hospital-based program, preschool, private service
Ferraioli and Harris, 2011	4	3-5 years	3 male, 1 female	Researcher	Homes
Frolli et al., 2021	84	20-30 months	64 males, 20 females	Parents	Home, school
Hansen et al., 2022	3	4 years	males	Researcher	Preschool
Jones, 2022	21	3-10 years	16 males, 5 females	ABA front-line workers	Therapeutic farm
Kaale et al., 2012	68	29-60 months	41 males, 27 females	Pre-school teachers	Preschool
Kourassanis-Velasquez and Jones, 2018	3	6-10 years	2 males, 1 female	Researcher, therapists	Homes, ABA center
Kryzak and Jones, 2015	3	2-8 years	males	Researchers, teachers, mother	School
Kryzak et al., 2013	3	3-14 years	males	Researchers	Classroom, home
Lawton and Kasari, 2012	16	3-5 years	Not specified	Teachers	Preschool
Schertz et al., 2013	23	Under 30 months	Not specified	Intervention coordinators	Home
Shih et al., 2021	179	2-5 years	Approximately 143 male, 36 female	Teachers, teaching assistants	Community, school
Shillingsburg et al., 2022	2	63-85 months	Not specified	Therapists	School
Spjut Janson et al., 2022	15	24–48 months	14 males, 2 females	Teachers, trained supervisor	School

Table 2.3 Continued Summary of Joint Attention Interventions (2010-2023).

	Study						
Author	DV	Research design	IV(s)	Measurement	Reinforcement	Results	Ancillary gains
Engelstad et al., 2020	IJA	RCT	EA-ES	Frequency of IJA	Social, characteristic	Positive	Directed gestures, spontaneous verbalizations
Chiang et al., 2016	Not specified	Quasi-experimental	Caregiver-mediated intervention with body movement play	EA-ES	Not specified	Positive	Decrease in unengaged states
Ferraioli and Harris, 2011	RJA, IJA	MP Across Participants	DTT; PRT	Percentage of IJA/RJA	Social, contrived	Mixed	Imitation
Frolli et al., 2021	RJA, IJA	Quasi-experimental	ABLLS-R; EA-ES; ESCS; JAML; JASPER; Mullen Scales of Early Learning Scores; PRFQ; Precursors of Joint Attention Measure, Vineland Adaptive Behavior Scales -III	ESCS; PRFQ; Vineland Adaptive Behavior pre/post test scores	Not specified	Positive	Not specified
Hansen et al., 2022	IJA	MBL across child-peer dyads	Peer training	Percentage RJA	Social	Positive	Not specified
Jones, 2022	Not specified	Random crossover experimental design	Equine Assisted Therapy and ABA	Six prompts throughout the session, ABLLS-R Social Interaction subtest, Assessment of joint attention in school-age children and adolescents	Not specified	No difference	Social functioning
Kaale et al., 2012	IJA	RCT	JASPER	EA-ES	Social	Positive	Not specified

Table 2.3 Continued Summary of Joint Attention Interventions (2010-2023).

	Study						
Author	DV	Research design	IV(s)	Measurement	Reinforcement	Results	Ancillary gains
Kourassanis-Velasquez and Jones, 2018	IJA	MP Across Participants	Peer training	Percentage IJA	Social	Positive	RJA
Kryzak and Jones, 2015	IJA	MP Across Participants	Circumscribed interest activities	Percentage IJA	Social	Positive	RJA
Kryzak et al., 2013	RJA	MP Across Participants	Circumscribed interest activities	Percentage RJA	Social	Positive	Social interaction
Lawton and Kasari, 2012	IJA	RCT	JASPER	EA-ES	Not specified	Positive	Not specified
Schertz et al., 2013	RJA, JA	RCT	JAML	Precursors of Joint Attention Measure	Not specified	Positive	Not specified
Shih et al., 2021	IJA	Two RCTs	JASPER	Mullen Scales of Early Learning Scores, Frequency of spontaneous IJA, whole interval recording of joint engagement	Not specified	Positive	Expressive and receptive language
Shillingsburg et al., 2022	IJA	Non-concurrent MBL across participants	Script fading, graduated guidance, and echoic prompting	Percentage IJA	Characteristic	Positive	RJA
Spjut Janson et al., 2022	IJA	RCT	Being imitated strategy	EA-ES	Not specified	Positive	Not specified

Note: Abbreviations: ABA: Applied Behavior Analysis; DTT: Discrete Trial Training; IJA: Initiating Joint Attention; MBL: Multiple Baseline Design; MP: Multiple Probe Design; PRT: Pivotal Response Training; RCT: Randomized Control Trial; RJA: Responding to Joint Attention

Assessments and Intervention Protocols: Assessment of Basic Learning and Language Skills (ABLLS-R; Partington, 2010); Assessment of joint attention in school-age children and adolescents (Bean & Eigsti, 2012); Early Achievements for Education Settings (EA-ES; Engelstad et al., 2020); Joint Attention Mediated Learning (JAML; Schertz et al., 2013) Joint Attention Symbolic Play Engagement Regulation (JASPER; Kasari et al., 2022); Mullen Scales of Early Learning Scores (Mullen, 1995); Parental Reflective Function Questionnaire (PRFQ; Luyten et al., 2017); Precursors of Joint Attention Measure (Schertz, 2005); Vineland Adaptive Behavior Scales -III (Sparrow et al., 2016)

Table 2.4 CEC Quality Indicator Analysis for Joint Attention Literature (2010-2023).

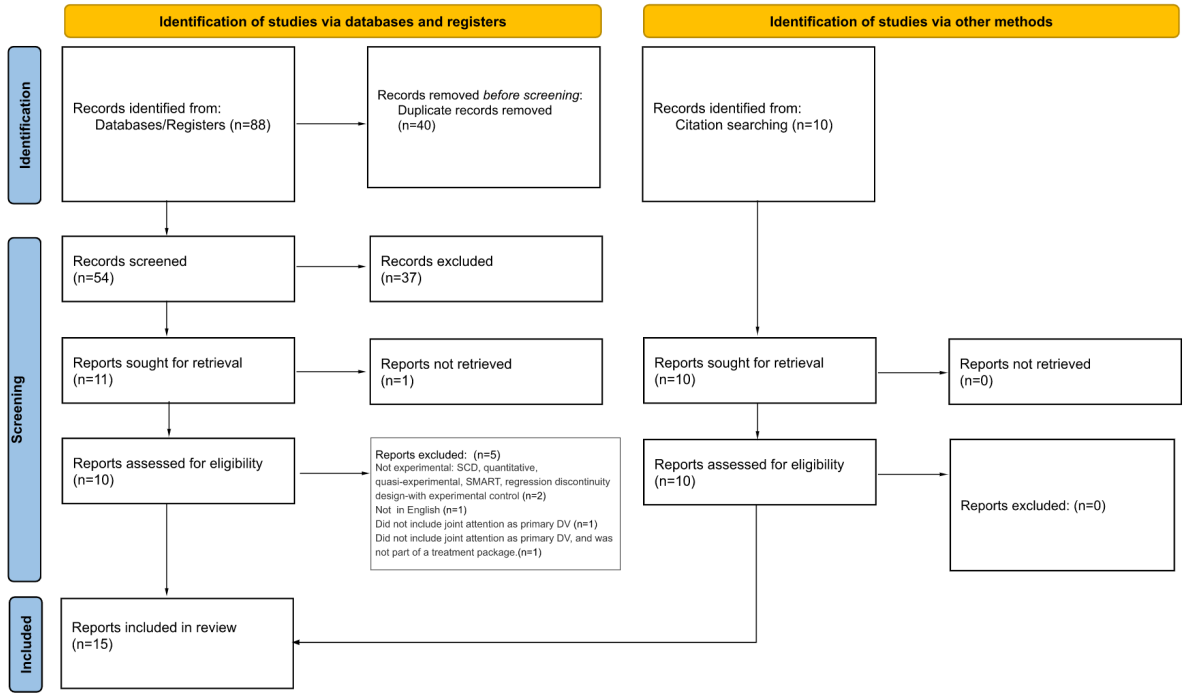
	Study														
	Engelstad et al., 2020	Chiang et al., 2016	Ferraioli and Harris, 2011	Frolli et al., 2021	Hansen et al., 2022	Jones, 2022	Kaale et al., 2012	Kourassanis-Velasquez, 2019	Kryzak and Jones, 2015	Kryzak et al., 2013	Lawton and Kasari, 2012	Schertz et al., 2013	Shih et al., 2021	Shillingsburg et al., 2022	Spjut Janson et al., 2022
Study Type (Group = G; SCRD = S)	G	G	S	G	S	G	G	S	S	S	G	G	G	S	G
Context and Setting															
1.1 Critical features of the context or setting described	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y
Participants															
2.1 Participant demographics described	Y	N	Y	N	Y	N	Y	Y	Y	N	Y	N	Y	Y	Y
2.2 Disability or risk status described	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Intervention agent															
3.1 Role of the intervention agent described	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
3.2 Specific training described	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y
Description of practice															
4.1 Detailed intervention procedures described	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	Y	Y	N	Y
4.2 Study materials described	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Implementation fidelity															
5.1 Adherence to protocol assessed and reported	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y
5.2 Dosage or exposure to IV assessed and reported	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
5.3 Fidelity IV implementation thoroughly assessed and reported	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	N	N	Y

Table 2.4 Continued CEC Quality Indicator Analysis for Joint Attention Literature (2010-2023).

	Study														
	Engelstad et al., 2020	Chiang et al., 2016	Ferraioli and Harris, 2011	Frolli et al., 2021	Hansen et al., 2022	Jones, 2022	Kaale et al., 2012	Kourassanis-Velasquez, 2019	Kryzak and Jones, 2015	Kryzak et al., 2013	Lawton and Kasari, 2012	Schertz et al., 2013	Shih et al., 2021	Shillingsburg et al., 2022	Spjut Janson et al., 2022
Internal validity															
6.1 The research controls and systematically manipulates the independent variable	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.2 The study describes baseline (single-subject studies) or control/comparison (group comparison studies) conditions	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y
6.3 Control comparison-condition or baseline-condition participants have no or extremely limited access to the IV	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6.4 The study clearly describes assignment to groups*		Y	Y		Y		Y	Y				Y	Y	Y	Y
6.5 The design provides at least three demonstrations of experimental effects at three different times**				Y		Y	Y		Y	Y	Y				
6.6 SSRD with a baseline phase, all baseline phases include at least three data points (except when fewer are justified)**				Y		Y			Y	Y	Y				
6.7 The design controls for common threats to internal validity**				Y		Y			Y	Y	N				
6.8 Overall attrition is low across groups (e.g., <30% in a 1-year study)*		Y	Y		Y		Y	Y				Y	Y	Y	Y
6.9 Differential attrition (between groups) is low (e.g., ≤10%) or is controlled for by adjusting for non-completers*		Y	Y		Y		Y	Y				Y	Y	Y	Y
Outcome measures/Dependent variables															
7.1 Outcomes are socially important		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.2 The study clearly defines and describes measurement of the DVs		Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.3 This study reports the effects of the IV, not just those for which a positive effect is found		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
7.4 Frequency and timing of outcome measures are appropriate		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
7.5 The study provides evidence of adequate internal reliability		Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	N	Y	Y
7.6 The study provides adequate evidence of validity, such as content, construct, criterion*		Y	Y		N		N	Y				Y	N		Y

Table 2.4 Continued CEC Quality Indicator Analysis for Joint Attention Literature (2010-2023).

	Study														
	Engelstad et al., 2020	Chiang et al., 2016	Ferraioli and Harris, 2011	Frolli et al., 2021	Hansen et al., 2022	Jones, 2022	Kaale et al., 2012	Kourassanis-Velasquez, 2019	Kryzak and Jones, 2015	Kryzak et al., 2013	Lawton and Kasari, 2012	Schertz et al., 2013	Shih et al., 2021	Shillingsburg et al., 2022	Spjut Janson et al., 2022
Data analysis															
8.1 Data analysis techniques are appropriate for comparing change in performance of two or more groups*	Y	Y		Y		Y	Y				Y	Y	Y		Y
8.2 The study provides a SSRD graph clearly representing outcome data across all study phases for each unit of analysis**			Y		Y			Y	Y	Y				Y	
8.3 The study reports one or more appropriate effect-size statistic or provides data from which appropriate ESs can be calculated*	Y	Y		N		Y	Y				Y	Y	Y		Y
	2	2	2	1	2	1	2	2	2	1	2	2	1	1	2
Total:	4	2	2	6	2	8	4	2	2	7	1	1	9	8	4
Meets all CEC Quality Indicators for methodologically sound research	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	N	N	Y
Meets all CEC Quality Indicators for methodologically sound research	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	N	N	Y



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

For more information, visit: http://www.prisma-statement.org/

Figure 2.1 Prisma Chart

3. INVESTIGATION OF A DIFFERENTIAL REINFORCEMENT AND TIME DELAY PROCEDURE TO TEACH AUTISTIC CHILDREN TO INITIATE JOINT ATTENTION: SINGLE-CASE EXPERIMENTAL STUDY

3.1 Joint Attention

Joint attention (JA) is the ability to coordinate attention between a social partner and the referent (object) in a social context. During JA episodes, individuals build social knowledge and experience with perspective-taking. JA is a pre-linguistic skill critical for social development, language acquisition, and cognitive development (Vaughan Van Hecke et al., 2007). The ability to adopt a common point of view or frame of reference leads to the development of social cognition (Mundy, 2017). JA behaviors emerge in the first six months of life and solidify around 18 months of typical development (Bakeman & Adamson, 1984).

3.2 Joint Attention and Autism

Social delays are inherent to the definition of autism (Ninci et al., 2013). The pervasive nature of these deficits includes language and socio-communicative behaviors (American Psychiatric Association, 2013). Approximately a third of autistic children do not develop functional language (Su et al., 2021), an outcome believed to be rooted in impairments of JA (Charman, 2003). The absence of JA before the first year of age is one of the earliest indicators of and a primary feature of ASD (Bruinsma et al., 2004; Brooks & Meltzoff, 2008). JA challenges include lack of eye contact, gaze shifting, and neglecting to respond to one's name (Stone et al., 1997). Researchers have indicated that joint-attentional behaviors should be targeted directly during early intervention for children with ASD (Mundy, 1995).

JA skills are one of the critical measures used for the diagnosis of autism spectrum disorder. Targeting JA responses for autistic children may mitigate or reduce these deficiencies, supporting the development of consequent socio-communication skills (Monlux et al., 2019). The implications for increasing spontaneous bids for JA are promising for autistic learners. A study by Carbone et al. (2013) offers a functional analysis of eye gaze behavior that includes motivation and discriminative variables, rendering it applied and socially significant. The value of this conditioning for social and language training has far-reaching benefits for autistic learners.

JA can occur in three ways: 1) gaining eye gaze: the child may look at something and look back at the adult as if to say, "Look at what I am looking at."(triadic gaze); 2) gestures: pointing or showing a toy or object; and 3) words: using words such as "look." Although these behaviors are topographically dissimilar, these behaviors feature the simultaneous engagement of two or more individuals on the same environmental event (Baldwin, 1995). Eye gaze can be broken down further into dyadic and triadic. In neurotypical infants, dyadic (eye-to-face) gaze develops first, followed by triadic eye gaze. Triadic eye gaze involves JA directed at a third party or object (Carbone et al., 2013). The initiation of triadic gaze and its importance for developing language for children with ASD cannot be understated.

This study focused on the triadic eye gaze behaviors, as insufficient eye gaze is a vital deficit that underlies many impairments manifest in children with developmental disorders, including autism (Mirenda et al., 1983).

3.3 Psychological and Behavioral Theories

Psychological theories initially dominated JA research and derived from developmental psychology literature (Dube et al., 2004). The term JA was coined by Scaife and Bruner (1975)

after observing that infants follow gaze in their first year, indicating that the human capacity to coordinate engagement develops before language (Mundy & Newell, 2007). Research on infants by Collis and Schaffer (1975) demonstrated the phenomena of visual co-orientation, the tendency of an infant and social partner to be focused on the same object simultaneously. This mutual reference on some collaborative environment attention provided the basis for an "interactive sequence" that can lead to other chains of referential behavior. Data demonstrated that social exchanges were not all caretaker-initiated, as was hypothesized. The findings indicated that infants engaged in spontaneous gaze behavior, resulting from mothers following the gaze of their children (Collis & Schaffer, 1975). The act of the child initiating JA would later be termed initiating JA, or IJA. In addition to infants' IJA, Scaife and Bruner (1975) described responding to bids for JA (RJA), in which the child followed the direction of the adult's gaze or point, labeled the "line of regard."

3.4 Social Meaning

Intersubjectivity, the sharing of subjective experience between two or more people, is essential to language and the production of social meaning (Baldwin, 1995). A typical social referencing episode is composed of the behavioral sequence of events: (a) presentation of a novel object or stimulus event, (b) the infant's gaze shift toward the adult, (c) facial expression demonstrated by the adult, and (d) infant's event-related behavioral response. This phenomenon of social referencing as a function of information source was investigated by Zarbatany and Lamb (1985) during infant studies in which infants would seek information via social referencing of adults in an ambiguous or "uncertainty-provoking" event. When a child's mother or a novel adult "stranger" assumed a happy expression, the infants approached the spider; when the adult assumed a fearful expression, the infants (after slight immobilization) retreated to the

adult. During the study, the infants sought information from mothers and strangers to interpret the event. However, they only used information delivered from mothers to regulate their behavior toward the spider. Pelaez (2009) later described that JA & social referencing are codependent skills derived from fundamental visual discriminations, prerequisites for relational responding, class formations, and language competence. She proposed teaching strategies for developing these core skills using behavioral interventions.

3.5 Intervention for Joint Attention Delays

Early behavioral interventions were conducted using various prompts (physical guidance, vocal prompts, repeated trials, overcorrection) with limited generality (Carbone et al., 2013). A popular and effective intervention for teaching JA skills, Pivotal Response Training, was developed in the 1970s by Drs. Koegel and Koegel (Weiss & Harris, 2001). Pivotal Response Training is a play-based training that targets four specific pivotal skills: 1) motivation, 2) responding to multiple cues, 3) self-management, and 4) self-initiations.

Researchers in the 1970s identified that improvements in these areas led to collateral skill increases in behaviors, including JA (Koegel & Frea, 1993). The authors credited Pivotal Response Training with improvement in JA due to teaching autistic children to direct their attention to objects and events in their environment (Weiss & Harris, 2001). Gomes et al. (2020) studied the effects of multiple-exemplar training, auditory scripts, and script-fading procedures to establish a generalized repertoire of initiating bids for JA. Researchers did not investigate the importance of social stimuli functioning as reinforcers before starting the intervention (Gomes et al., 2020). A notable limitation of this study was that this treatment package featured contrived reinforcement. Whalen and Schreibman (2003) assessed the efficacy of teaching triadic gaze JA behaviors using a naturalistic behavior modification approach. The intervention was effective for

all subjects for RJA and was maintained for all participants during follow-up measures. IJA, on the other hand, was adequate for four out of five subjects but not maintained by any participants at follow-up. Researchers hypothesized that pointing (but not triadic gaze) might be a more salient behavior resulting in more consistent reinforcement by parents (Whalen & Schreibman, 2003).

There is a limited amount of research from a behavior analytic framework, given the prevalence of autism and the critical nature of this behavior. The topic of JA remained in the psychoanalytic realm until the late 1990s when interventions derived from the principles of behavior were conducted. The issue remains under-researched in behavior analysis. Many studies that featured explicit JA instruction use a combined behavioral and developmental approach. There is strong support for explicit JA interventions for autistic children, but it is unclear which intervention or interventionist factors yield the best results (Murza et al., 2016). Tangentially, there are no conclusive data on which interventions work for which type of children (e.g., severity, language ability, age). In many studies, the definitions of JA were unclear (Manwaring & Stevens, 2017), did not provide adequate information regarding dosage, and there was limited follow-up data (Murza et al., 2016) and procedural fidelity (Rocha et al., 2007). Historical and current JA literature incorporates multiple components designed to teach RJA and JA functionally different behaviors with "distinct but interacting processes" (Mundy & Newell, 2007).

3.6 Behavioral Account of Joint Attention

Dube et al.'s (2004) foundational study featured a behavioral account of teaching JA. The authors broke the functionally distinct behaviors (IJA and RJA) into discrete operant chains of antecedents-behaviors-consequences. Using operant teaching, behavior is broken down into the

"three-term contingency" (Catania, 1979); behavior change is affected through manipulating antecedents (i.e., what comes before the behavior) and consequences (i.e., what comes after the behavior; Leaf et al., 2018). Breaking these skills into discrete behaviors allows for developing behavior-analytic teaching strategies to remediate the JA deficits among children with autism (Brim et al., 2009). Many behavioral programs now shape JA skills using operant learning approaches (Holth et al., 2009). Isaksen and Holth (2009) taught children to engage in triadic gaze behavior, thereby conditioning social attention as reinforcement that did not include "extrinsic" reinforcement. The intervention consisted of three main phases: 1) RJA, the establishment of conditioned social reinforcers; 2) teaching the participants to use JA skills in turn-taking tasks; and 3) a combination of RJA and IJA.

Carbone et al. (2013) extended the three-term contingency to include the motivating operation, specifically the establishing operation, a motivation operation that increases the effectiveness of a stimulus as a reinforcer (Cooper et al., 2019). Carbone et al.'s intervention, derived from a verbal behavior account of language, was designed to teach children with ASD to initiate triadic gaze. Teaching children to initiate JA while manding (requesting; Skinner, 1957) for preferred stimuli reinforces JA behavior while conditioning the face of the social partner as a preferred stimulus, thus programming for generalization and conditioning social interaction as reinforcement during naturalistic opportunities.

3.7 Measuring Social Validity Through Assent Behavior

Applied behavior analyst practitioners and researchers select behaviors for change because of their importance to human and society rather than theory. Social validation considers social criteria for evaluating treatment protocols, focus, and effects on an individual's behavior performance (Kazdin, 1982). Social validity identifies connections between social importance,

maintenance, generalization, treatment fidelity, and an individual's culture (Baer et al., 1968; Finn & Sladeczek, 2001). In addition, social validity can be measured and assessed by the outcome and the magnitude of change due to the intervention; the intervention should be cost-effective and practical (Horner et al., 2005; Wendt & Miller, 2012).

When researchers assess social relevance, research must be grounded in empirical, conceptually systematic research and have demonstrated social validity (Spear et al., 2013). Wolf's (1978) call to action states that behavior scientists historically avoid subjective in favor of objective measurement. When measuring socially valid behaviors, he noted that behavior could only be evaluated by individuals in their social community who can attest to whether contextual improvements have occurred (Kazdin, 1982; Wolf, 1978). Wolf (1978) proposed that SV be measured in three ways: 1) The social significance of the goals; are the child's goals meaningful to them and relevant to their immediate environment? 2) The social appropriateness of the procedures; are the treatment goals suitable, and will they support the individual to promote engagement with their social community? 3) The social importance of the effects; will the outcomes of the individual's behavioral goals help society? Wolf also posited the question, “are consumers satisfied with the results, including unpredicted ones?” (Finn & Sladeczek, 2001; Hanley, 2010; Wolf, 1978).

Treatment acceptability from the consumer's perspective remains a largely unexamined area of research. Researchers and practitioners are beginning to develop a means of assessing treatment acceptability in consumers, particularly for young children receiving behavioral services (Finn & Sladeczek, 2001). Gathering and responding to participant acceptability data can help researchers identify whether or not effective practices are experienced by children receiving services (Hanley, 2010).

Behavior analyst researchers and practitioners should use operant principles of behavior to teach skills that enable children to establish effective control over the contingencies in their natural environments by teaching and providing opportunities for choice within the context of habilitation (Owen & Symons, 1993). Allowing children with ASD or intellectual disabilities to demonstrate preferences creates active participation in social validation (Schwartz & Baer, 1991). Following child motivation by assessing assent and assent withdrawal has recently been referred to as "voting with their feet" (Fabrizio, 2012; Hanley, 2010).

Social invalidity may include withdrawing from the program; practice recommendations include evaluating procedures to trace the source of dissatisfaction to specific programs or environmental variables. Choice-making may facilitate habilitation by increasing child satisfaction with habilitative goals and strategies and increasing willingness to participate (Bannerman et al., 1990).

Objective evidence based on children's choices can guide the development of adaptable, socially valid behavior-change procedures (Hanley, 2010). The question must be: How can researchers collect objective data to measure the presence or absence of SV? Behavioral, another dimension of behavior, affirms that since an individual's behavior is composed of physical events, its study requires precise measurement (Baer et al., 1968). To precisely measure behavior, researchers must operationally define them, providing an objective, clear, and concise description of the behavior to be measured (Cooper et al., 2019). Assent and assent withdrawal must be operationally defined for each child to be objectively measured. The research literature on social and behavioral gains associated with assent practices needs to be more extensive. Careful measurement and visual analysis of child data can allow single-case researchers to evaluate behavior change, generality, and the social validity of behavior-change procedures.

In this study, each behavior clinician was explicitly trained to gather assent before starting activities and recognize behavior topographies communicating assent withdrawal. The child's intervention team identified and operationally defined each client's idiosyncratic assent and assent withdrawal behavior before initiating the current research study. These data were analyzed to assess student willingness to participate, indicating the social validity of goals and treatment.

3.8 Differential Reinforcement and Time Delay

Differential reinforcement is an effective method for teaching autistic children (Karsten & Carr, 2009). Differential reinforcement is an operant procedure employed to increase the frequency of a desirable behavior while simultaneously decreasing the occurrence of the targeted behavior for change (Vladescu & Kodak, 2010). Typically, differential reinforcement is the implementation of reinforcing only the appropriate response (or behavior you wish to increase) and extinction (i.e., withholding reinforcement for all other responses; Cooper et al., 2019). Three known aversive effects of extinction include an increase in the frequency of the target response (extinction burst) and an increase in aggression (extinction-induced aggression; Lerman et al., 1999; Trump et al., 2020). Further, extinction procedures can also produce extinction-induced response variability; other forms of the response or different responses that emerge during periods of extinction may emerge (Grow et al., 2008). While extinction could induce response variability in the form of aggression or other unwanted behaviors, this process could evoke desirable adaptive responses (Lalli et al., 1994).

Researchers have recently begun investigating differential reinforcement without extinction (MacNaul & Neely, 2018) for when eliminating reinforcement for established behaviors may be contraindicated. In three experiments, Athens and Vollmer (2010) found that

differential reinforcement procedures were effective without extinction by manipulating dimensions of reinforcement. Interventionists did not implement extinction; instead, they reinforced the occurrence of an independent targeted response in the presence of the preferred stimuli (Mayer et al., 2019) and reduced the delivery of some dimensions of reinforcement for the emission of the target response following response prompts. Van Haaren (2017) proposed the term differentiated reinforcement to describe the practice of varying some dimension of reinforcement contingent on accuracy of responding. Altered dimensions of reinforcement can include topography, latency, duration, amplitude, magnitude, rate (Van Haaren, 2017), schedules of reinforcement (Olenick & Pear, 1980), and quality of reinforcement (Cividini-Motta & Ahearn, 2013; Karsten & Carr, 2009).

In response-prompting procedures, the teacher initially provides the student with assistance following an antecedent stimulus until the learner emits the targeted response (Morse & Schuster, 2004). The purpose of response prompts is to reduce errors and provides more opportunities for reinforcement. The prompts then faded with subsequent presentations of the stimulus. Prompting can co-occur with the stimulus (simultaneous prompting) or with a short time delay (Walker, 2008). Time delay procedures, described by Touchette (1971), have been demonstrated to increase manding repertoires in children with developmental disabilities (Carbone et al., 2010; Lorah et al., 2014). Time delay, an errorless instructional procedure, is an effective method for teaching discrete behaviors (Handen & Zane, 1987) and involves a transfer of stimulus control in which a pause or a specific amount of time is inserted between the discriminative stimulus or instruction and a controlling prompt. During the delay between the antecedent stimulus and the prompt, the student is given the opportunity to perform the response without assistance (Schuster et al., 1988), minimizing prompt dependence and promoting learner

independence (Vladescu & Kodak, 2010). By inserting small increments of time between the presentation of the stimulus and the delivery of a controlling response prompt (Touchette, 1971), independent responding is transferred from the contrived prompt to the naturally occurring stimulus (Browder et al., 2009; Cooper et al., 2019; Schuster et al., 1988). Time delay procedures can be constant or progressive. With constant time delay, practitioners implement a fixed delay (usually 3-5 seconds); with progressive time delay, the delay between providing the discriminative stimulus and delivery of the controlling prompt gradually and systematically increases (Walker, 2008). With time delay procedures independent and prompted responses, the application of concurrent schedules of reinforcement; correct independent responding is reinforced with a denser schedule of reinforcement, while prompted responses receive reinforcement on a leaner schedule, which may result in response differentiation. The findings of a study by Olenick and Pear (1980) demonstrate that schedules that provide more reinforcement for independent responding may produce more robust skill acquisition (Vladescu & Kodak, 2010).

3.9 Research Questions

Building upon the work of Carbone et al. (2013), research participants were taught to mand for preferred items or activities using vocal-verbal language accompanied by triadic gaze. The primary purpose of the present study was to evaluate the effects of a differential reinforcement without extinction and a time delay procedure to teach autistic children to IJA through triadic gaze during naturalistic language training sessions. The researcher also measured assent and assent withdrawal behavior as a representation of the social validity of the behavior change goals and procedures. Due to the movement towards distance training and services of applied behavior analysis, the first author of the present study was also interested in the

functional utility of online training for verbal behavior programming. See Table 3.1 for a comparison of the Carbone et al. (2013) and the current study.

The following research questions were evaluated in the current study: (a) Is there a functional relation between a differential reinforcement and time delay procedure and an increase in autistic children's ability to IJA with social partners? (b) Was the intervention socially valid for participants as measured by their assent and assent withdrawal behavior?

3.10 Method

3.10.1 Participants

Four participants, who met the diagnostic criteria for autism spectrum disorder in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013), were selected for participation in this study based on inclusion criteria and the clinical director's professional judgment. Inclusion criteria included being between the ages of two to eight years, the ability to communicate through speech using one word or more, the absence of aggressive behavior, and the child attending the autism clinic at least three days per week. Clinician recommendations were confirmed by the Autism Severity Rating Scales (ASRS; Goldstein & Naglieri, 2009), Vineland Adaptive Behavior Scales-3 (Sparrow et al., 2016), Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008), and parent reports. See Table 3.2 for additional information on participant assessment scores. Institutional Review Board approval from the first author's university and informed consent from all participants' parents were obtained before beginning the study. One participant was withdrawn when she was enrolled in school and had reduced hours at the clinic. The remaining three participants were four-to-six-year-old boys who received applied behavior analysis services at a clinic for children with ASD at least three days per week.

All demonstrated fluent manding repertoires using one or more words and did not demonstrate RJA or IJA. In addition, these participants demonstrated low rates of challenging behavior and did not engage in aggressive behavior. See Table 3.3 for additional information on the characteristics of each participant.

Behavior clinicians were trained to gather assent and monitor for assent withdrawal for all participants during treatment sessions. Each participant's individualized behavior intervention and treatment plan included operationally defined idiosyncratic assent and assent withdrawal behaviors (see Table 3.4).

3.10.2 Settings and Materials

The setting for this study was an applied behavior analysis clinic for autistic children. The clinic was located in a suburban area of the southeastern region of the United States. The clinic served 25 children; approximately 18 other children were present during instructional sessions. The 7500 sq. ft. clinic contained five therapy rooms and four community spaces that featured learning materials, play activities, toys, and gross motor equipment. The intervention occurred in various areas of the clinic, depending on the child's motivation. Preferred items were identified for each participant using informal daily stimulus preference assessments (Pace et al., 1985). Informal stimulus preference assessments included naturalistic and contrived free operant preference assessments (i.e., allowing the child to freely choose preferred items) and multiple stimulus without replacement (i.e., presenting the child with a small array of items and allowing them to choose, and once the item was chosen it was not represented in the array; Karsten et al., 2011). The behavior clinicians also asked the participants what activities they would like to engage in. Throughout the training session, the clinicians presented multiple opportunities for

engagement with various preferred and salient objects and social reinforcers to increase motivation for the child to engage in JA (Jones & Carr, 2004).

The interviews, social validity and consent, ongoing communication, training, support, interobserver agreement (IOA), and fidelity measures were conducted via Microsoft Teams© software. All sessions were recorded using Microsoft Teams© video software. Behavior clinicians recorded data through DataFinch Technologies Catalyst© software on each behavior clinician's assigned tablet. The experimenter accessed session recordings through Microsoft Teams© and client data through DataFinch Technologies Catalyst© software for interobserver agreement and treatment fidelity measures.

3.10.3 Experimental Design

Single case research designs (SCRD) are commonly used in behavior analysis and special education to evaluate the effectiveness of behavioral interventions (Horner et al., 2005; Wolfe et al., 2018). The repeated measurement of a behavior across time and conditions and the visual analysis of gathered data to make treatment decisions are defining features of these designs.

For this study, the researcher used a multiple probe across participant's design. With the multiple probe design, a variation of multiple baseline (MB) across participants, the independent variable is sequentially introduced across several participants who exhibit similar behaviors or behavioral deficits and provides an alternative for researchers when extended baselines are unnecessary or impractical (Cooper et al., 2019; Horner & Baer, 1978; Ledford & Gast, 2018). All three participants had functionally similar verbal behavior repertoires and demonstrated deficits in IJA. There were three tiers representing the three participants, and the introduction of the intervention was staggered by time across tiers. Subsequent participants entered the intervention after the previous participant demonstrated increased RJA.

The CEC's guidelines for evidence-based single-case research includes specific design criteria for multiple probe design. The criteria for multiple probe design include systematic manipulation of the independent variable, containing a minimum of three AB tiers, with each phase featuring three or more data points. All three independent replications must demonstrate an effect; a demonstration of effect is established if behavior performance changes when and only when the intervention is initiated with a strong effect demonstrated when the behavior change is immediate, and there is a large and persistent change in behavior compared to baseline performance (Kazdin, 1982; Ledford & Gast, 2018). Baseline measures were taken for all three participants until each demonstrated a steady state of performance, meaning one could predict, using visual analysis, that without intervention, the participant's performance was unlikely to demonstrate a therapeutic change (Johnston et al., 2020). Prediction, an element of baseline logic, asserts that if the intervention were not applied or there were no changes in the subject's environment, successive measures of the behavior of study would continue within a similar range of values (Horner & Baer, 1978). Practice effects (a type of testing effect) are a threat to internal validity inherent to MB design. With practice effects, improvement in performance results from opportunities to perform a behavior repeatedly during baseline measures (Cooper et al., 2019). Because behavior change in baseline resulting from repeated measurements (Ledford & Gast, 2018; Slocum et al., 2022) are more likely with multiple baseline design due to the continuous nature of baseline measurements (Cooper et al., 2019; Ledford & Gast, 2018), the researcher chose a multiple probe design for this study.

3.10.4 Dependent Variables (DVs)

The dependent variable was the IJA, as measured by percent independent per occurrence. IJA was defined as the individual gazing toward the referent (object or activity of interest) and

then shifting their gaze to a social partner from whom they were requesting immediately before or simultaneously with the vocal mand response. Triadic gaze may or may not have included JA without time delay or spoken verbal prompts. Prompted responding was defined as time delay and vocal verbal prompts followed by the participant emitting the target request with JA. Non-examples included looking at an object when instructed to do so. A specific gaze duration towards the social partner was not required to promote natural response topographies. The dependent measure in this study was the percentage of mands accompanied by eye contact during a 30-minute session three times a week. Data were also recorded on participant assent withdrawal. If the participant withdrew assent, each instance was recorded as frequency, the number of times the response occurs (Mayer et al., 2019).

3.10.5 Experimenter and Interventionists

The experimenter for this study was a Board Certified Behavior Analyst® (BCBA), licensed through the state of Texas, and a fourth-year doctoral student. The experimenter had 12 years of experience providing ABA services for children with autism spectrum disorder and extensive experience providing in vivo and online training and supervision for behavior clinicians.

All behavior clinician interventionists underwent an initial one-hour remote workshop training program with the researcher before implementing the intervention procedure. They received remote training and support through baseline, intervention, and maintenance conditions. See Table 3.5 for additional information on the characteristics of each behavior clinician.

3.11 Procedure

The independent variable was a treatment package of differential reinforcement and time delay (Carbone et al., 2010). According to Mundy and Newell (2007), in autism, challenges with

IJA are more profound than with RJA. In the current study, behavior clinicians promoted IJA by capturing naturally occurring mands and contriving situations for the participant to have the opportunity to request preferred items or activities through triadic gaze.

A fixed three-second time prompt delay (Fisher et al., 2021; Snell & Gast, 1981; Walker, 2008) with a movement prompt was inserted by interventionists to accurately teach the child to mand for preferred items with triadic gaze (Mayer et al., 2019). The moment prompt consisted of the behavior clinician slowly moving the referent closer to their face to guide the learner to initiate gaze (Cooper et al., 2019). Reinforcement for independent and prompted responses was differentiated by varying some dimension or schedule of reinforcement contingent on the accuracy of responding.

3.11.1 Baseline

In the baseline condition, the independent variable was not present, and data were gathered to function as a control condition to determine the effects of the independent variable (Cooper et al., 2019). During the baseline condition, before the initiation of the training session, the clinician gathered assent by asking the child, "Hi (child's name), we are going to go to the (room)! If there is something you like, you can look at it and then look towards me. Do you want to go play?" or similar language. If assent was granted as per each child's idiosyncratic operationally defined assent behavior, and the child demonstrated motivation, the clinician waited up to five seconds for the participant to emit a vocal verbal mand (one word or more) paired with triadic eye gaze (eye gaze alternating from object to clinician's eye region). If the child independently manded for the item paired with the initiation of JA (triadic eye gaze), the clinician delivered the item immediately, followed by one to two-minute access to the requested item or until the food item was consumed. If the participant failed to emit the vocal verbal mand

paired with triadic gaze, the clinician delivered the item immediately, followed by one to two-minute access to the requested item or until the food item was consumed. No prompting was delivered in the baseline condition.

If the child demonstrated behavior that they wanted to end the training session (assent withdrawal as operationally defined for each participant), the clinicians asked them, "Do you want to stop asking for things? You may stop at any time". If the child demonstrated assent withdrawal, the clinician recorded AW (Assent Withdrawal), stopped the trial, and redirected the participant to another activity for 5 minutes before initiating another trial.

3.11.2 Differential Reinforcement Without Extinction and Time Delay

Procedures were the same in the intervention, except if the child failed to emit the vocal verbal mand paired with triadic gaze and continued to indicate motivation for the object, emitting subsequent requests without JA during the 5-second time frame, the clinician provided prompts to evoke the targeted response. The clinician modeled the vocal-verbal response by labeling the name of the preferred item and moving the stimuli closer to their eyes until the participant made eye contact and echoed the verbal model. The clinician recorded a P (Prompted), and the manded for item was delivered. The clinician altered the magnitude, duration, or quality of reinforcement by delivering shorter durations of access or smaller portions of food.

If the child demonstrated a loss of motivation or unwillingness to participate, the clinicians asked them, "Do you want to stop asking for things? You may stop at any time". If the child demonstrated assent withdrawal, the clinician recorded AW (Assent Withdrawal), stopped the trial, and redirected the participant to another activity for 5 minutes. See Figure 3.1 for additional information on the procedure of the intervention.

3.11.3 Measurement

Trial-by-trial data were collected on independent and prompted responses during natural environment training in both baseline and intervention conditions. Each clinician recorded the number of independent and prompted mands using Catalyst© software on their tablets. Percentage-of-correct-performances measures were determined by dividing the number of independent IJA mandss by the total number of mands multiplied by 100. The researcher calculated and graphed the percentage-of-correct performances of independent mands with triadic gaze data for visual analysis. Percentage is typically expressed as a ratio of the number of responses to a specific type of behavior to occur per total number of responses multiplied times 100 (Cooper et al., 2019).

3.11.4 Generalization and Maintenance

Generalization, defined by Stokes and Baer (1977), is the occurrence of behavior under different, non-training conditions. Examples include responding across different subjects, settings, people, and times other than specifically trained. Generalization was programmed in several ways: training with multiple exemplars, programming common stimuli, and establishing natural maintaining contingencies (Cooper et al., 2019; Stokes & Baer, 1977). Two or more clinicians conducted interventions for all participants in several clinical areas where the treatment occurred. Known and novel preferred stimuli were incorporated into play using socially mediated consequences. Training trials were embedded in fun, naturalistic activities with natural behavior change agents, using naturally occurring stimuli. This approach is more generalizable, resulting in the maintenance of behavior change (Ayllon & Azrin, 1968; Schreibman et al., 2015; Whalen & Schreibman, 2003).

3.11.5 Social Validity

Social validity assesses the social significance of the change goals, the intervention's appropriateness, and the results' social importance (Wolf, 1978). The study's outcomes were assessed for social validity post-intervention through interviews with each child's parents and behavior clinicians. Questionnaire data assessed the social acceptability of goals, procedures, and outcomes. For the behavior clinicians, 11 questions regarding the participant's perception of the social validity of the experiment were measured by a five-point Likert-like scale (1 = strongly disagree to 5 = strongly agree). The participant's parents were asked a similar social validity questionnaire with six questions. The ratings for each question were analyzed to identify and evaluate the extent to which participants found components of the experiment to be socially valid. See Table 3.6 and Table 3.7 for additional information on the parent and behavior clinician social validity measures.

Both parents and clinicians were asked a final open-ended question requesting that they elaborate on social and communicative gains they recognized in the participant. Responses gathered provided information about child improvement perceptions and social, linguistic, and educational benefits. Social validity reports gathered from the participants' behavior clinicians and parents included the following: "Winston is now (noticed by many people) attending and focusing more on others' actions and position in a room. He is making more eye contact and general scanning/observation of the natural environment." "Zachary has shown an increase in expressive language and getting and maintaining the attention of others since engaging in this study. He has also been able to generalize the use of RJA across novel people." "Gregory has been joining the family for more events, such as watching TV together."

Throughout the study, client willingness to participate was assessed through assent and assent withdrawal measures. Low levels of assent withdrawal in both baseline (overall average of 1 per child in baseline and treatment) indicate a willingness to participate, thus enhancing the social validity of treatment. See Table 3.8 for more details.

3.11.6 Reliability and Procedural Fidelity

Interobserver agreement (IOA) was collected for an average of 38% of treatment sessions in baseline and 44% in intervention conditions. The overall IOA was calculated as an average of 89% in baseline (range = 81%-94%) and 90% in intervention (range = 72%-100%) conditions. Trial-by-trial IOA were calculated by dividing the number of agreements by the total number of agreements and disagreements and multiplying by 100 (Ledford & Gast, 2018). IOA of 80% or higher in each condition demonstrates that data are believable, trustworthy, and deserving of interpretation (Cooper et al., 2019). See Table 3.9 for more details.

Procedural fidelity increases internal validity; high procedural fidelity demonstrates adherence to conditional protocols increasing confidence that behavioral outcomes are related to the intervention and not confounding variables (Ledford & Gast, 2018). Procedural fidelity was collected for an average of 38% of each participant's sessions in baseline and 51% in intervention conditions using the procedural fidelity implementation checklist. The experimenter observed session recordings and tallied the number of steps performed correctly and incorrectly by the clinicians for each trial. The number of steps performed correctly was divided by the total number of steps multiplied by 100. Procedural fidelity was calculated as an average of 95% in baseline (range = 85%-100%) and 90% in intervention (range = 72%-100%) conditions. Low procedural fidelity in intervention session four for Gregory was due to the interventionist prompting triadic gaze with the vocal prompt “look” rather than movement prompt only. A

booster training session was conducted to promote adherence to protocol. See Table 3.10 for more details.

3.11.7 Open Data

Supplementary materials for this study, including raw data, are available on the Open Science Framework at osf.io/vw39m.

3.12 Results

A functional relation was demonstrated between the intervention package and IJA. See the visual inspection, effect size, and Tau-U analysis sections for justification of this conclusion. The results of this study support and extend the findings of previous research examining the use of a differential reinforcement and time delay procedure to increase IJA in young autistic children. Results demonstrated the efficacy of using this treatment package during naturalistic teaching procedures to increase the frequency of IJA behaviors by all participants.

All children demonstrated increased initiations of JA during teaching condition relative to baseline with an overall average of 5 in baseline (range = 0-14) and 9 in treatment (range =1-26). Zachary, Winston, and Gregory showed an average frequency of 5 (range = 3-6), 6 (range = 2-14), and 2 (range = 0-5) initiations of JA in the baseline condition, respectively. Respective rates of independent IJA in the treatment condition increased to an overall average of 9 (range = 1-26).

Zachary, Winston, and Gregory showed an average frequency of 8 (range = 2-10), 7 (range = 1-14), and 13 (range = 2-26) IJA in the treatment condition, respectively. The percentage of independent responses was calculated by dividing the frequency of independent mands with triadic gaze divided by the total number of mands multiplied by 100. The percentage of independent mands with triadic gaze increased from an overall average of 27% independent in baseline (range = 0%-56%) to 54% in treatment (range = 7%-100%). Zachary, Winston, and

Gregory showed an average percentage of independent IJA of 58% (range = 25%-100%), 43% (range = 7%-73%), and 60% (range = 18%-97%) in the treatment condition, respectively. The frequency and percentage of independent initiations of JA for all three participants are presented in Table 3.11.

3.12.1 Visual Inspection

IJA behavior data were graphed (see Figure 3.2 for intervention data). Visual analysis involves interpreting the level, trend, and variability of performance within and across baseline and intervention conditions (Horner et al., 2005). Visual analysis is the primary method of data analysis in SCRD (Wolfe et al., 2018). It is used to make experimental decisions (formative, behavior change), identify the presence or absence of a functional relation (summative), and assess the magnitude of the effect (summative; Ledford & Gast, 2018). Demonstration of experimental effect is evidenced when predicted change in the dependent variable (trend, level, or variability) covaries with manipulation of the independent variable. Kratochwill et al. (2013) developed guidelines for evidence-based single-case research through the What Works Clearinghouse (WWC; https://ies.ed.gov/ncee/wwc) initiative, including specific design criteria for MBL and its variations, including multiple probe. Kratochwill et al. (2013) suggested that multiple baseline designs must demonstrate three effects, or changes in the dependent variable between adjacent conditions, at three different points to provide evidence of a functional relation. Utilizing the multiple probe technique across participants, initial baseline probes were conducted for each participant, followed by intermittent measures taken concurrently before the initiation of intervention (Ledford & Gast, 2018). When data in all tiers were stable, the researcher initiated an intervention for the participant assigned to the first tier, while data were concurrently and continuously monitored in untreated tiers (Kazdin, 1982). The intervention was introduced for

successive participants in subsequent tiers in a time-lagged fashion when consistent change in level between A and B conditions in the first tiers were observed.

For all three participants, baseline levels of independent IJA were relatively low (average = 27%; range = 0%-56%). When the intervention was introduced to each participant, changes in trends were observed, with levels of independent IJA increasing to an average of 54 % (range = 7%-100%). Following the introduction of the differential reinforcement and time delay intervention, accelerating overall trends occurred within one to three intervention sessions across all three participants. These changes in trend and level occurred only when the intervention was introduced to each participant and at no other time. Following the introduction of the intervention, there was some variability due to extraneous variables. A new behavior technician implemented the intervention with Zachary on the fifth treatment session, and Winston contracted COVID-19 following his third treatment session. When we identified that these confounds resulted in highly variable data, we held all aspects of the child's environment steady until the data reflected stable responding (Cooper et al., 2019). Accelerating trends occurred within one to three intervention sessions across all three participants, increasing confidence in functional relation.

3.12.2 Immediacy of Change

The immediacy of change was analyzed across all participants. The immediacy of change across adjacent conditions (baseline and intervention in the case of multiple probe design) represents the degree of behavioral change that occurs as soon as the intervention is introduced (Horner et al., 2005). Behavior change occurred in the therapeutic direction within one to three treatment sessions for all children indicating the likelihood that the behavior was altered due to manipulation of the independent variable was high. Further, the immediacy and magnitude of

change are consistent across tiers (Barton et al., 2018), increasing confidence in a functional relation between IJA and the intervention.

3.12.3 Consistency of Data

The consistency of data within and between conditions were analyzed. Zachary's baseline average was 46% (range = 40%-56%; average total trials = 10), and the average in his intervention was 58% (range = 25%-100%; average total trials = 14). Winston's baseline average was 28% (range = 25%-40%; average total trials = 24), and his intervention average was 43% (range = 7%- 73%; average total trials = 17). Gregory's baseline average was 6% (range = 0%-13%; average total trials = 41), and his intervention average was 60% (range = 18%-96%; average total trials = 19).

The inconsistency among data could be attributed to the uneven number of trials across conditions among each participant and across participants themselves. For example, on the second day of treatment, Zachary independently manded for a preferred item with triadic gaze ten times out of 21 opportunities in which he demonstrated motivation. On the first day of treatment, Winston requested a preferred item with triadic gaze ten times out of 35 opportunities in which motivation was demonstrated. Because we converted, measured, and analyzed percent data, these behaviors represent Zachary independently requesting a preferred item with triadic gaze in 48% of opportunities and Winston requesting a preferred item with triadic gaze in 29% of opportunities where he demonstrated motivation. The researcher did not set a specific trial count because the motivating operation controlled each trial. Behavior clinicians were trained to contrive situations for the child to mand with triadic gaze while at the same time being sensitive to shifting motivations.

3.12.4 Tau-U

Quantitative procedures to evaluate SCRD data used in with conjunction with visual analysis can assist in measuring the experimental rigor of educational and behavioral research and can aid in summarizing research findings (Shadish, 2014). Quantifying intervention effects for SCRD studies provides practitioners with information about treatment outcomes, calculating the amount of improvement made by the client (Parker et al., 2011a) via level change between adjacent conditions (Barton et al., 2018, p. 209). Tau-U (Parker et al., 2011b) is a technique for analyzing SCRD data to determine the effect size; the estimation of the overall magnitude of behavior change (Moeyaert et al., 2018). Tau-U is a quantitative approach for analyzing SCRD data that combines nonoverlap between phases with intervention phase trend and can control undesirable Phase A trend (Parker et al., 2011a). Tau-U $_{\text{A vs. B}}$ (Parker et al., 2011b) was calculated determine effect sizes. The measure Tau-U $_{\textbf{A vs. B}}$ estimates non-overlap of all pairs and is appropriate for use when there is no significant baseline trend for each individual case (Fingerhut et al., 2021).

When interpreting Tau-U, >0.80 represents a large to very large change, 0.60 to 0.80 represents a large change**,** 0.20 to 0.60 a moderate change, and <0.20 improvement is considered a small change (Vannest & Ninci, 2015**).** The Tau-U $_{\text{A vs. B}}$ value for the current study was calculated as 0.6759, indicating a positive association between the treatment and dependent variable (Tarlow, 2017).

3.12.5 Effect size Calculations

Effect size indicates the practical significance of a research outcome (i.e., the magnitude of the relationship between variables or the difference between groups; Lakens, 2013). A large effect size means that the research finding has practical significance, while a small effect size

indicates limited practical applications (Aarts et al., 2013). As SCRD relies on visual inspection to conclude whether an intervention produced a favorable outcome on the dependent variables, effect size measurement provides information about the magnitude of change (Valentine et al., 2016). The inherent subjectivity implicated with the visual analysis of SCRD can be supported with the objective data derived from effect size calculations grounded in statistical methodology (Shadish et al., 2008); in other words, the question of, "Is there a treatment effect?" can be enhanced with, "How large is the treatment effect?" (Aarts et al., 2013). In 2014, Pustejovsky and colleagues introduced the between-case standardized mean difference (BC-SMD), a statistical framework for estimating standardized mean difference effect sizes from SCRDs (Valentine et al., 2016). This effect size metric can be compared across the two types of study designs: treatment reversal and multiple baseline across participants (Valentine et al., 2016). For the current study, a multiple probe design across participants – a variation of multiple baseline across participants – BC-SMD effect size was calculated using the SCDHLM web app at https://jepusto.shinyapps.io/scdhlm/. When interpreting effect sizes, they can be categorized into small, medium, or large according to Cohen's criteria; an effect size of 0.2 is considered small, 0.5 is considered medium, and 0.8 or greater is considered large (Cohen, 1988). The BC-SMD estimate for the current study was 1.08, meaning that the research finding demonstrated practical significance with a large effect size (Pustejovsky et al., 2014; Wolfe et al., 2018). See Figure 3.3 for the BC-SMD effect size graph.

3.13 Discussion

This study sought to analyze whether a differential reinforcement with time delay procedure could effectively teach three autistic children to IJA. The findings of this study demonstrate that all three participants successfully learned to engage in triadic gaze while

requesting preferred stimuli. Further, the results suggest that this procedure was accomplished through remote training and supervision. Lastly, the low rates of participant assent withdrawal support that this intervention was meaningful and socially valid for each child. High scores in parent and clinician social validity provide further evidence of this. The findings have several significant theoretical and clinical implications.

Although other studies have featured naturalistic behavioral strategies to teach JA, the current study focused on capturing and contriving motivation to teach autistic children to IJA while requesting preferred items and activities in their environment. Leveraging motivation for the preferred stimulus, the social partner's face was conditioned as a reinforcer during the triadic gaze sequence. This intervention used preferred stimuli, and multiple social partners, during naturalistic instruction to plan for the generalization and maintenance of behavior change outside training sessions and post-intervention, offering a technology for increasing behavior change without the use of extinction. This departs from the Carbone et al. (2013) study in which response variability inherent in extinction was the mechanism by which IJA was induced. Differentiated reinforcement without extinction, was used in this procedure by varying some dimensions of reinforcement contingent on the accuracy of responding. From these analyses, the researcher can conclude a functional relation between the differential reinforcement and time delay intervention and the target behavior across three participants.

The successful use of remote training and supervision for behavior clinicians is essential because it suggests that remote training and telehealth may be useful in increasing the accessibility of behavior-analytic interventions for schools, clinics, or homes where in-vivo training and supervision may not be readily available. In this study, eight behavior clinicians ages 21-49 could implement the procedure with high fidelity, a range of education, and differing

years of experience in applied behavior analysis. The intervention could easily be replicated in various applied settings, especially in which language-based programming for autistic children is already in progress.

In addition to examining the gains in IJA for each participant, this research also assessed student willingness to participate in treatment by monitoring ongoing assent and measuring the frequency of assent withdrawal. To the researcher's knowledge, this is the first JA study to measure student assent as an indicator of social validity. Low levels of assent withdrawal in both baseline and intervention (Baseline average = 1, range = 0-5; Intervention average = 1, range = 0-5) reflect that the children were actively and voluntarily engaged in the learning process. The clinicians honored the assent withdrawal when the children engaged in escape or avoidance behaviors from the IJA protocol, as indicated by their individualized behavior topographies. They analyzed environmental manipulations to reengage the child as part of the learning process. There is currently a limited number of behavior analytic research studies that consider assent with learners. Assent is vital because it helps ensure that an intervention is affirmative and respectful of the client's needs and preferences. Affirming assent behavior is crucial to gauge their willingness to participate and ensure that therapy is ethical and respectful of the client's autonomy. By honoring a child's assent, the researchers and interventionists assessed the social validity of intervention treatment and procedures, ensuring meaningful and ethical behavior change procedures.

3.14 Limitations & Implications for Future Research

There are several limitations of the study that warrant discussion. First, there was a relatively homogeneous sample due to inclusion criteria and parental consent, despite attempts to recruit diverse participants more representative of students receiving behavior analysis services.

A second limitation is the need for generalization and maintenance measures. Although generalization and maintenance were purposefully programmed for, these probes were not formally taken during or post-intervention. Anecdotal evidence in the form of clinician and family reporting confirms the generality of behavior change, including RJA and social referencing across different social partners and in untrained environments.

A final limitation of note is the setting and subject confounds experienced during this study. Although unplanned, these confounding variables were assessed, and the extent to which these factors influenced the behavior change was evaluated. During the intervention, Zachary was placed with a new clinician who needed additional training to effectively capture and contrive motivation to evoke triadic gaze during naturalistic training sessions. After a booster session, Zachary's IJA behavior increased, as indicated by a steep slope in the last three sessions. Winston contracted COVID-19 resulting in two weeks off from attending sessions at the clinic. Following his return, there was high variability in manding with triadic gaze. The motivational influences that account for momentary variability in operant behavior (Skinner, 1953) could account for the variability observed. Winston's IJA behavior stabilized with restricted access to preferred items and consistent naturalistic training sessions, and the ascending trend continued.

Future research could resolve these limitations by actively recruiting a more diverse group of participants across different ages, genders, races, socioeconomic statuses, and modes of communication. Replicating this study in settings other than clinics, such as homes, schools, or communities, may reach more families whose children fit the inclusion criteria. Although the current study featured a multiple probe design, a nonconcurrent multiple baseline design could be considered for instances where beginning baseline probes concurrently is not feasible (Slocum et al., 2022; Watson & Workman, 1981). In applied settings, it is impossible to guard against all

threats to validity. Careful monitoring of interventionist performance and shifting motivations of clients could mitigate unexplained variability in data, strengthening confidence in the intervention and reducing alternative explanations of the results.

Finally, the results of this study contribute to the growing literature on teaching JA to children with autism. The benefits of this behavior cusp are far-reaching, from enhanced academic and safety skills to complex language and social engagement. The conditions under which both topographies (RJA and IJA) are learned through operant learning should continue to be evaluated thoroughly in future research.

3.15 References

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Table 3.1 Comparison of Study Dimensions.

	Study	
	Carbone et al., 2013	Georgio et al., 2023
	Participants	
Number	1	3
Age (avg)	3 years old	5 years 3 months
Disability Category	ASD	ASD
Race/ethnicity	Caucasian/ White	Caucasian/ White
Gender	Male	Male
Verbal Performance	Intermediate	Intermediate
	Interventionists	
Researcher credential	BCBA*	Doctoral Student BCBA
Researcher years experience	30+ years	12+ years
Supervisor	BCaBA**	N/A
Number	4	6
Age (avg)	N/A	30
Education	3 bachelors, 1 masters	2 high school, 2 bachelors, 2 masters
Credential(s)	N/A	2 BCBA*, 3 RBT***, 1 BT***
Years employed as behavior clinician (avg)	1 year	4 years
Years employed as behavior clinician (range)	2-18 months	1 month-14 years
	Setting	
Geographical location	Northeastern US	Southeastern US
Educational Setting	Private autism clinic	Private autism clinic
Intervention Location	All settings	All settings
Other children present (approx..)	9	18

Table 3.1 Continued Comparison of Study Dimensions.

		Study	
		Carbone et al., 2013	Georgio et al., 2023
		Intervention Design and Delivery Features	
	Research Design	AB design (conceptual analysis)	Multiple Probe Design
	Independent Variable	Differential reinforcement (with extinction)	Differential reinforcement (without extinction) and time delay
	Dependent Variable	Mands accompanied with eye contact	Mands accompanied with triadic gaze
	Measurement	Percentage of mands accompanied with eye contact	Percentage of mands accompanied with triadic gaze
	Treatment delivery	Face to face with in vivo training	Face to face with remote training
	Generalization	Multiple instructors, settings; naturally occurring stimuli under the control of the motivating operation	Multiple instructors, settings; naturally occurring stimuli under the control of the motivating operation
	Maintenance	N/A	N/A
		Dosage	
	Minutes per session	360	30
	Number of sessions per week	3	3
Total Sessions (avg)	BL[a]	6	4
	IV	37	8
		Reliability	
Procedural fidelity (overall)	BL[a] (avg)	N/A	95%
	BL[a] (range)	N/A	85%-100%
	IV[b] (avg)	N/A	90%
	IV (range)	N/A	72%-100%
Interobserver Agreement (overall)	BL[a] (avg)	89%	89%
	BL[a] (range)	N/A	81%-94%
	IV (avg)	92%	90%
	IV (range)	N/A	72%-100%

Table 3.1 Continued Comparison of Study Dimensions.

		Study	
		Carbone et al., 2013	Georgio et al., 2023
		Reliability	
Social validity (overall)	Parent interview	N/A	84%
	Clinician interview	N/A	89%
	Assent withdrawal (range)	N/A	0-5
	Assent withdrawal (mean)	N/A	1

Note: *BCBA=Board Certified Behavior Analyst **BCaBA=Board Certified assistant Behavior Analyst ***RBT=Registered Behavior Technician ****BT=Behavior Technician

[a]=Baseline [b] =Intervention

Table 3.2 Participant Assessment Scores

	Autism Severity Rating Scale® (ASRS)		Vineland Adaptive Behavior Scales-3®*						Verbal Behavior Milestones Assessment and Placement Program® (VB-MAPP)		
	Raw Score	Autism Severity	Receptive Language Age Equivalence	Expressive Language Age Equivalence	Interpersonal Relationships Age Equivalence	Level 1	Level 2	Level 3	Overall Score	Dev. Level	Age Equiv.
Zachary	76	Clinically Significant	2:09	2:06	1:06	45	54	32	131	3	30-48 months
Winston	78	Clinically Significant	1:06	1:01	0:04	40.5	14.5	4	59	2	18-30 months
Gregory	74	Clinically Significant	1:04	1:08	1:11	45	58	41	144	3	30-48 months

Note: * Denotes age equivalence

Table 3.3 Participant Characteristics.

	Sex	Race	Ethnicity	Home Language	Diagnosis	Chronological Age
Zachary	Male	Caucasian/ White	Non-Hispanic	English	ASD	4y 9m
Winston	Male	Caucasian/ White	Non-Hispanic	English	ASD	6y 6m
Gregory	Male	Caucasian/ White	Non-Hispanic	English	ASD	4y 7m

Table 3.4 Assent Behaviors.

	Assent Behaviors	Non-Assent/ Assent Withdrawal Behaviors
Zachary	**Engagement in play:** manipulating toys or activities to make the object/items move, light up, spin, or perform in a functionally appropriate manner. Example: rolling a toy car down a car ramp. **Engagement in the task:** attending to materials and making an effort to respond when given instruction. Example: upon presentation of a preferred children's book, will read known words out loud. **Vocal agreement:** vocally stating willingness to engage in conversation or activity. Example: stating "yes", "ok", or similar language. **Echoes stated activity:** when asked to do a specific activity, repeat the activity name. Example: When the instructor says, "Do you want to go outside?" Repeats, "go outside". **Approaches:** moves toward instructor to access attention. May or may not include emitting vocalizations or extreme proximity to the instructor. Example: Walking towards the instructor and standing within 6 inches while repeating the name of the activity.	**Vocal refusal:** vocally stating unwillingness to engage in conversation or activity. Example: stating "no", "stop", or similar language. **Pushing:** uses hands to move presented task or activity away; may also use hands to move person giving instruction away. Example: When presented with a music toy, extends hands and pushes them off the table or towards the instructor. **Eloping:** getting up when given a task, traveling more than 3 feet from the designated work area, and not returning with one verbal prompt. May be accompanied by smiling and waiting for an adult to provide attention. Example: Walking away from activity or instructor when presented with an instructive.

Table 3.4 Continued Assent Behaviors

	Assent Behaviors	Non-Assent/ Assent Withdrawal Behaviors
Winston	**Approaching:** Moving body towards the instructor's location. Example: walking towards the instructor and activity when the instructor says, "let's go play catch outside". **Reaching towards/ grabbing items:** Using hands to make and maintain contact with preferred items and task stimuli. Example: reaches towards the ball when the instructor says, "let's go play catch outside". **Answering questions:** Responding to instructions and directions when asked. Example: upon presentation of a preferred children's book, will answer questions regarding the characters in the book.	**Escape from task demand:** getting up when presented with a task, traveling more than 3 feet from the designated work area, and not returning with one verbal prompt. May be accompanied by smiling and waiting for an adult to provide attention. Example: walking away from an activity or instructor when presented with an instructive. **Flopping:** taking the body to the floor when an instruction has been placed. Example: drops body to the floor when the instructor delivers the instruction, "let's go play catch outside". **Vocal refusal:** vocally stating unwillingness to engage in conversation or activity. Example: when the instructor delivers the instruction, "let's play with legos", stating "no", "stop", or similar language. **Head butting:** Applying head to another person's head or a stationary item such as the wall or floor with force, leaving an audible thud or a red mark on himself or the person he hit. Example: when the instructor delivers the instruction, "it's time for a snack", hits head against the wall.
Gregory	**Vocal agreement:** vocally stating willingness to engage in conversation or activity. Example: stating "yes", "ok", or similar language. **Discussing topics:** Initiates or responds to a conversation regarding preferred topics. Example: when presented with bubbles and bubble want states, "bubbles go pop!". **Engagement in the task:** attending to materials and making an effort to respond when given instruction. Example: upon presentation of an array of common items, will select them when named by the instructor.	**Physical refusal:** Resisting instruction by leaning back or pushing task stimuli. Example: upon presentation of an array of common items and named by the instructor will push them towards the back of the table. **Vocal refusal:** vocally stating unwillingness to engage in conversation or activity. Example: stating "no", "stop", "break", or similar language. **Crying:** Producing tears when asked to follow instructions or complete tasks. May or may not accompany physical or vocal refusal. Example: upon presentation of an array of common items and named by the instructor, cries and says "stop".

Table 3.5 Behavior Clinician Interventionist Characteristics.

	Assigned Child Participant	Gender Identity	Race	Chronological Age	Level of Education	Credential	Years Working as Behavior Clinician
Salli	Zachary	Female	Caucasian/ White	25	Master's Degree	RBT	1.5 years
Ellie	Zachary	Female	Caucasian/ White	22	Bachelor's Degree	BT	1 month
Melissa	Gregory	Female	Caucasian/ White	32	High School	RBT	9 months
Chad	Gregory	Male	Caucasian/ White	42	Master's Degree/	BCBA	14 years
Krista	Winston	Female	Caucasian/ White	36	Master's Degree	BCBA	7 years
Maggie	Winston	Female	Caucasian/ White	21	High School	RBT	8 months

Note: *BCBA=Board Certified Behavior Analyst **BCaBA=Board Certified assistant Behavior Analyst
***RBT=Registered Behavior Technician ****BT=Behavior Technician

Table 3.6 Results from Parent Social Validity Questionnaire.

	% Selected Response				
Question	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I feel that this intervention was explained to me in a way that I can understand	33%	67%	0%	0%	0%
I can identify the social significance of joint attention	33%	67%	0%	0%	0%
My child initiates joint attention in the home	33%	67%	0%	0%	0%
My child responds to joint attention in the home	33%	33%	33%	0%	0%
I feel that this intervention increased my child's social engagement with clinicians and other adults	33%	33%	33%	0%	0%
I feel that this intervention increased my client's social engagement with other children	33%	33%	33%	0%	0%
I feel that this intervention was socially significant for my child	33%	33%	33%	0%	0%
			Overall total		84%

Table 3.7 Results from Clinician Social Validity Questionnaire.

Question	% Selected Response				
	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I feel that this intervention was explained to me in a way that I can understand	83%	17%	0%	0%	0%
I feel that this intervention was feasible to conduct during daily therapy sessions with my clients	67%	0%	33%	0%	0%
I feel capable of teaching learners with ASD to initiate joint attention	50%	50%	0%	0%	0%
I feel capable of teaching learners with ASD to initiate joint attention while requesting	50%	50%	0%	0%	0%
I can identify the social significance of joint attention	67%	33%	0%	0%	0%
My client now engages in an adequate amount of social engagement through initiating joint attention	33%	33%	33%	0%	0%
I feel equipped to promote social engagement through joint attention training with other learners with ASD	50%	50%	0%	0%	0%
I feel that this intervention increased my client's social engagement with clinicians and other adults (besides myself)	33%	50%	17%	0%	0%
I feel that this intervention increased my client's social engagement with other children	33%	33%	33%	0%	0%
I notice that the client is now responding to joint attention (RJA)	50%	50%	17%	0%	0%
I feel that this intervention was socially significant for this client	50%	33%	17%	0%	0%
			Overall Total		89%

Table 3.8 Assent Withdrawal Behavior.

Participant	Condition	Mean Instances of Assent Withdrawal	Range
Zachary	Baseline	0	-
	Intervention	1	0-5
Winston	Baseline	1	0-5
	Intervention	1	0-5
Gregory	Baseline	1	0-5
	Intervention	0	-
Overall	Baseline	1	0-5
	Intervention	1	0-5

Table 3.9 Interobserver Agreement (IOA).

Participant	Condition	Percentage of sessions with IOA (%)	Mean IOA%	Range %
Zachary	Baseline	33%	88%	88%
	Intervention	50%	90%	72%-100%
Winston	Baseline	40%	84%	81%-94%
	Intervention	42%	92%	87%-100%
Gregory	Baseline	40%	94%	89%-94%
	Intervention	40%	87%	83%-88%
Overall	Baseline	38%	89%	81%-94%
	Intervention	44%	90%	72%-100%

Table 3.10 Procedural Fidelity (PF).

Participant	Condition	Percentage of sessions with PF Measures (%)	Mean PF%	Range %
Zachary	Baseline	33%	100%	100%
	Intervention	50%	92%	83%-100%
Winston	Baseline	40%	86%	100%
	Intervention	42%	93%	83%-100%
Gregory	Baseline	40%	86%	85%-87%
	Intervention	40%	85%	72%-83%
Overall	Baseline	38%	95%	85%-100%
	Intervention	51%	90%	72%-100%

Table 3.11 Independent Mands with Initiation of Joint Attention (IJA).

Participant	Condition	Mean Prompted	Range	Mean Independent	Range	Percent Independent (%)
Zachary	Baseline	5	3-6	5	4-9	46%
	Intervention	6	0-11	8	2-10	58%
Winston	Baseline	18	6-20	6	2-14	28%
	Intervention	10	3-26	7	1-14	43%
Gregory	Baseline	39	34-46	2	0-5	6%
	Intervention	6	1-11	13	2-26	60%
Overall	Baseline	21	5-46	5	0-14	27%
	Intervention	7	1-26	9	1-26	54%

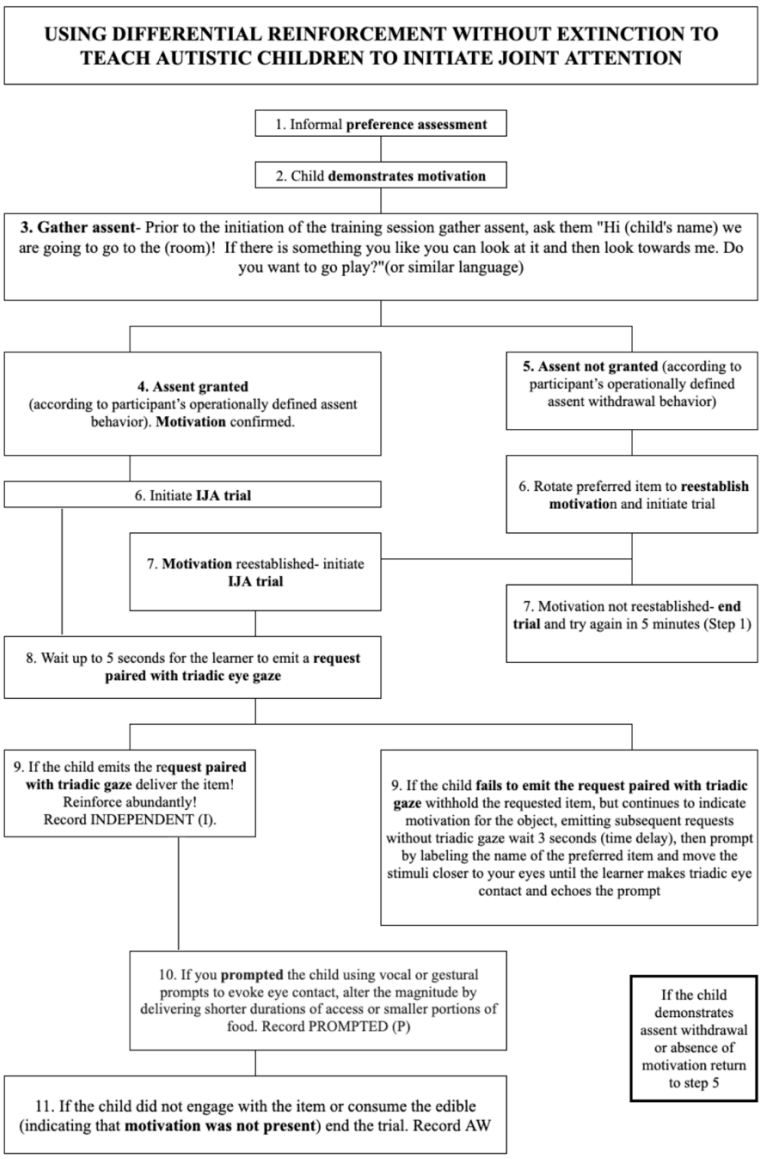

Figure 3.1 A Decision Making Flowchart for the Implementation of the Joint Attention Training Procedure.

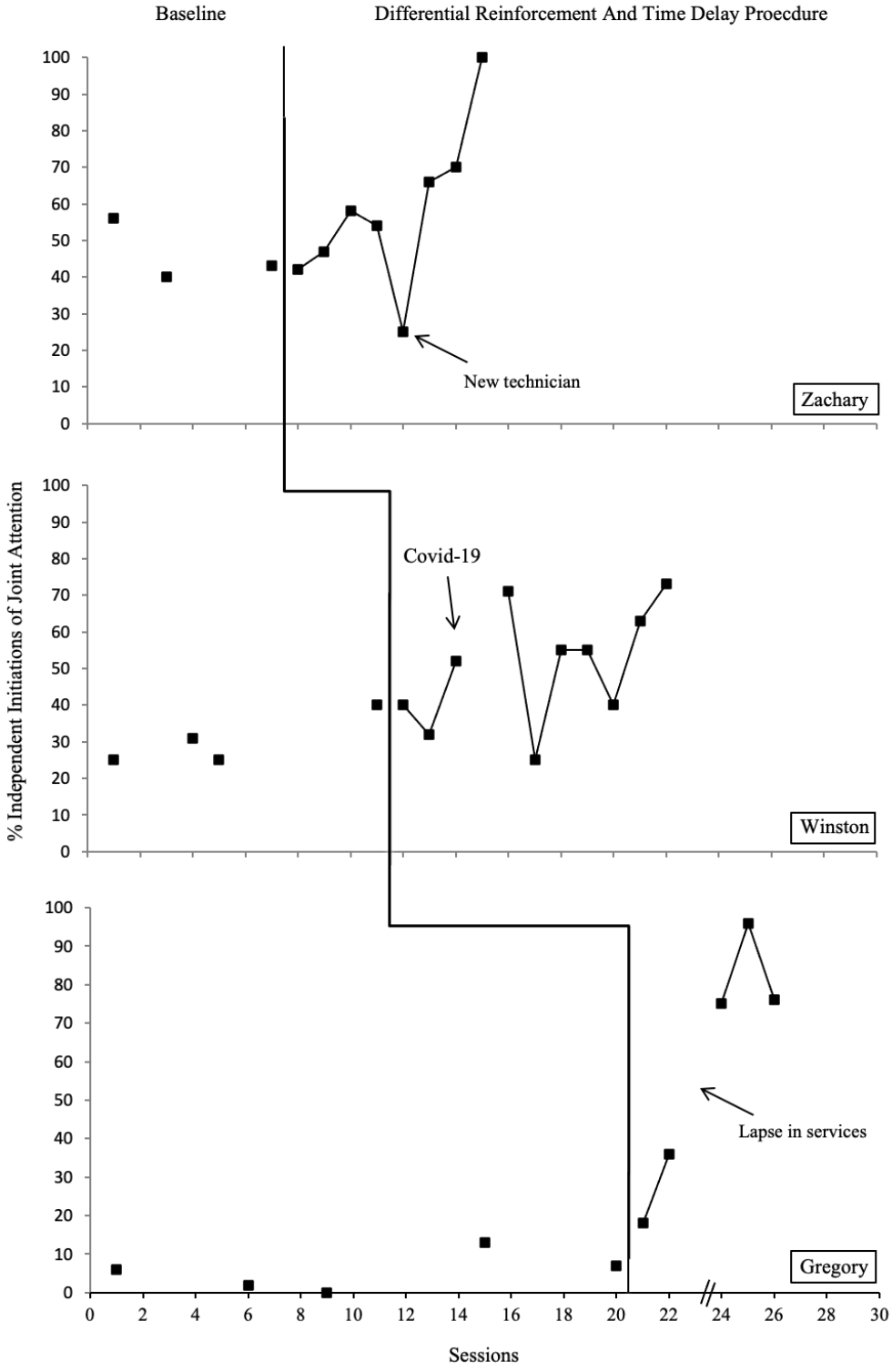

Figure 3.2 Multiple Probe Graph.

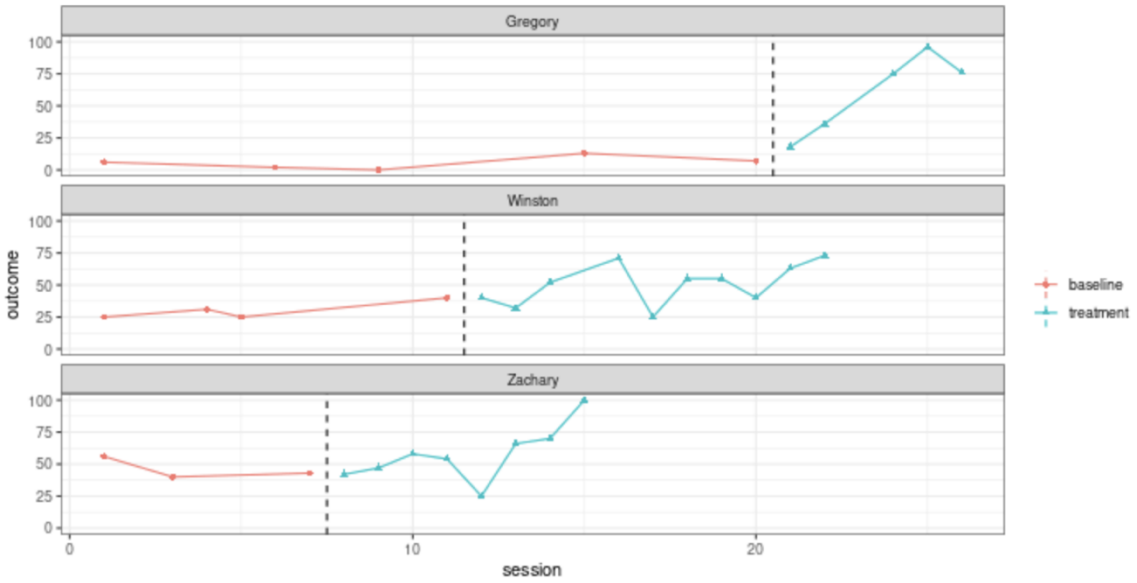

Figure 3.3 Between-Case Standardized Mean Difference (BC-SMD) Graph.

4. CONCLUSIONS

Diagnosis and early intervention are critical for young children with autism. The role of joint attention (JA) on the trajectory of language and social competency has been identified by both cognitive psychologists and behaviorists. Function-based procedures for increasing responding to and initiating joint attention have been positive, with many reported benefits, from engagement in social interactions to academic engagement and complex language skills. An operant analysis includes arranging the environment to capture and contrive motivational opportunities and deliver reinforcement contingent on the emission of these behaviors. While researchers have successfully taught JA to autistic children, the literature remains sparse.

The systematic review presented here highlights the need for further exploration of these significant behaviors to enhance the quality of life for individuals with autism through improved social repertoires. The findings of the current experiment align with previous research that the use of the principles of behavior can effectively enhance this essential prerequisite to language development. Systematic replications in schools, homes, and clinics with common people such as parents, siblings, teachers, and behavior providers are warranted, as these variables are present in the child's natural environment and are likely to be supported by naturally occurring contingencies of reinforcement.

While there is clearly a need for greater attention to the enhancement of JA, the current literature is promising; with the exponential growth in the diagnosis of ASD, and enhanced focus on these behaviors show great promise for enriching the lives of autistic children in our homes, school, and communities.