# Examining the Effects of Varying Responsive Interaction Strategies in Naturalistic Developmental Behavioral Interventions

By

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I dedicate this to my family for the inspiration, support, and encouragement all along the way.

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# CHAPTER 1

## Introduction

With roots in developmental psychology and behavioral science, Naturalistic Developmental Behavioral Interventions (NDBIs) are blended intervention approaches characterized by individualized learning goals, precise fidelity of implementation criteria, and ongoing progress monitoring. NDBIs utilize developmental strategies (e.g., modeling salient language, imitating play actions) alongside behavioral strategies (e.g., prompting learning targets, providing immediate reinforcement) to enhance motivation and teach new skills. Drawing from both developmental and behavioral theories of learning, these approaches emphasize the importance of managing reinforcement contingencies within meaningful and ecologically valid contexts to support children's experiential learning. Various forms of manualized NDBIs with evidence to support their efficacy exist, including Early Start Denver Model (ESDM; Rogers & Dawson, 2010), Enhanced Milieu Teaching (EMT; Kaiser & Hester, 1994), Reciprocal Imitation Training (RIT; Ingersoll, 2010), Joint Attention Symbolic Play Engagement and Regulation (JASPER; Kasari et al., 2006), Pivotal Response Treatment (PRT; Koegel and Koegel, 2006), and Project ImPACT (Ingersoll and Wainer, 2013). There is evidence for their use in supporting language, play, and social communication skills for autistic children (Sandbank et al., 2020a; Tiede & Walton, 2019) and children with developmental language disorder (Camarata et al., 2024). Integrating behavioral and developmental approaches to intervention is increasingly recognized as best practice for young children on the autism spectrum (Zwaigenbaum et al., 2015) and although work on broader implementation of NDBIs is still emerging, there is reason to believe that NDBI strategies may be feasible and effective for

most toddlers and preschoolers in inclusive childcare settings (D'Agostino & Frost, 2024; Maye et al., 2020).

Across approaches, NDBIs share core features related to the nature of teaching targets, learning contexts, and instructional strategies used (Schreibman et al., 2015). Fundamentally, these interventions are characterized by child-led interactions that emphasize broad skill-building across developmental domains (as opposed to teaching discrete skills in isolation) and include a combination of antecedent- and consequence-based strategies (Bruinsma et al., 2020). They seek to promote children's active engagement by using preferred materials in natural learning contexts, and are designed for implementation by caregivers, teachers, and therapists within play or daily life routines to promote generalization (Biggs & Meadan, 2018; Schreibman et al., 2015). Recent efforts to identify common elements of NDBIs have resulted in agreement about the significance of the following: (a) remaining face-to-face and on the child's level, (b) following the child's lead, (c) displaying positive affect and animation, (d) modeling language, (e) responding to attempts, (f) using communicative temptations, (g) frequency of direct teaching episodes, and (h) quality of direct teaching episodes (D'Agostino et al., 2023; Frost et al., 2020). Using these strategies in combination to increase child motivation and improve socially significant skills is a defining characteristic of NDBIs.

Although approaches share defining features, the extent to which individual strategies are emphasized and utilized across published training materials and procedural fidelity checklists guiding implementation differs (Lane et al., 2016; Windsor & Ledford, in progress). Importantly, it is not expected that all interventions would share identical components, particularly given their varying goals and applications. For example, ESDM is a comprehensive treatment package which includes an assessment and curriculum tool that is used to develop learning objectives

across several areas of development (e.g., motor skills, receptive language, expressive language; Rogers & Dawson, 2010), whereas EMT is primarily a language-focused intervention (Kaiser & Hampton, 2017), and RIT emphasizes the acquisition of imitation (Ingersoll, 2010). Nevertheless, researchers have called for additional work clarifying the crucial components and active ingredients across interventions (Crank et al., 2021; D'Agostino et al., 2023; Fuller & Kaiser, 2020; Schreibman et al., 2015). This information will assist in understanding the needed frequency and balance of strategies included in NDBIs.

In a systematic review of 49 single case NDBI studies, Windsor & Ledford (in progress) found that direct teaching strategies tended to be consistently reported (e.g., using prompts to evoke behaviors of interest and contingent, natural reinforcement to maintain said behaviors). In contrast, there was less consistency in the use of responsive interaction strategies. In some instances, strategies were explicitly delineated in one intervention and not described in another. Examples included remaining face-to-face and on the child's level, displaying positive affect and animation, modeling language, using contingent imitation, interspersing maintenance and acquisition tasks, and establishing joint activity or play routines with balanced turns. In other cases, the same strategy was included, but the definition varied. For instance, descriptions of "following lead" might have been characterized primarily by using child-chosen materials or by the play behaviors the implementer engages in after identifying these materials (e.g., imitating, modeling) (cf. Bryson et al., 2007; Chang et al., 2016).

Recent endeavors to create intervention-agnostic NDBI fidelity measures have elucidated these differences. Both the Measure of NDBI Strategy Implementation-Caregiver Change (MONSI-CC; Vibert et al., 2020) and Naturalistic Developmental Behavioral Intervention Fidelity (NDBI-Fi; Frost et al., 2020) were designed to capture caregiver change in

implementation of NDBI strategies. However, the MONSI-CC includes 18 items across 5 domains (environmental set-up, child-guided interactions, active teaching and learning, opportunities for engagement, natural reinforcement and scaffolding) whereas the NDBI-Fi includes 8 items across 4 domains (promoting engagement, modeling skills, encouraging communication, direct teaching). While both measures share considerable overlap of key features, specific strategies often fall under different domains and are described with varying levels of specificity. As an example, in the MONSI-CC, items related to opportunities for engagement include providing choices and using turn taking, whereas in the NDBI-Fi, items for promoting engagement include being face-to-face and on the child's level, following lead, and using positive affect/animation. Given that these measures are designed for evaluating broad change in NDBI implementation over time, these differences are not problematic, however, they point to the lack of clarity and consensus in the field regarding which strategies are essential and for what purpose.

There are a number of NDBI strategies (also referred to as "motivational strategies") that have been identified as particularly relevant for heightening social motivation and engagement, including: (a) using child-selected, highly preferred activities, (b) displaying positive affect and animation, (c) using contingent imitation (i.e., imitating the child's language, play, and movements), (d) following child lead (e.g., observing and responding to child preference across and within activities; embedding teaching into child-chosen activities), (e) providing choices, (f) sharing control (e.g., balanced turns, gaining control of preferred items), and (g) reinforcing attempts (e.g., reinforcing attempts at the target behavior and shaping successive approximations toward the terminal goal over time) (Minjarez & Bruinsma, 2020). These strategies may be helpful for increasing child attention to the adult, encouraging ongoing interaction, and

increasing shared enjoyment of the interaction (Bruinsma & McNerney, 2012; Carter, 2001; Dawson & Adams, 1984; Ingersoll & Dvortscak, 2010; Kaiser et al., 1992; Koegel & Koegel, 2006; Siller & Sigman, 2002; Yoder et al., 1993).

Evaluating the unique effects of NDBI strategies on dyadic engagement is of particular relevance for young autistic children and those with social communication delays. While some children may seek out and demonstrate preference for reciprocal, play-based interactions with a familiar adult (as is the context of NDBIs), others may actively avoid such exchanges. Previous research has shown that autistic children may be less likely than their non-autistic peers to orient to social stimuli and more likely to prefer non-social stimuli (Dawson et al., 1998; Gale et al., 2019; Mundy, 1995). Additionally, for many autistic individuals, social stimuli that are naturally occurring in early childhood contexts (e.g., proximity to peers, praise statements, access to social games) may not function as reinforcers (Axe & Laprime, 2017). This decreased preference for and attention to social information (e.g., faces, voices, gestures) can have cascading effects on development because the number and salience of learning opportunities that are available in the child's environment is diminished over time (Rogers & Dawson, 2010; Su et al., 2021). Thus, understanding the ways NDBI strategies influence social orienting, seeking, and maintaining skills would be useful for implementers using these approaches to support skill development.

It is probable that myriad NDBI strategies differentially influence overt behaviors consistent with the construct of dyadic engagement. Likewise, we would expect to see variation in the effect of each strategy on behavior across participants based on relevant pre-intervention characteristics such as language, play, and preference for social interactions. Thus, additional information is needed about how, when, and for whom these strategies work best. Specifically, further empirical evidence is needed to help to identify children most likely to benefit from each

approach, modify intervention as needed when progress is not apparent, and efficiently teach critical components to endogenous implementers to assist with broad dissemination efforts. Previous work isolating treatment fidelity components is helpful in this regard. In a study examining the specific contributions of ESDM fidelity items to children's intervention response, Zitter et al. (2021) found that the use of joint activity routines and the three-term contingency were associated with children's acquisition of targeted skills, and that modulating affect/arousal, behavior management, and provision of communication opportunities were not associated with progress on learning response. In another study examining relationships between the use of specific ESDM techniques and child outcomes, Waddington et al. (2020) found positive correlations with management of attention, teaching opportunities, clear antecedents, instructional techniques, and elaboration with child expressive language. They also observed correlations between managing attention, dyadic engagement, sensitivity/responsivity, positive affect, and child engagement. Correlations between techniques and outcomes varied across mother/child dyads. In another example, Stahmer et al. (2019) examined relationships between child skills and potential key components of PRT. Increased use of antecedent strategies such as gaining attention and shared control were associated with child participation and responsivity within sessions. Together, these findings underscore the notion that NDBI techniques have unique contributions to child outcomes and point to the potential importance of responsive, attention-promoting strategies for facilitating dyadic engagement.

It is likely that caregivers, educators, and researchers instinctively engage in several of these strategies irrespective of the guidance of clearly defined procedures. In a survey of 901 service providers (e.g., Board Certified Behavior Analysts [BCBA], Registered Behavior Technicians [RBT]), Hampton and Sandbank (2022) found that 91% of BCBAs reported

incorporating responding to child communication attempts and reciprocal turn-taking into their practice most of the time, and 79% reported incorporating language modeling and mapping most of the time or always. However, professionals were less likely to report using play expansions, modeling play, and broadening attentional focus of the child. Similarly, in an evaluation of service providers' use of responsive interaction techniques prior to training, Lane et al. (2016) found that participants often responded to child communication and described the child's play during interactions prior to training, but less frequently imitated the child's play. In a survey of 22 speech-language pathologists, participants reported often following the child's lead and modeling target language, but less often arranging the environment or recasting (Lee et al., 2022). This suggests that although various populations may be familiar with a number of NDBI strategies, others remain unknown or infrequently used, and additional guidance on best practice for broad implementation would be advantageous.

When implementing NDBIs, a key adult role is to build upon and foster existing child motivation to engage and communicate (Schuck et al., 2021). As previously indicated, NDBIs are well-suited to address both ability (i.e., whether a child *can* demonstrate a particular skill given the right supports) and propensity (i.e., whether a child *does* demonstrate that skill across settings; see Bravo & Schwartz, 2021 and Vivanti, 2015 for further discussion on this distinction). With regards to dyadic engagement, NDBI strategies are likely to influence social orienting, seeking, and maintaining skills (e.g., pointing to show, commenting, imitating) by simultaneously creating learning environments that encourage children to use mastered skills and by directly teaching skills that are still emerging. In this study, we were interested in identifying in what contexts and under what conditions children tend to use skills already in their repertoire to seek and maintain engagement with others. Therefore, we omitted direct teaching strategies

and utilized only strategies we hypothesized would impact motivation or propensity. Using an alternating treatments design, we compared the effects of a low interaction control condition to two high interaction variations, one characterized by higher rates of modeling and expanding on language (i.e., high language), and another that included higher rates of modeling and expanding on play behaviors in addition to language (i.e., high language + play). This study extends the literature on critical NDBI components by systematically evaluating the distinct contribution of several responsive interaction strategies on dyadic engagement for young children in an inclusive preschool.

**Research Questions**

To evaluate the effects of varying responsive NDBI strategies on indicators of dyadic engagement, we asked the following research questions:

1. Primary: Do high language interaction and high language + play interaction conditions result in increased dyadic engagement indicators between the child and implementer during play-based interactions compared to a low interaction control condition?
2. Secondary: Does either high interaction condition result in higher frequency of dyadic engagement indicators, and does this relation vary across participants?
3. Secondary (exploratory): Do child outcomes vary based on pre-intervention characteristics (e.g., language, play, preferences)?
4. Social Validity: Do participants prefer high interaction conditions to the low interaction control? And do participants have differential preference for either high interaction condition?
5. Social Validity: How do naïve raters characterize child affect, adult affect, matched affect, child interest, and rapport across conditions?

# CHAPTER 2

## Method

### Participants

We obtained IRB approval of materials and procedures prior to recruitment and enrollment. We recruited participants from a university-affiliated preschool serving children with and without disabilities located in the Southeast. We asked administrators to nominate potential participants who could benefit from responsive play interactions in a one-on-one context. We sent home a consent form to these families for review and conducted assessments after gaining consent to confirm eligibility. Children were eligible for inclusion if they were (a) between 18 to 60 months old at the time of enrollment, (b) with a medical diagnosis of an autism spectrum disorder (ASD) or social communication delays as evidenced by screener results (e.g., *Communication and Symbolic Behavior Scales Developmental Profile* [CSBS DP]).

Four toddlers and preschoolers participated in all phases of the study. Anthony was a 41-month-old boy who communicated by vocalizing, showing objects, and occasionally using single words or phrases. At the time of the study, he did not have a medical or educational diagnosis but was receiving speech services each week. Camron was a 33-month-old boy who communicated using phrase speech. He did not have a diagnosis and was not participating in any outside services. Evelyn was a 60-month-old girl with a speech delay. She communicated using phrase speech and received speech, occupational therapy, and physical therapy. Lyla was a 41-month-old autistic girl. She communicated by vocalizing and leading and was receiving speech, occupational therapy, physical therapy, and applied behavior analysis (ABA) therapy. Participant demographic characteristics are summarized in Table 1.

### *Intake Assessments*

**Pervasive Developmental Disorder Behavioral Inventory.** The PDDBI (Cohen et al., 2003) is a rating scale designed for assessment, treatment planning, and treatment monitoring in children between 18 months and 12.5 years. It contains 176 items across the dimensions of behavioral approach/withdrawal and receptive/expressive social communication. It has been shown to have good reliability (alpha coefficient of 0.94) (Cohen et al., 2003, 2009; Cohen & Sudhalter, 2005). The PDDBI was standardized with autistic children and each T-score has a mean of 50 with a standard deviation of 10 and a total range of 10-100. Each participant's classroom teacher completed the Social Approach subscale (SOCAPP) on the teacher rating form. This subscale includes 32 items representing social approach behaviors such as joint attention, imaginative play, and social play.

**Motor Imitation Scale.** The Motor Imitation Scale (MIS; Stone et al., 1997) measures elicited imitation skills in a structured context. This assessment includes eight object and eight gestural imitation tasks and is scored using a rating scale with each task receiving a score of 0-2. Participants receive an overall score ranging from 0-32 that is converted into a percent ranging from 0-100%. Previous studies have found the MIS to have adequate internal consistency and reliability (Ingersoll, 2010). Trained implementers completed the MIS with each participant prior to the first baseline session.

**Structured Play Assessment**. We adapted the Structured Play Assessment (SPA; Ungerer & Sidman, 1981) to observe spontaneous play prior to the first baseline session for all participants. The SPA is a semi-structured play interaction designed to elicit specific play behaviors with an examiner that takes approximately 15-20 minutes to complete. During this

assessment, the child is introduced to five toy sets (shape sorter/puzzle, tea set, dolls with grooming materials, dolls with sleeping materials, barn). The experimenter comments on the child's actions, but initially does not provide prompting or give directions related to play. If the child does not engage with the materials, the examiner moves from environmental arrangement (e.g., placing a bottle next to the baby) to verbal prompting ("what should we play with?") before moving on to the next toy set. The assessment is video-taped and can be scored for frequency and complexity across play types. Previous studies have used the SPA with young autistic children to characterize participant play prior to intervention (Freeman & Kasari, 2013; Kasari et al., 2006). For all participants, the first author watched the SPA interactions and collected data on the types of play acts observed (e.g., exploratory, relational, functional, symbolic) and the category that was most frequently observed across all toy sets.

**Preschool Language Scales- 5th Edition.** The PLS (Zimmerman et al., 2012) is a standardized and norm-referenced assessment for measuring children's language proficiency. It yields standard scores and age-equivalencies for auditory comprehension, expressive communication, and total language. Trained implementers completed the PLS-5 with each participant and obtained scores based on direct testing and observations prior to the first baseline session.

**Play-based Language Sample**. We adapted the play-based language sample protocol from previous research on EMT (Pak et al., 2024) to describe children's typical language use during one-on-one play interactions with an adult. During this play-based, semi-structured interaction, the child is introduced to five toy sets (babies and feeding, tea time, building and cars, book, art) and the administrator models the same specific comments, questions, and play acts across each activity (e.g., "let's eat cookies and tea" during tea time). The protocol was

designed to be administered in both English and Spanish and to last 20 minutes; for the purposes of this study only the English version was used and we shortened the assessment to be completed in 10 minutes. The assessment was video-taped and the first author collected data on communication and language used (e.g., vocalizing, single words, 3-word phrases) for all participants. Participant play and language characteristics are summarized in Table 2.

**Teacher and caregiver questionnaires.** After consenting to participate in the study, caregivers completed a brief, researcher-developed questionnaire about their child. The questionnaire contained open-ended demographic questions (e.g., age, race/ethnicity, diagnosis/disability status), open-ended questions about their child's likes and dislikes (e.g., top three favorite activities; "[…] If you play with the same materials as your child while they are playing with it, do they generally like it or dislike it?"), and multiple answer questions about communication and areas of interest. Teachers also completed a researcher-developed questionnaire about their student's preferences and areas of interest in the classroom. This included the same open-ended questions about their favorites (e.g., top three favorite toys/objects), dislikes (e.g., activities; textures/sensory items), and areas of interest (e.g., letters/alphabet, animals, vehicles). It also included the question, "Does this student enjoy praise and social attention?" See Appendix A for questionnaires. Respondent answers to questions about playing with the same materials as an adult and enjoying praise and social attention are summarized in Table 3.

**Preference assessment.** We conducted 1-2 free operant preference assessments to identify: (a) preferred materials to be used during baseline and intervention sessions, (b) relative preference across reinforcer categories (e.g., social, activity-based, and tangible reinforcers as highly preferred, moderately preferred, non-preferred), and (c) relative preference across

interaction types (e.g., play alone, play with peers, play with teachers as highly preferred, moderately preferred, non-preferred). For all participants, we conducted a naturalistic free operant assessment, in which children engage in their typical, everyday environments while observers record the frequency and duration of approach and engagement behaviors, during free play in their classrooms (Chazin & Ledford, 2016). For Anthony, Camron, and Evelyn, we also completed a contrived free operant assessment, in which we set up a resource room with a variety of potentially preferred items. For all assessments, during a 15-minute observation period, we collected data on the items and activities participants approached, did not approach, engaged with, and the duration of engagement. These data were summarized to identify the highest preferred items, moderately preferred items, and low preferred items. See Appendix B for preference assessment data sheets. Highest preferred items that were selected for baseline and intervention sessions are shown in Table 3.

**Implementers**

Implementers included three graduate students in special education, including the author. All identified as White females. Two were certified behavior analysts and the third was completing supervised fieldwork and coursework to become certified. Implementers had varying levels of prior experience implementing NDBIs with young children, but all had some previous exposure through coursework or practice. Prior to the study, implementers participated in training with the first author. Training included (a) didactic instruction and materials review (e.g., procedural fidelity checklist, tip sheets, and related resources), (b) modeling of key procedures, (c) role play of key procedures, (d) rehearsal with a child from the preschool who did not participate in the study, and (e) feedback on implementation. If procedural fidelity fell below

90% for two or more sessions, the implementer would have been re-trained; however, this did not occur.

**Settings and Materials**

The study occurred in a fulltime inclusive preschool with eight classrooms serving approximately 80 children with and without disabilities. We held sessions in resource rooms on campus for Anthony, Camron, and Evelyn and the child's classroom for Lyla. We used caregiver report, teacher report, and direct observations to determine sets of preferred play materials (e.g., bubbles, balls, play house, cars) to use during teaching. Materials varied across participants (see Table 3); for each participant, we made materials equally available across conditions and presented children with choices between play sets prior to and during sessions. Based on child engagement, we introduced additional materials as needed to prevent satiation; when this occurred, we introduced the same materials across all conditions and continued to present them for the duration of the study. We used a Canon video camera to record sessions and ProCoder for Digital Video (ProcoderDV; Tapp, 2003) to code data from recorded videos.

**Dependent Variables**

We collected data based on video recording of the first 10 minutes of every session across baseline and intervention for all conditions. A 10-minute observation period was selected because it is frequently used in the context of single case NDBI studies to evaluate child outcomes (Bruinsma et al., 2020). To assess child engagement, we used number of intervals containing indicators of dyadic engagement as the primary dependent variable of interest. We estimated count in the immediate training context during sessions with an implementer using 5 s partial interval recording (PIR) based on the following response definitions:

1. Indicators of dyadic engagement include: (a) look (orienting body and gazing at adult or coordinating attention to objects and the adult), (b) point/reach (gaining or directing attention), (c) show/give (holding out or giving objects), (d) say (commenting on the interaction or materials with a secondary indicator such as looking, tapping, or pointing; requesting continuation of play, objects, or materials related to the current interaction; requesting attention), and (e) imitate (copying the adult's language, movements, or play with a secondary indicator within 5 s from the adult's model). Across all indicators, affect could range from neutral to positive and close proximity to the implementer was not required to code for dyadic engagement.
    a. Examples: (a) responding to adult gestures by looking and smiling (e.g., adult sings "wipers on the bus go swish swish swish" and child looks and smiles); looking at an object and the adult simultaneously with neutral affect (e.g., watching adult pretend to drink tea), (b) gaining or directing attention (e.g., pointing to picture on the wall, waving, saying "hey" or "look"), (c) showing or giving objects to the adult (e.g., handing the baby doll to the adult), (d) making a statement about the play materials (e.g., pours out water and says "dump", throws ball and says "ba"); requesting continuation of play (e.g., signs more, says "more bubbles", points to bubble container), (e) copying the adult's play act (e.g., adult feeds baby a bottle, child feeds baby a bottle 5 seconds later).
    b. Non-examples: manipulating same materials as adult without acknowledging adult's participation; orienting body away from the adult and/or materials (e.g., standing up, walking away, wandering); looking at other objects in the

room (e.g., floor, ceiling, camera); looking at adult, making a statement, or manipulating materials with negative affect (e.g., whining, crying); throwing materials in a way that is not contextually relevant or potentially dangerous (e.g., throwing trains across the room) while looking at adult; refusing or protesting the play or adult's actions (e.g., "stop", "no that's mine").

In the event that the session lasted less than 10 minutes, we estimated the number of intervals by calculating the percent of intervals and using a proportion (e.g., if we observed indicators in 33 out of 93 intervals, we converted that to 43 of 120 intervals). This occurred in 2 sessions each for Anthony, Camron, and Lyla; in sessions 12 and 13 for Anthony, 4 and 15 for Camron, and 2 and 13 for Lyla. We chose to use PIR and report the number of intervals rather than percentage of intervals because we were most interested in the count of short and long-duration engagement behaviors from participants, including brief but meaningful behaviors like orienting, pointing, and giving, as opposed to the duration of states of joint engagement which would be subject to contextual measurement error in the context of this study (Ledford & Gast, 2024; Yoder et al., 2018).

### *Interobserver Agreement*

The coding team included the three implementers and three additional master's students. The first author trained all coders to criteria by reviewing the coding manual, showing practice videos, and providing feedback. Coders reached 80-100% agreement with the first author across at least two practice videos prior to beginning. The primary author and coder met for re-training if agreement fell below 80% for two consecutive sessions. Additionally, discrepancy discussions took place on an ongoing basis with coders and the first author throughout the duration of coding as needed.

Two observers independently coded sessions selected for reliability. Primary coders remained naïve to the sessions that would be coded for reliability and implementers never served as the primary coder for their own sessions. A master's student in a different research lab from the implementers completed all primary data collection for the dependent variable (i.e., dyadic engagement). Interobserver agreement (IOA) data were collected for a minimum of 33% of sessions across variables, conditions, and participants. We coded 43.75% of sessions for reliability for Anthony, 36.36% for Camron, 38.1% for Evelyn, and 35.39% for Lyla. We used point-by-point agreement to determine IOA and calculated overall IOA for each session with the formula [intervals with agreements / total intervals] x 100. Average IOA for dyadic engagement was 87.65% (range = 73.33-99.17%). See Table 4 for more information about IOA across conditions and participants.

**Procedural Fidelity**

Trained observers collected procedural fidelity (PF) data for a minimum of 33% of sessions across phases, conditions, and participants. Implementers were naïve to which sessions would be scored for procedural fidelity. We used a fidelity checklist (see Appendix C) to evaluate whether the implementer used the following strategies during baseline and intervention sessions: following the child's lead of materials, remaining face-to-face, placing materials between the child and adult, displaying positive affect, and responding to initiations. A total percentage correct implementation was obtained by calculating [number of correct components] / [total number of components] x 100. We used PF data summatively to rule out threats to internal validity related to procedural infidelity. We also used these data formatively to ensure appropriate adjustments were made if fidelity did not reach at least 90% at any point. We collected PF in 37.5% of sessions for Anthony, 36.36% of sessions for Camron, 38.1% sessions

for Evelyn, and 41.18% sessions for Lyla. The average procedural fidelity score was 100%. Of the sessions for which we calculated PF, we scored 44.83% for reliability using the formula [number of agreements] / [number of agreements and disagreements] x 100. Average IOA for PF data was 99.15% (range = 88.89-100%) across participants. Table 5 depicts PF across participants.

Additionally, we measured the rate per minute the implementer modeled and expanded language using event recording and the percentage of intervals the implementer modeled and expanded play using 10 s momentary time sampling. For these behaviors, we set pre-specified criterion for correct implementation a priori. We determined that modeling language should occur less than two times per minute during baseline/control sessions and four or more times per minute during high language and high language + play conditions. For play, we set criteria at less than 20% of intervals during baseline/control and high language conditions, and greater than or equal to 50% of intervals during high language + play. We measured modeling and expanding play and language in 100% of sessions. Across participants, modeling and expanding language occurred an average of 0.91 times per minute in baseline/control sessions, 7.99 times per minute in high language interaction conditions, and 8.79 times per minute in high language + play interaction sessions. Modeling and expanding play occurred in 3.97% of intervals during baseline/control, 7.87% of intervals during high language interaction, and 62.13% of intervals during high language + play interaction. Across participants, average IOA for rate of modeling language was 80.25% (range = 33.33-100%) and average IOA for percent of intervals modeling play was 92.03% (range = 73.33-100%). These findings are presented in Tables 5 and 6.

## Experimental Design

We used an alternating treatments design (ATD) to compare the effects of a low interaction control condition to two variations of high interaction conditions (language-focused and language + play-focused) for four participants. This type of comparison is useful for refining existing interventions by evaluating variations to assess whether more or less of a procedure results in differential behavior change (Ledford & Gast, 2024). We collected a minimum of three initial baseline data points and included an ongoing control condition so that we could compare both high interaction conditions to each other and to a low interaction condition. To minimize sequence effects, we used restricted randomization to determine session order in five session blocks (with a qualifying rule that each session type could be repeated no more than two consecutive times). Prior to the study, we determined that we would complete at least two series of five intervention sessions for each participant (two of each high interaction condition and one control) and would continue with additional sessions as needed based on visual analysis of the data.

## Procedures

We met one-on-one with participants for 10-minute sessions once a day 4-5 times a week. We determined session days and times in collaboration with the child's classroom teacher, and usually met at the same time each day (e.g., 10:20-10:30 am Monday through Thursday). Total duration of study participation ranged from 3-6 weeks, for an average of 38 days. Number of intervention sessions ranged from 10-15 ($M$ = 12.75) and number of sessions overall (including baseline and child choice) ranged from 16-22 ($M$ = 19). In an effort to control for the possibility of variable engagement based on participant preference for a specific implementer, each participant worked with the same implementer for all session types; however, we used three

different implementers across the four participants. At the start of the study, each session type was assigned a color and shape (i.e., green semicircle for high language + play, black trapezoid for control, red plus sign for high language). The implementer signaled the session type to the participant by making a verbal statement (e.g., "Today is a red day; I will talk and you can play"), displaying a corresponding sign with the shape and color on the door or table where the session was held, and using a green, black, or red rug on the floor.

***Baseline***

Initial baseline ranged from 3-4 sessions across participants. During these sessions, implementers arranged the environment to minimize potential distractions (e.g., removed non-study materials) prior to picking the student up from their classroom. At least three sets of preferred play materials were always visible and readily available. To begin the session, implementers commented on the play materials (e.g., "ooh I see trains!"). They then followed the child's lead to their chosen materials and sat across from them, with the materials placed between the child and adult. During these sessions, the implementer held a clipboard to signal that they were working and would not be playing. The implementer displayed positive affect and animation and responded and acknowledged all initiations with a neutral statement of acknowledgement but refrained from consistently modeling or expanding on the child's language or play (e.g., child points to train; implementer smiles and nods). Implementers were instructed to imitate what the child was doing, imitate what the child was saying, or make a comment on what the child was attending to about once a minute if they had not already responded to them during that time. If a child remained unengaged for sustained periods of time (i.e., wandering the room, not manipulating any play materials for 60 s), the implementer would attempt to re-engage the child by offering choices, introducing a new way to play with materials, or delivering non-

contingent reinforcement. The same procedures were used during the ongoing control condition throughout the duration of the study.

### *Intervention*

**High Language Interaction Condition.** Just as in baseline, to begin a session, the implementer prepared the physical space and environment by setting out preferred materials and minimizing potential distractions. During intervention sessions, implementers in the high language interaction condition: (a) followed the child's lead of preferred materials (e.g., provide options and move with child to child-chosen activities), (b) remained face-to-face (e.g., bodies oriented towards each other and within line of sight), (c) placed the play materials between themselves and the child, (d) displayed positive affect and animation (e.g., adjust vocal quality, tone, gestures, and facial expressions to match child arousal levels; overall interaction is characterized by warmth, interest, and positivity), and (e) responded to all communicative attempts or initiations within 5 s (see Appendix C for PF checklists). Unlike baseline, in this condition, implementers responded to child initiations with a contextually-relevant statement rather than a neutral statement (e.g., child points to train; implementer says "train!"). During this condition, they continued to refrain from consistently modeling or expanding play. Instead, the implementer was instructed to: 1) imitate child gestures, vocalizations, words, and phrases within 5 s from the model, 2) comment on child actions and play (provide a label, description, or comment on what the child is doing or attending to [i.e., looking at, touching, communicating about]) at or slightly above the child's mean length of utterance), and 3) expand on child language (add 1-3 additional words or respond with a novel but related phrase) at least 4 times per minute.

**High Language + Play Interaction Condition.** Just as in baseline and the high language interaction condition, to begin a session, the implementer prepared the physical space and environment. During intervention sessions, implementers in the high language + play interaction condition engaged in the same procedures described in the high language interaction condition. In this condition, in addition to imitating, commenting, and expanding on language, the implementer was also instructed to consistently manipulate the same play materials as the child for the duration of the interaction. Specifically, they were told to: 1) imitate child movements or play actions using the same, similar, or pretend objects within 5 s from the model, 2) expand on child play behaviors (mirror the child's action and add a different object or action) with the materials of interest or related materials, and 3) model new ways to play with the materials of interest or related materials.

## Social Validity

### *Dissent*

In addition to gaining consent prior to the start of each session, we also used the following dissent procedures for all participants: (a) if the child asked to leave or indicated they wanted to leave (e.g., walking to door and pulling on handle) twice during a session, the implementer ended the session, (b) if the child dissented for three consecutive sessions, they would have been withdrawn from participation in the study.

### *Participant Preference*

After the final intervention session, we offered participants a choice of session type across three different days to assess their relative preference for each condition. We picked the child up or met them in their classroom as usual, walked to the instructional setting, reviewed what each condition card signified ("I will work and you can play" for the black card, "I will talk and you

can play" for the red card, "I will talk and play" for the green card) and gave the instruction, "you pick!" or asked "what do you want to do?" with a gesture towards the condition cards. To detect for potential side biases, we rotated the order of condition card presentation across the three days. After the child made a selection, the implementer ran that session type. If the child did not make a selection after 60 s and additional prompting, the implementer ran a pre-determined, randomly selected session type; in this case, the implementer rotated across all three condition types.

***Naïve Ratings***

As a measure of social validity, we used naïve ratings by non-participant consumers to evaluate acceptability of intervention procedures by the extended community for the two participants whose parents consented to these procedures (i.e., showing study videos to non-researchers). Upon completion of the study, we invited teachers and early childhood professionals from the participants' school to watch 1-minute videoclips of intervention procedures across all conditions for Anthony and Camron, whose sessions were conducted by different implementers. All participants were naïve to the condition type and strategies being used in each clip. However, they had varying levels of familiarity with the children in the videos and the overall purpose of the study based on their student's involvement and their role in the school. Participants viewed the same six clips (one per condition for both Anthony and Camron), though we rotated the viewing order across participants. We selected clips that were representative of the procedures for each condition type. For each video, participants completed a 5-question researcher-developed questionnaire using a 5-point Likert scale to evaluate: (a) child affect, (b) adult affect, (c) match between child and adult affect, (d) child interest in the materials and implementer, and (e) rapport between the child and implementer. We compensated

participants $20 for their participation. In total, 15 participants completed the questionnaires. The questionnaire can be found in Appendix D.

# CHAPTER 3

## Results

### Research Question #1

We used visual analysis to determine whether high language interaction and high language + play interaction conditions resulted in increased dyadic engagement indicators between the child and implementer during play-based interactions compared to a low interaction control condition. Figures 1-4 depict these findings across participants. For Camron and Evelyn (Figures 2-3), we concluded that a functional relation was present such that both high interaction conditions led to higher levels of engagement than the low interaction control. Although engagement was variable across sessions, there was clear differentiation in level for these participants when comparing the high language interaction or the high language + play interaction to the low interaction condition. For Lyla (Figure 4), we determined a clear functional relation between the high language + play condition compared to the low interaction control. However, there was overlap between the high language interaction and low interaction conditions, such that we observed similar levels of engagement in these conditions for several sessions. For Anthony (Figure 1), we observed an increasing trend in engagement during the control and high language + play interaction conditions. Anthony dissented during the final two intervention sessions (control and high language) and provided indications that this was due to preference for high play conditions (i.e., showing and giving materials to implementer to initiate play routines); thus, we moved into the child choice phase without three potential demonstrations of effect for the control condition.

**Research Question #2**

We also used visual analysis to determine whether either high interaction condition resulted in higher frequency of dyadic engagement indicators, and if this relation varied across participants. For Anthony, Evelyn, and Lyla, there was clear differentiation between the high language + play condition and the high language condition. Engagement was greater in the high language + play condition for these three participants. For Camron, engagement was variable across sessions (range = 24-73), with substantial overlap between conditions.

**Research Question #3**

Though the primary purpose of including multiple participants in this study was replication of effect, and not necessarily to draw comparisons across participants, it is interesting to examine differences in child outcomes based on pre-intervention characteristics such as language, play, and preferences for social interaction. Although exploratory and not experimental in nature, a few patterns emerged. The first has to do with baseline levels of engagement. In baseline, Anthony and Camron often looked at and made comments or asked questions to the implementer, with the total number of intervals containing indicators of dyadic engagement ranging from 36-39 ($M$ = 37.67) and 31-45 ($M$ = 38.25), respectively. This is in contrast with Evelyn and Lyla, who infrequently engaged with the implementer at baseline (range = 9-14; $M$ =12 and range = 13-18; $M$ = 15.67). For both Evelyn and Lyla, levels of engagement were substantially higher in the high language + play condition compared to the baseline and ongoing control, whereas for Anthony and Camron, levels of engagement remained similar in intervention relative to baseline.

Another pattern was related to differences between the high interaction conditions. For Camron and Evelyn, who often used phrase speech to communicate and engaged in imitative

play, we observed similar levels of dyadic engagement between the two high interaction conditions. On the other hand, for Lyla, for whom these skills were still emerging, there was a clear difference in engagement during the high language + play condition compared to the high language condition alone. This was also somewhat true for Anthony, though less pronounced.

In addition to varying language and play skills at baseline, these differences can also be interpreted in light of the fact that preferences for social attention and play varied across participants according to teacher and caregiver report. Camron, Evelyn, and Anthony's teachers indicated that they enjoyed social praise and attention, whereas Lyla's teacher responded that she was "not motivated by praise or social attention." In terms of play, Camron's parent reported that he "dislikes" playing with the same materials as an adult, Evelyn's parent said that she "generally likes" it, and Lyla's parent said that "for the most part it doesn't bother [her]." The questionnaire was not returned by Anthony's caregiver.

**Research Question #4**

We examined the cumulative number of choices for each condition type to answer our questions about participant preference for the high interaction conditions compared to the low interaction control. High language + play was the highest preferred condition type. Anthony, Camron, and Evelyn chose the high language + play condition for all three choice sessions; Lyla did not make a selection for any sessions, but showed the highest engagement with the implementer during this condition. No participants chose the control or high language interaction conditions.

We also analyzed findings from the teacher and professional-reported questionnaires to better understand how the broader early childhood community views interactions characterized by varying combinations of NDBI strategies. The 15 participants included 1 behavior analyst, 1

speech-language pathologist, 1 occupational therapist, 1 physical therapist, 1 school nurse, 8 teachers, and 2 graduate students studying to become certified teachers. After viewing videos showing the control condition, participants most often rated child and adult affect as neutral. Responses regarding the match between child and affect ranged from mostly mismatched to matched, with neutral reported most frequently. Respondents indicated there was some child interest in the materials and the adult and most frequently rated rapport in these interactions as neutral. Alternatively, child and adult affect were frequently rated as mostly positive in the high language interaction condition. A range of responses regarding matched affect remained, with a skew towards matched. Most participants rated the child as mostly interested in the adult and materials, and rapport in these interactions as good. The high language and play interaction condition received the most favorable ratings, with less variability in responses. Most participants rated child and adult affect as positive, with matched affect. Most ratings suggested the child was mostly interested in the adult and materials, and that the rapport between the adult and child was excellent. These results are depicted in Table 7.

# CHAPTER 4

## Discussion

In this study, we used an alternating treatments design to compare the effects of varying combinations of responsive NDBI strategies on indicators of children's dyadic engagement. Our results can be interpreted in light of the fact that following lead and using preferred materials, sitting face to face, and responding to attempts were held constant across conditions; thus isolating the distinct contributions of modeling language and modeling language and play on engagement. We found that the high interaction conditions consistently resulted in increased engagement compared to the low interaction control, despite the exclusion of direct teaching strategies. Additionally, the high language + play condition resulted in increased levels of child engagement compared to the high language condition alone for three of four participants. Our findings suggest that language and play modeling, imitation, and expansions are critical NDBI components for creating a context in which children are more likely to seek and maintain engagement with the implementer during one-on-one play-based interactions. This is consistent with previous quantitative and qualitative findings regarding the identification of mirrored pacing as an active treatment ingredient (Gulsrud et al., 2016) and the significance of following the child's lead, imitation, and modeling communication for increasing social engagement responsiveness (Frost et al., 2021; Frost & Ingersoll, 2023).

It is notable that clear differences emerged between at least two conditions for all participants given that we did not use playful obstruction or gain control of materials (i.e., participants had free access to all materials for the duration of all sessions) and used other attention-gaining strategies (i.e., affect and animation) across all conditions. This highlights the distinct usefulness of combining commenting and expanding on language with imitating,

modeling, and expanding on play to support high motivation and dyadic engagement for children in inclusive preschool settings. Further, Lyla's results (Figure 4) indicate that actively joining in play may be a particularly critical NDBI strategy for establishing dyadic engagement during intervention with autistic toddlers, given the lack of differentiation between the control and the high language interaction condition.

Altogether, our results also confirm the idea that, rather than working in a universal way across participants, these strategies likely interact with participant characteristics in different ways to impact different skills. Previous studies have shown that children's response to naturalistic interventions can vary based on interest in toys, gesture use, and language skills prior to intervention (Laister et al., 2021; Sandbank et al., 2020b; Schreibman et al., 2009; Yoder & Stone, 2006). Consistent with these prior observations, we found differences in response to intervention strategies across participants, though these differences did not appear to be clearly delineated by any single measure of play or language. Although we determined a functional relation between the high language + play and either the control or the high language condition for all participants, we observed varying responses to intervention across participants, potentially based on baseline engagement levels, imitation, and communication skills.

Overall, for children with lower levels of dyadic engagement at baseline, we observed greater increases during the high-language + play intervention condition, compared to children who began the study with higher levels of engagement. For example, the average number of intervals containing indicators of engagement for Evelyn (Figure 3) was 12 during baseline and 34.5 during the high language + play intervention condition (excluding child choice sessions). This is in contrast with Camron (Figure 2), who had an average of 40 intervals with engagement indicators during baseline and 48 during the high language + play intervention condition. This

may reflect a preference for play with someone else as opposed to solitary play; anecdotally, both Camron and Anthony regularly made efforts to recruit attention during the baseline and control condition (e.g., showing toys, looking at the implementer, asking questions) compared to Evelyn and Lyla who contentedly engaged in solitary play during these conditions. It may also indicate the importance of modeling and expanding on play for children who begin intervention with lower levels of dyadic engagement.

Similarly, our findings point to the particular impact of play for facilitating dyadic engagement among children with complex communication needs or emerging imitation skills. When examining differences between the two high interaction conditions, we found more overlap between these conditions for Camron and Evelyn, with clearer differentiation observed for Anthony and Lyla. There is an abundance of research highlighting the importance of language modeling in NDBIs to support the development of young children's language and communication (Clark-Whitney et al., 2022; Crandall et al., 2019; Roberts & Kaiser, 2011); however, language without play may not be sufficient for the purpose of promoting joint attention and engagement for autistic children or those with social communication delays. This may have been particularly true in this study given that the implementers used only one communication modality and relatively high rates of adult language input. Across participants, implementers commented, imitated, and expanded child language an average of 8.79 times per minute during the high interaction conditions. It is possible that while this rate of modeling was a good fit for Camron and Evelyn, it was mismatched for Anthony and Lyla, who might have benefitted from fewer comments or more time between comments. A better understanding of how we model and provide language input during NDBIs is an important area for future research (Frost et al., 2022).

Finally, all participants who communicated a preference in this study selected the high language + play condition. This was true regardless of caregiver and teacher reports related to preference for praise, social attention, and play with the same materials as an adult. Additionally, naïve observers consistently rated child affect, adult affect, matched affect, child interest in materials, and rapport most positively in this condition. Most striking was the difference between perceived affect and child interest in the high language and high language + play conditions, especially given the fact that implementers in both conditions followed the child's lead and displayed positive affect and animation. According to these data, we can infer that play during NDBIs is useful not only for creating an engaged and responsive teaching context that supports future skill development, but also for building positive relationships with toddlers, preschoolers, and early childhood professionals.

**Future Directions**

Thus, focusing on imitating, modeling, and expanding on play when teaching caregivers, teachers, and other endogenous implementers how to use NDBIs is warranted. This is especially true given inconsistencies in how well play behaviors are described and emphasized in existing NDBI manuals and training studies, and variability in the extent to which professionals currently report using these strategies. Our findings suggest that modeling and expanding play in combination with modeling and expanding language are active ingredients for supporting young children's dyadic engagement. These crucial NDBI strategies likely set the stage for reciprocal, responsive interactions between children and implementers. In this study, we sought to isolate the effects of play by using two high interaction conditions characterized by approximately 8 vocal comments, imitations, and expansions per minute. However, additional work is needed to investigate the frequency and balance of these strategies best-suited for children with varying

social communication and play skills is needed. Therefore, specifying the frequency and types of play behaviors used in future protocols and research reports is a priority.

Relatedly, in this study, we attempted to hold all non-independent variables constant and therefore used the same materials and locations across sessions for each participant. Although not a focus of this study, we found that the amount and type of materials, along with the organization of the space is another important, but not always well-described, component of NDBIs. Understanding the effects of the materials used during sessions on child outcomes would be a beneficial area for future research. This might include studies evaluating the impact of features such as the number of available materials, novelty of materials across sessions, preference for those materials (e.g., moderately vs. highly preferred), and intended use of materials (e.g., those designed for independent play vs. those that lend themselves to cooperative play) on children's language, play, and dyadic engagement. In terms of practice, additional guidance for caregivers and practitioners on determining the types of toys and play strategies to use to become an engaging and motivating play partner when implementing NDBIs would be useful.

**Limitations**

Several limitations of this study warrant discussion. First, although we attempted to include a wide range of possible behaviors in our response definition of dyadic engagement, it is still based on neurotypical norms and may provide a limited view of engagement. For example, Camron and Evelyn commonly indicated engagement by commenting or asking questions, whereas Anthony and Lyla commonly indicated engagement by looking at the implementer. It is possible there were additional instances where Anthony or Lyla were attending or engaged with the implementer, but it was not captured by our definition. Though this concern is somewhat

lessened by the differentiation we observed between conditions, it remains a worthwhile consideration when analyzing data on dyadic engagement.

Second, sequence effects are particularly relevant to any alternating treatments single case design study (Ledford & Gast, 2024). Camron's results point to the potential inhibitive effects on the control condition when the high interaction conditions were introduced. This does not preclude determination of a functional relation; however, it suggests that the interaction between conditions may have influenced the engagement levels we observed. Our findings should be interpreted in light of this potential threat to internal validity.

Third, Camron and Evelyn often communicated using phrase speech and engaged in symbolic play with the implementer during sessions. As a result, implementers' modeling play and modeling language behaviors were often intertwined (e.g., while playing hair salon, the implementer says, "it's the princesses turn next"). Therefore, momentary time sampling did not always capture play behaviors in these sessions that might have included brief, symbolic play acts (e.g., pretending to use a blow dryer).

**Conclusion**

There is evidence to support the use of NDBIs for teaching toddlers and preschoolers a wide range of communication, play, and adaptive skills. Importantly, these approaches often include developmentally appropriate teaching strategies within the context of reciprocal and responsive adult interactions to maintain or increase the value of social interactions while teaching new skills. Understanding how these interventions work and which components are linked to specific child outcomes will help researchers and practitioners alike to tailor their recommendations and adjust intervention as needed to promote the best possible child outcomes (Bruinsma et al., 2020; Schreibman et al., 2015; Vivanti et al., 2018). Engagement is one child

outcome of interest that has implications for downstream, broader effects over time (Frost & Ingersoll, 2023; Wetherby et al., 2018). Our findings lend evidence to the role of modeling and expanding on play in combination with modeling and expanding on language for supporting children's joint engagement during intervention, particularly for those who experience difficulties with social communication and imitation.

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## Tables and Figures

**Table 1.** *Participant Demographic Characteristics*

| Child | Age at Intake | Sex | Race | Disability Status & Related Services |
|---|---|---|---|---|
| Child 1 ("Anthony") | 41 months | Male | Black & Native American | None identified; receiving speech |
| Child 2 ("Camron") | 33 months | Male | Caucasian & Pacific Islander | None identified; no outside services |
| Child 3 ("Evelyn") | 60 months | Female | African American | Speech delay; receiving speech, OT, and PT |
| Child 4 ("Lyla") | 41 months | Female | African American | ASD; receiving speech, OT, PT, and ABA |

*Note.* ASD = autism spectrum disorder, OT = occupational therapy, PT = physical therapy, and ABA = applied behavior analysis therapy

**Table 2.** *Participant Language and Play Characteristics at Intake*

| Child | PLS-5 Standard Score | MIS Score | PDDBI SOCAPP T Score | SPA | Play-based Language |
|---|---|---|---|---|---|
| Anthony | Auditory: 55<br>Expressive: 66<br>Total: 58 | 56.25% | 57 | Functional play | Vocalizing and looking |
| Camron | Auditory: 112<br>Expressive:111<br>Total: 112 | 87.5% | 67 | Relational play | 3+ word phrases |
| Evelyn | Auditory: 88<br>Expressive: 80<br>Total: 83 | 100% | 68 | Symbolic play | 3+ word phrases |
| Lyla | Auditory: 57<br>Expressive: 62<br>Total: 56 | 37.5% | 42 | Functional play | Vocalizing and leading |

*Note.* PLS-5 = Preschool Language Scales 5th Edition, MIS = Motor Imitation Scale, PDDBI = Pervasive Developmental Disorder Behavior Inventory, SOCAPP = Social Approach Behaviors subscale, SPA = Structured Play Assessment

**Table 3.** *Participant Preferences*

| Child | Preferred Toys and Materials | Caregiver Questionnaire | Teacher Questionnaire |
|---|---|---|---|
| Anthony | Baby doll set<br>Toy food<br>Ball drop<br>Tea set/utensils | Questionnaire not returned by caregiver | Occasionally enjoys praise |
| Camron | Toy motorcycle<br>Car ramp/truck<br>Figurines<br>Dinosaurs<br>Toy skateboards | Dislikes playing with same materials as adult | Enjoys praise and social attention |
| Evelyn | Baby doll set<br>Hair accessories<br>Figurines<br>Tea set/utensils<br>Blocks | Generally likes playing with same materials as adult | Enjoys praise and social attention |
| Lyla | Baby doll set<br>Toy food<br>Playdoh<br>Art materials | Typically not bothered playing with same materials as adult | Not motivated by praise or social attention |

*Note.* Responses from open-ended questions on questionnaires have been summarized.

**Table 4.** *Dyadic Engagement Inter-Observer Agreement (IOA) Data across Participants and Conditions*

| Participant | Total | Control | High Language | High Language + Play |
|---|---|---|---|---|
| Anthony | 89.95% (82.5-96.67%) | 93.84% (91-96.67%) | 92.61% (90.22-95%) | 85.56% (82.5-87.5%) |
| Camron | 85.29% (81.51-89.17%) | 86.04% (82.5-89.17%) | 83.67% (81.51-85.83%) | 85.42% (84.17-86.67%) |
| Evelyn | 87.29% (73.33-97.5%) | 95.83% (92.5-97.5%) | 86.94% (83.33-92.5%) | 75% (73.33-76.67%) |
| Lyla | 88.61% (83.33-99.17%) | 93.34% (87.5-99.17%) | 88.34% (86.67-90%) | 84.17% (83.33-85%) |
| Total | 87.65% (73.33-99.17%) | 91.45% (82.5-99.17%) | 87.78% (81.51-95%) | 82.87% (73.33-87.5%) |

*Note.* Data were collected across baseline, intervention, and child choice phases. Averages are displayed followed by ranges in parentheses.

**Table 5.** *Procedural Fidelity (PF) and Inter-Observer Agreement (IOA) Data across Participants*

| Participant | PF | PF IOA | Modeling Language IOA | Modeling Play IOA |
|---|---|---|---|---|
| Anthony | 100% | 100% | 75.87% (67.14-90%) | 90.83% (73.33-100%) |
| Camron | 100% | 100% | 84.57% (62.5-100%) | 92.5% (81.67-100%) |
| Evelyn | 100% | 100% | 87.44% (80-100%) | 90.21% (78.33-100%) |
| Lyla | 100% | 97.22% (88.89-100%) | 69.29% (33.33-83.33%) | 94.97% (88.33-100%) |
| Total | 100% | 99.15% (88.89-100%) | 80.25% (33.33-100%) | 92.03% (73.33-100%) |

*Note.* IOA = inter-observer agreement. Data were collected across baseline, intervention, and child choice phases. Averages are displayed followed by ranges in parentheses.

**Table 6.** *Modeling Language and Play Data across Participants and Conditions*

| Participant | Control | High Language | High Language + Play |
|---|---|---|---|
| Anthony | | | |
| Modeling Language | 0.95 (0.6-1.25) | 9.23 (8.9-9.6) | 10.61 (8.6-13.2) |
| Modeling Play | 2.82% (0-5%) | 6.77% (3.33-8.7%) | 67.62% (41.67-95%) |
| Camron | | | |
| Modeling Language | 1.1 (0.8-1.4) | 7.47 (6.6-8.7) | 8.37 (6.4-10.4) |
| Modeling Play | 9.56% (0-15%) | 11.67% (6.67-20%) | 66.25% (48.33-78.33%) |
| Evelyn | | | |
| Modeling Language | 1.1 (0.6-1.4) | 8.11 (7-9.1) | 8.32 (7.4-9.7) |
| Modeling Play | 0.56% (0-3.33%) | 5.83% (1.67-10%) | 47.96% (28.33-70%) |
| Lyla | | | |
| Modeling Language | 0.57 (0.2-1) | 7.46 (6.6-8.5) | 7.82 (6.1-9.3) |
| Modeling Play | 2.14% (0-5%) | 6.67% (0-16.67%) | 72.55% (63.33-98.33%) |
| Total | | | |
| Modeling Language | 0.91 (0.2-1.4) | 7.99 (6.6-9.6) | 8.79 (6.1-13.2) |
| Modeling Play | 3.97% (0-15%) | 7.87% (0-20%) | 62.13% (28.33-98.33%) |

*Note.* Modeling language reflects average rate per minute and modeling play reflects average percent of intervals.

**Table 7.** *Naïve Ratings of Interaction Characteristics across Conditions*

| Characteristic | All Conditions (*n*=90) | Control (*n*=30) | High Language (*n*=30) | High Language + Play (*n*=30*) |
|---|---|---|---|---|
| Child affect | Mostly Positive (38.9%) | Neutral (70%) | Mostly Positive (60%) | Positive (73.3%) |
| Adult affect | Positive (40%) | Neutral (73.3%) | Mostly Positive (63.3%) | Positive (93.3%) |
| Matched affect | Matched (54.4%) | Neutral (36.7%) | Matched (50%) | Matched (86.7%) |
| Child interest | Mostly Interested (63.3%) | Some Interest (50%) | Some Interest (70%) | Mostly Interested (93.1%) |
| Rapport | Good (43.3%) | Neutral (46.7%) | Good (63.3%) | Excellent (65.5%) |

*Note.* The most frequently selected answer is reported followed by the percent of respondents who provided that rating. There was one participant who did not answer the questions about child interest or rapport from one of the high language + play interaction videos.

**Table 8.** *Naïve Ratings for the Control Condition*

| Characteristic | Negative | Mostly Negative | Neutral | Mostly Positive | Positive |
|---|---|---|---|---|---|
| Child affect | 0 | 0 | 21 (70%) | 9 (30%) | 0 |
| Adult affect | 0 | 1 (3.3%) | 22 (73.3%) | 7 (23.3%) | 0 |
| | Mismatched | Mostly Mismatched | Neutral | Mostly Matched | Matched |
| Matched affect | 0 | 4 (13.3%) | 11 (36.7%) | 7 (23.3%) | 8 (26.7%) |
| | Mostly Disinterested | Some Disinterest | Neutral | Some Interest | Mostly Interested |
| Child interest | 1 (3.3%) | 2 (6.7%) | 3 (10%) | 15 (50%) | 9 (30%) |
| | Poor | Fair | Average | Good | Excellent |
| Rapport | 1 (3.3%) | 4 (13.3%) | 14 (46.7%) | 11 (36.7%) | 0 |

*Note.* The total number of responses for each category is reported followed by the percent of respondents who provided that rating.

**Table 9.** *Naïve Ratings for the High Language Condition*

| Characteristic | Negative | Mostly Negative | Neutral | Mostly Positive | Positive |
|---|---|---|---|---|---|
| Child affect | 0 | 0 | 10 (33.3%) | 18 (60%) | 2 (6.7%) |
| Adult affect | 0 | 0 | 3 (10%) | 19 (63.3%) | 8 (26.7%) |
| | Mismatched | Mostly Mismatched | Neutral | Mostly Matched | Matched |
| Matched affect | 0 | 1 (3.3%) | 4 (13.3%) | 10 (33.3%) | 15 (50%) |
| | Mostly Disinterested | Some Disinterest | Neutral | Some Interest | Mostly Interested |
| Child interest | 0 | 0 | 0 | 9 (30%) | 21 (70%) |
| | Poor | Fair | Average | Good | Excellent |
| Rapport | 0 | 0 | 7 (23.3%) | 19 (63.3%) | 4 (13.3%) |

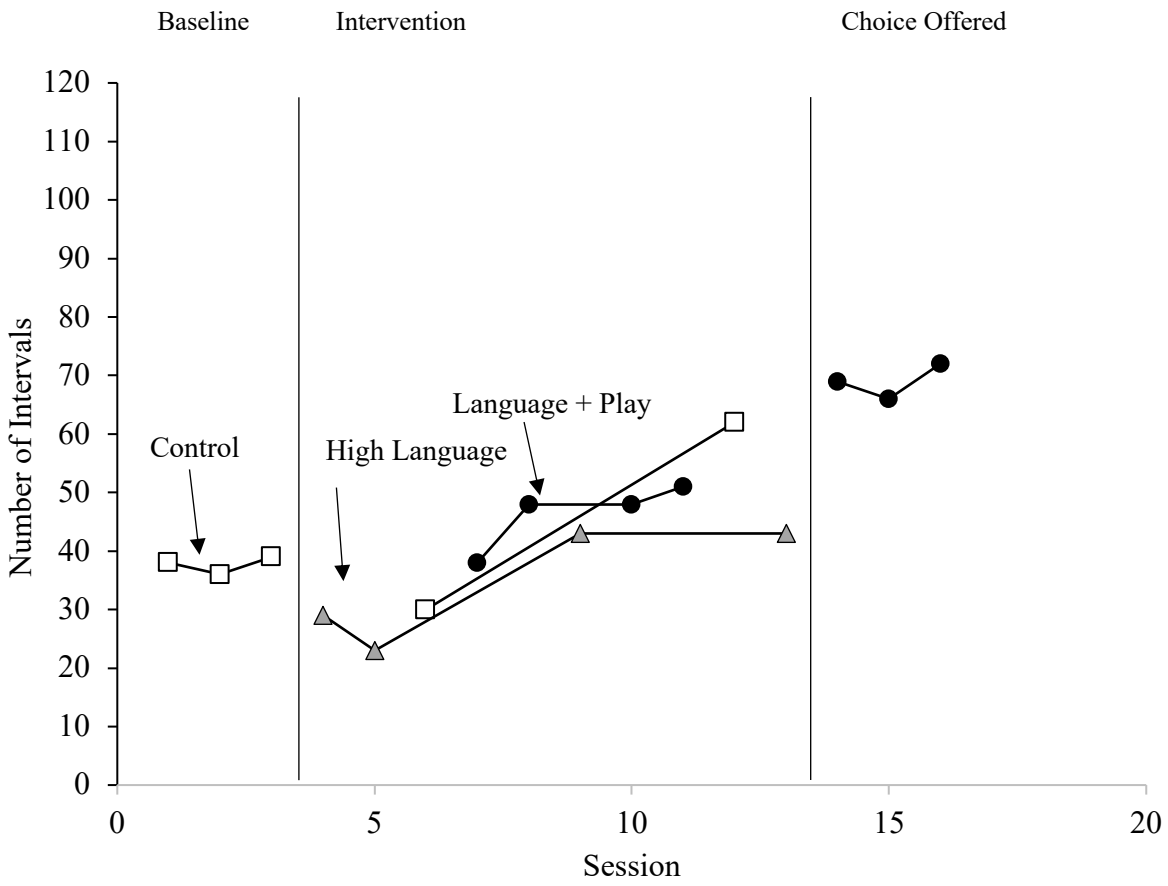
*Note.* The total number of responses for each category is reported followed by the percent of respondents who provided that rating.

**Table 10.** *Naïve Ratings for the High Language + Play Condition*

| Characteristic | Negative | Mostly Negative | Neutral | Mostly Positive | Positive |
|---|---|---|---|---|---|
| Child affect | 0 | 0 | 0 | 8 (26.7%) | 22 (73.3%) |
| Adult affect | 0 | 0 | 0 | 2 (6.7%) | 28 (93.3%) |
| | Mismatched | Mostly Mismatched | Neutral | Mostly Matched | Matched |
| Matched affect | 0 | 2 (6.7%) | 0 | 2 (6.7%) | 26 (86.7%) |
| | Mostly Disinterested | Some Disinterest | Neutral | Some Interest | Mostly Interested |
| Child interest | 0 | 0 | 0 | 2 (6.9%) | 27 (93.1%) |
| | Poor | Fair | Average | Good | Excellent |
| Rapport | 0 | 1 (3.4%) | 0 | 9 (31%) | 19 (65.5%) |

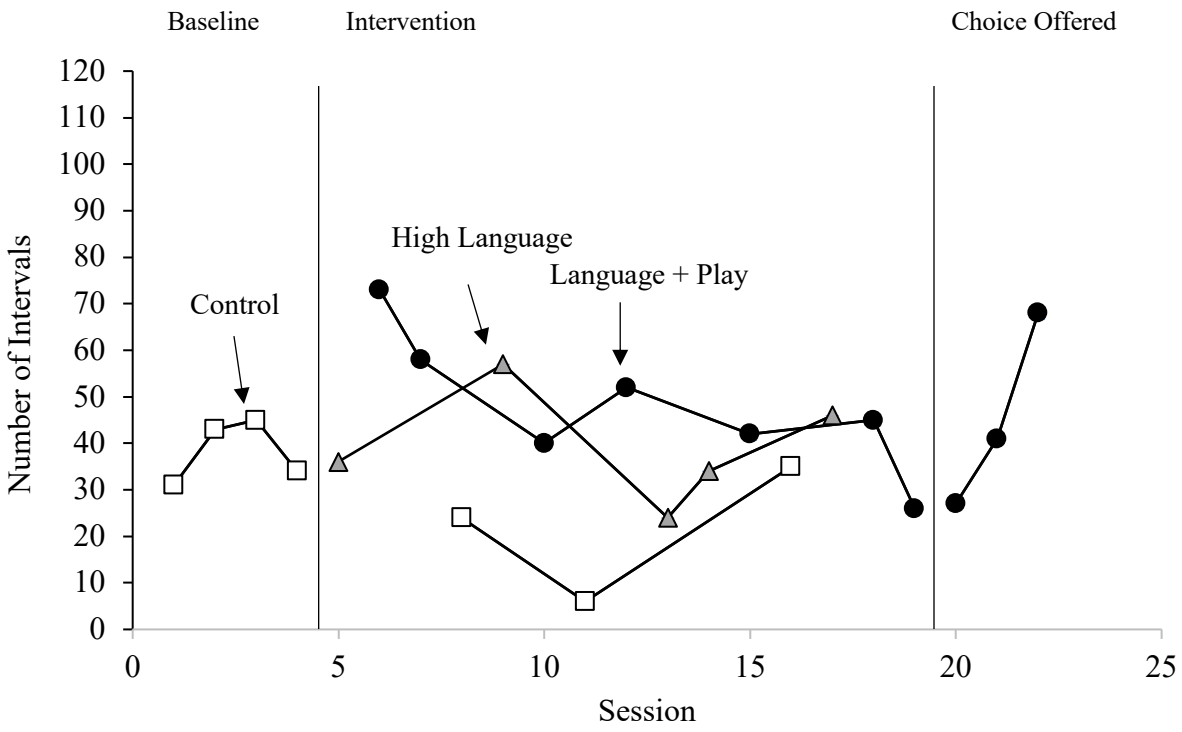
*Note.* The total number of responses for each category is reported followed by the percent of respondents who provided that rating.

**Figure 1.** *Dyadic Engagement for Anthony*




*Note.* We estimated number of intervals in sessions 12 and 13.

**Figure 2.** *Dyadic Engagement for Camron*




*Note.* We estimated number of intervals in sessions 4 and 15.

**Figure 3.** *Dyadic Engagement for Evelyn*

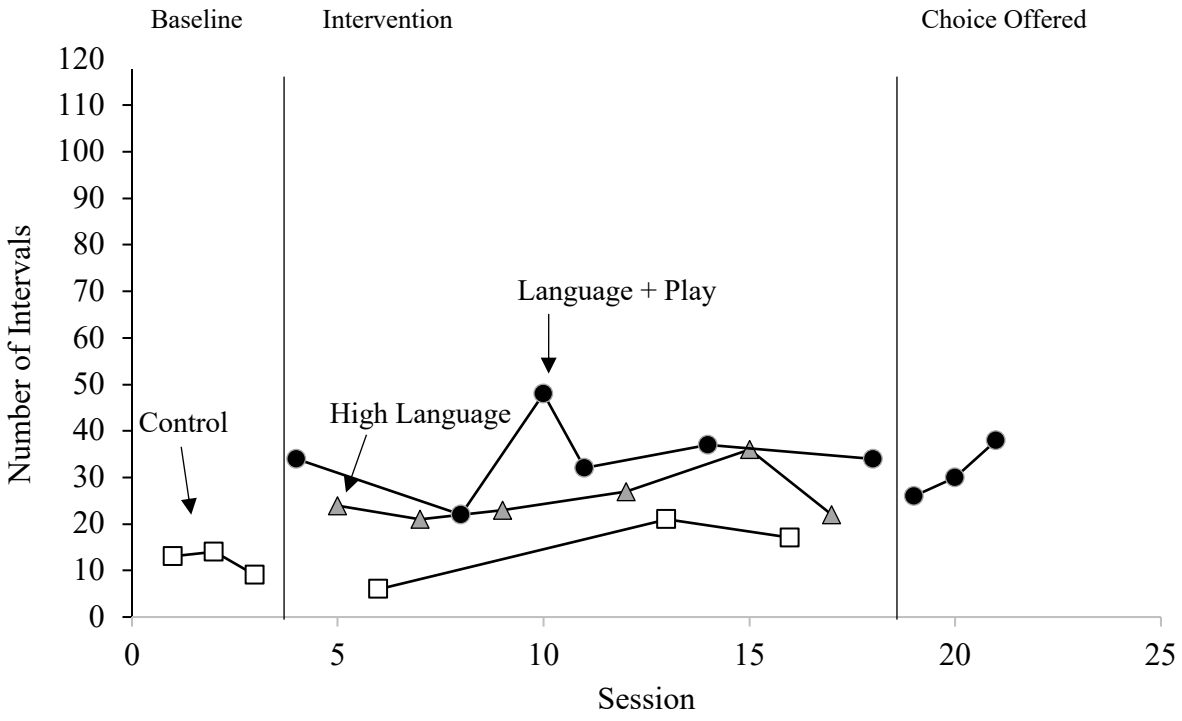
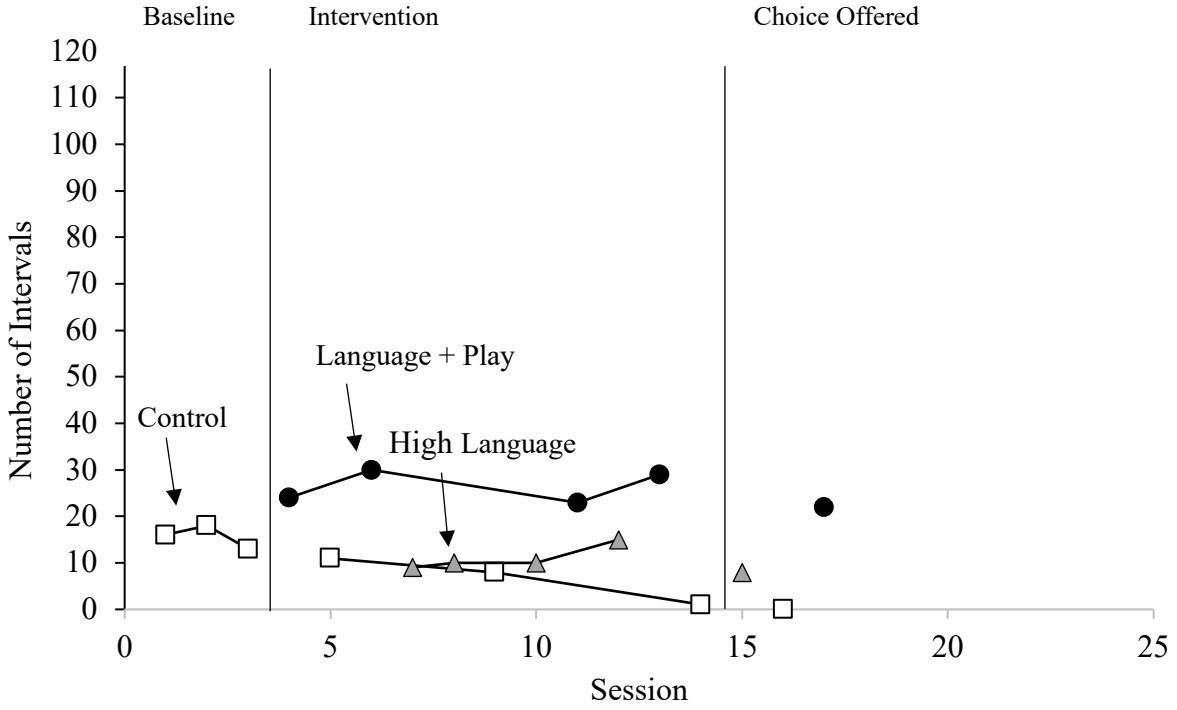


**Figure 4.** *Dyadic Engagement for Lyla*




*Note.* We estimated number of intervals in sessions 2 and 13. She did not communicate a choice; therefore, data in this phase reflect randomized session types.

## Appendix A

Caregiver Questionnaire

**Participant Demographic Information**

Child Age & Birthday:

Sex:

Race/Ethnicity:

Diagnosis/Disability Status:

When was the diagnosis received?

Does your child currently receive any additional educational services or therapies?
Yes / No

If yes, please list what type and how often:

There are some children who like playing with the same materials as an adult and some who don't. If you play with the same materials as your child while they are playing with it, do they generally like it or dislike it?

_____
_____
_____

How does your child usually communicate with you?

- ☐ Sounds
- ☐ 1-2 Words
- ☐ Phrases
- ☐ Gestures/Pointing
- ☐ Sign Language/AAC
- ☐ Other: _____

Favorites

Top three favorite activities:

Top three favorite toys/objects:

Other:

Dislikes

Activities:

Toys/objects:

Textures/sensory items:

Other:

Areas of Interest

- ☐ Letters/Alphabet
- ☐ Shapes
- ☐ Sports
- ☐ Animals
- ☐ Numbers
- ☐ Vehicles
- ☐ _____

Anything else you'd like us to know?

_____
_____
_____
_____

Teacher Questionnaire

Favorites
Top three favorite activities:

Top three favorite toys/objects:

Other:

Dislikes
Activities:

Toys/objects:

Textures/sensory items:

Other:

Areas of Interest

- ☐ Letters/Alphabet
- ☐ Shapes
- ☐ Sports
- ☐ Animals
- ☐ Numbers
- ☐ Vehicles
- ☐ _____

Does this student enjoy praise and social attention?

_____
_____
_____

## Appendix B

Free Operant Data Sheet

| Date: | Location: | Teacher: | Child: |
|---|---|---|---|

| Item/Activity | Approached | Did not approach | Engaged with | Duration of engagement |
|---|---|---|---|---|
| | | | | _____ min, _____ s |
| | | | | _____ min, _____ s |
| | | | | _____ min, _____ s |
| | | | | _____ min, _____ s |
| | | | | _____ min, _____ s |
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| | | | | _____ min, _____ s |
| | | | | _____ min, _____ s |

**Highest preferred** (approached frequently, engage with for longest durations):

**Moderately preferred** (approached, engaged with shortest durations):

**Low preferred** (did not approach):

## Appendix C

Baseline PF Checklist

Video Name:

Data Collector Initials:

| Start of Session | | | | Criterion/Notes |
|---|---|---|---|---|
| Apparent distractions or unused materials have been removed or minimized | Yes | No | NA | |
| A variety of preferred materials are visibly available in the space | Yes | No | NA | At least three play sets/choices of materials |
| Begins sessions by commenting on available play materials (e.g., I see trains!) | Yes | No | NA | |
| **During Session** | | | | |
| Follows the child's lead of preferred materials (e.g., provides options and moves with child to child-chosen activities) | Yes | No | NA | <1-2 missed opportunities or changes in activity/materials without child indication of preference |
| Remains face to face (e.g., bodies oriented towards each other and within line of sight) | Yes | No | NA | <1-2 missed opportunities (not face to face for >60 s) |
| Moves play materials or self to position toys between implementer and child | Yes | No | NA | <1-2 missed opportunities (toys not positioned for >60 s) |
| Contingent on sustained disengagement, attempts to re-engage child by offering choices or introducing a new way to play with materials | Yes | No | NA | <1-2 missed opportunities (disengaged for >60 s) |
| Displays positive affect and animation (e.g., adjusts vocal quality, tone, gestures, and facial expressions to match child arousal levels; overall interaction is characterized by warmth, interest, and positivity) | Yes | No | NA | |
| Responds to all communicative attempts or initiations with a neutral statement of acknowledgement within 5 s | Yes | No | NA | <1-2 missed opportunities or off-topic responses |
| Number of: | | | | Percent: |

# Intervention PF Checklist

Video Name:

Data Collector Initials:

| Start of Session | | | | Criterion/Notes |
|---|---|---|---|---|
| Apparent distractions or unused materials have been removed or minimized | Yes | No | NA | |
| A variety of preferred materials are visibly available in the space | Yes | No | NA | At least three play sets/choices of materials |
| Begins sessions by commenting on available play materials (e.g., I see trains!) | Yes | No | NA | |
| During Session | | | | |
| Follows the child's lead of preferred materials (e.g., provides options and moves with child to child-chosen activities) | Yes | No | NA | <1-2 missed opportunities or changes in activity/materials without child indication of preference |
| Remains face to face (e.g., bodies oriented towards each other and within line of sight) | Yes | No | NA | <1-2 missed opportunities (not face to face for >60 s) |
| Moves play materials or self to position toys between implementer and child | Yes | No | NA | <1-2 missed opportunities (toys not positioned for >60 s) |
| Contingent on sustained disengagement, attempts to re-engage child by offering choices or introducing a new way to play with materials | Yes | No | NA | <1-2 missed opportunities (disengaged for >60 s) |
| Displays positive affect and animation (e.g., adjusts vocal quality, tone, gestures, and facial expressions to match child arousal levels; overall interaction is characterized by warmth, interest, and positivity) | Yes | No | NA | |
| Responds to all communicative attempts or initiations with on-topic or contextually relevant response within 5 s | Yes | No | NA | <1-2 missed opportunities or off-topic responses |
| | Number of: | | | Percent: |

## Appendix D

Video Name: _____ Date: _____

What is your current professional role?

_____Student
_____Teacher
_____Researcher
_____Behavior Analyst
_____Speech-Language Pathologist
_____Occupational Therapist

1. Overall, how would you characterize the child's affect during this interaction?
   *Negative*: appears discontent, upset, or disinterested (whining, crying, fussing, frowning)
*Neutral*: maintains neutral facial expressions, energy, and interest
   *Positive*: appears enthusiastic, happy, and interested (laughing, smiling)

Negative Mostly Negative Neutral Mostly Positive Positive

2. Overall, how would you characterize the adult's affect during this interaction?
   *Negative*: appears discontent, upset, or disinterested
   *Neutral*: maintains neutral facial expressions, energy, and interest
   *Positive*: appears enthusiastic, happy, and interested

Negative Mostly Negative Neutral Mostly Positive Positive

3. Overall, how would you characterize the match between the adult and child's affect (including vocal quality, tone, volume, gestures, and facial expressions) during this interaction?
   *Mismatched*: adult and child appear out of sync most of the time
   *Neutral*: adult and child appear neither highly attuned nor out of sync; similar amounts of matched and mismatched affect are observed
   *Matched*: adult and child appear attuned and in sync most of the time

Mismatched Mostly Mismatched Neutral Mostly Matched Matched

4. Overall, how would you characterize the child's interest in the adult and materials during this interaction?
   *Mostly Disinterested*: often actively avoids interacting with the adult or materials
   *Neutral*: neither avoiding nor seeking out interaction with the adult or materials
   *Mostly Interested*: often actively seeks out interaction with the adult or materials

Mostly Disinterested  Some Disinterest  Neutral  Some Interest  Mostly Interested

5. Overall, how would you characterize the rapport between the child and adult?
   *Poor*: there is no relationship, or a negative relationship between the child and adult
   *Neutral*: the relationship between the child and adult is neither positive nor negative
   *Excellent*: there is a strong positive relationship between the child and adult

Poor  Fair  Average  Good  Excellent