NATURALISTIC BEHAVIORAL INTERVENTIONS FOR SOCIAL-COMMUNICATION SKILLS IN YOUNG CHILDREN WITH ASD: A SYSTEMATIC LITERATURE REVIEW AND EMPIRICAL INVESTIGATION

by

ASHLEY H. DUBIN

(Under the Direction of Rebecca Lieberman-Betz and A. Michele Lease)

ABSTRACT

Significant social communication impairments, including deficits in joint attention (JA) are present in individuals with autism spectrum disorder (ASD) and impede development across several aspects of functioning (American Psychiatric Association [APA], 2013). Much research has been devoted to evaluating interventions designed to improve early social communication deficits, as improvement in these pivotal skills is thought to lead to overall improvement in the developmental trajectory (e.g., Mundy & Crowson, 1997). The purpose of the following two studies was to synthesize the extant research on naturalistic behavioral interventions designed to target early social communication skills for children with ASD and further the research base by conducting an empirical investigation of one such naturalistic behavioral intervention, Prelinguistic Milieu Teaching (PMT), implemented in preschool classrooms with children with or at risk for ASD. The first study was a systematic review of studies examining the effects of naturalistic behavioral interventions on prelinguistic social communication skills in children with ASD. Results suggested evidence for interventions effects; however,

methodological issues precluded interpretation of effects in several studies. Information was provided regarding study quality, the students and behaviors for which naturalistic interventions have demonstrated functional relations, information about components of effective interventions as well as generalization and maintenance of effects. In the second study, PMT was empirically investigated within the context of a multiple baseline design across participants. Results provide support for the use of PMT in preschool classrooms, as all three participants exhibited gains in intentional communication skills upon implementation. Furthermore, although PMT was implemented by graduate students, teachers were observed to utilize some strategies consistent with PMT during teacher-child play samples. Results from the systematic literature review and empirical investigation of PMT implemented in preschool classrooms have implications for future research and practice in the area of intervention to improve prelinguistic social communication skills for students with or at risk for ASD.

INDEX WORDS: Autism Spectrum Disorder, prelinguistic social communication, naturalistic behavioral intervention

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CHAPTER 1

INTRODUCTION

Autism spectrum disorder (ASD) is a developmental disorder characterized by impairments in social communication and the presence of restricted and repetitive patterns of behaviors and interests (American Psychiatric Association [APA], 2013). As defined in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5), shared qualitative impairments in the two core areas are rated on a severity scale to account for heterogeneity of symptom presentation and functioning manifest across individuals with ASD (APA, 2013; Mahjouri & Lord, 2012). ASD symptoms typically begin to emerge in infancy and early childhood (Ozonoff, Goodlin-Jones, & Solomon, 2005; Mundy, Sigman, Ungerer, & Sherman, 1986) and can be diagnosed reliably by age two (Chawarska, Klin, Paul, & Volkmar, 2007).

According to the most recent report from the Centers for Disease Control and Prevention (CDC), it is estimated that 1 in 68 children in the United States has been diagnosed with ASD by age 8 (CDC, 2014). The current prevalence rate estimate reflects an increase from the national estimate of 1 in 88 in 2012, and is consistent with increasing trends reported in recent years (Chakrabarti & Fombonne, 2005). Additionally, according to data from a report by the Office of Special Education Programs (OSEP), 710,371 students ages three to five years received special education services in 2007 (OSEP, 2009). Of these students, 5.6% were served under the autism eligibility category, which represents the third largest preschool special education

category behind speech language impairment (46%) and developmental delay (38%). Given the increase in prevalence rates, number of students receiving special education services, and overall increases in public awareness (CDC, 2012, 2014; OSEP, 2009), a large proportion of ASD research continues to focus on interventions addressing core ASD impairments.

Social Communication Development

Social communication impairments are often considered the primary deficits in ASD, as early emerging social communication skills that are delayed or absent in children with ASD form the foundation for learning and functioning across several developmental domains (Kasari, Freeman, & Paparella, 2001; Sigman & McGovern, 2005). The earliest recognized social communication deficit unique to ASD is delayed or absent *joint attention* (JA; Baron-Cohen, Allen, & Gillberg, 1992; Mundy et al., 1986; Osterling & Dawson, 1994), which involves actively coordinating attention between an object or event and another person for the purpose of sharing (Bakeman & Adamson, 1984). In typically developing children, JA behaviors involved in engagement, communicating with and responding to others emerge between 9 and 18 months of age (Bakeman & Adamson, 1984). JA impairments are evident within the first year of life and differentiate children with ASD from typically developing children and children with other developmental delays (Charman et al., 1997; Dawson et al., 2004; Lewy & Dawson, 1992; Landry & Loveland, 1988; Mundy et al., 1986).

Siebert, Hogan, and Mundy (1982) outlined terminology to describe early social communicative behaviors involving coordinated attention based on pragmatic function and whether the child is initiating communication or responding to another's

communication: responding to joint attention (RJA), defined as a child's response to another's gaze shift, gesture, or vocalization, initiating joint attention (IJA), defined as child use of gaze shifts, gestures, and/or vocalization to direct another's attention, initiating behavioral requests (IBR), which involves behaviors similar to IJA used for the purpose of requesting, and responding to behavioral requests (RBR), defined as complying with another's request.

The coordinated use of the aforementioned prelinguistic behaviors in a purposeful manner is often referred to as intentional communication (Warren et al., 2006), which can serve the pragmatic functions of showing or labeling (i.e., proto-declaratives or IJA), requesting (i.e., proto-imperatives or IBR), and social interaction (Bruner, 1981). Prelinguistic behaviors that comprise intentional communication for the aforementioned pragmatic functions (e.g., gestures, eye gaze, vocalizations) are often impaired in children with ASD (Chawarska et al., 2007; Shumway & Wetherby, 2009; Stone, et al., 1997). When compared with typically developing children and children with other developmental delays, children with ASD display fewer and less complex forms of intentional communication (Mundy, Sigman, & Kasari, 1990; Sigman & Ruskin, 1999; Stone, et al., 1997), although several studies have demonstrated requesting may be less impaired than sharing attention (Baron-Cohen, 1989; Curcio, 1978; Loveland & Landry, 1986; Mundy, 1986; Paparella et al., 2011; Stone, Ousley, Yoder, Hogan, & Hepburn, 1997; Wetherby et al., 1989).

Given deficits in prelinguistic social communicative behaviors, children with ASD experience significantly fewer communication and learning opportunities within the context of social interaction. Reduced participation in social interactions with adults has

significant ramifications for later learning and development, as many early skills involved in language and socialization are learned within the context of social interactions between a child and caregiver or other adult (Adamson, Bakeman, & Deckner, 2004; Baldwin, 1995; Bruner, 1981; Tomasello, 1995). Prelinguistic social communication involving JA has been shown to be concurrently and predictively related to spoken language (Dawson et al., 2004; McCathren, Yoder, & Warren, 1999; McDuffie, Yoder, & Stone, 2005; Mundy, Kasari, Sigman, & Ruskin, 1995; Watt, Wetherby, & Shumway, 2006). Such evidence has prompted several researchers to suggest that prelinguistic social communication may establish the foundation for using spoken language to communicate (McCathren et al., 1999; Toth, Munson, Meltzoff, & Dawson, 2006; Watt et al., 2006). In addition to spoken language, JA is also related to development of more complex social behaviors, such as social initiations and symbolic play, in typically developing children and children with ASD (Bates, et al., 1979; Carpenter & Tomasello, 2000; McCathren, et al., 1999; Mundy & Gomes, 1998).

The variety of communication and learning opportunities afforded by JA suggest it may be a pivotal skill (Mundy & Crowson, 1997; Schreibman, Stahmer, & Pierce, 1996), which is a behavior that once improved has the potential to facilitate improvements across several other related behaviors (Charman, 2003; Koegel, Koegel, & Carter, 1999). The classification of JA as a pivotal skill highlights the need for early intervention services that prioritize facilitating JA and other prelinguistic social communication skills for children showing deficits associated with ASD (Jones & Carr, 2004; Mundy & Crowson, 1997). The extant research on early social communication interventions is promising, as several different interventions have been shown to produce

improvements across a range of skills (e.g., Carr & Kemp, 1989; Lovaas, 1987; Yoder & Stone, 2006; Yoder & Warren, 1998, 1999).

Early Social Communication Interventions

Early intervention programs with the most research support include variants of *early intensive behavioral interventions* (EIBI), which use principles of applied behavior analysis to teach various skills including RJA and IJA, and developmental models that apply similar principles in a more functional framework (Warren et al., 2011). Whereas the effectiveness of highly structured behavioral interventions is a replicated finding, limitations exist including lack of generalization to natural environments and skill maintenance (Lovaas, 1997; Schreibman & Ingersoll, 2005). Evidence of limited generalization and maintenance, as well as the movement toward providing education in the least restrictive environment, has led to increased use of naturalistic behavioral interventions (Ledford & Wolery, 2011; Sowden, Perkins, & Clegg, 2011). Naturalistic interventions are considered effective in teaching core social communication skills to children with ASD (Kaiser & Trent, 2007; NRC 2001; White et al., 2011). Compared with highly structured, adult-led behavior interventions, which may not facilitate spontaneous, generalized child-initiated social communication due to the adult-led nature of instruction (Kaiser & Trent, 2007; Schreibman, 1997; Wetherby, 1986), naturalistic interventions may be more appropriate for teaching prelinguistic social communication. In contrast, key components of naturalistic interventions, including instruction embedded in the child's natural environment and the provision of natural consequences, are consistent with strategies used to program for generalization (Stokes & Osnes, 1989). In naturalistic interventions, skills are taught using child preferred items and activities that

may increase child engagement and therefore motivation to communicate. Motivation is especially important to teach generalized IJA, or intentional communication for the sole purpose of sharing attention, for which the natural consequence is social interaction (Koegel & Koegel, 1995). Jones and Carr (2004) suggest finding social interaction reinforcing is a prerequisite to acquisition of IJA for children with ASD. For many children with ASD, social interaction is not a natural reinforcer and thus may need to be facilitated for interventions to produce generalized improvement in IJA (Dube, MacDonald, Mansfield, Holcomb, & Ahearn, 2004; Jones & Carr, 2004). By first establishing fun social routines between the child and adult, and teaching prelinguistic communication for the purpose of requesting prior to targeting communication for the purpose of sharing attention, naturalistic behavioral interventions may condition social interactions as reinforcers and thus provide a motivating context for IJA instruction.

Several naturalistic behavioral interventions exist that share the goal of promoting generalized behavior change across a variety of skills (including prelinguistic social communication) through similar instructional strategies (Kaiser & Trent, 2007; Yoder & Warren, 1998, 1999; Yoder & Stone, 2006). Examples include prelinguistic milieu teaching (PMT; Yoder & Warren, 1998), Pivotal Response Training (PRT; Koegel, Koegel, Harrower, & Carter, 1999), and Responsive Interaction (RI; Kaiser & Delaney, 1998). These interventions share components including embedding instruction within natural environments and activities, following the child's lead, strategic use and fading of prompts, and providing natural consequences (Kaiser & Trent, 2007).

In addition to repeated demonstrations of the efficacy of naturalistic behavioral interventions implemented in home and clinic settings (e.g., Kasari, Freeman, &

Paparella., 2006; Whalen, Schreibman, & Ingersoll, 2006; Yoder & Stone, 2006) for both targeted and collateral behaviors, evidence is beginning to emerge supporting the use of such interventions in preschool classrooms (e.g., Lawton & Kasari, 2012; McCathren, 2000). The use of naturalistic behavioral interventions in preschool classrooms appears to be consistent with mandates for use of research-supported interventions recommended by the National Research Council (NRC, 2001) and outlined in the reauthorization of the Individuals with Disabilities Education Improvement Act (IDEIA, 2004). Despite mandates, many teachers lack knowledge of research-supported interventions for students with ASD (Barnard, Knapp, & Neuharth-Pritchett, 2011; Kasari, Freeman, Bauminger, & Alkin, 1999). Additionally, prelinguistic social communication behaviors are often not targets of instruction, even in preschool special education classrooms with students with ASD for whom such instruction is crucial (Wong & Kasari, 2012). Consultation between school psychologists and preschool teachers regarding naturalistic behavior interventions may be a viable option to promote teacher knowledge and use of research supported interventions (Christensen-Sandfort & Whinnery, 2013; Hoagwood & Johnson, 2003), especially given preschool teacher preference for naturalistic interventions (Turan, Ostrosky, Halle, & Destefano, 2004). Continued research exploring specific, operationally-defined child outcomes as well as teacher attitudes and behaviors is required to determine the efficacy and feasibility of implementing naturalistic prelinguistic social communication interventions in preschool classrooms.

Purpose of the Studies

The purpose of the following studies is to provide a comprehensive synthesis of prior research on naturalistic behavioral interventions used to improve early social

communication skills for children with ASD and extend past research by conducting an empirical investigation of one such intervention, PMT, in a preschool classroom for children with or at risk for ASD. First, Study 1, a systematic review of studies that have investigated the use of naturalistic interventions to target prelinguistic social communication skills for children with ASD, provides a synthesis of the existing empirical evidence for these interventions. The review will primarily focus on the students and behaviors for which naturalistic interventions have demonstrated effects, information about generalization and maintenance of effects, quality of studies, and components of effective interventions. Study 2 serves as an empirical investigation of PMT that seeks to extend previous research through (a) implementation in a preschool classroom, (b) measurement of collateral effects of PMT on RJA, imitation, spoken language, and object interest, and (c) collection of data on teacher behavior and attitudes before, during, and after PMT implementation to provide information about the feasibility of teacher implementation. Through collecting data on well-defined child behaviors, including PMT targets and associated non-targeted behaviors, across baseline, intervention, generalization, and maintenance conditions, it may be possible to provide a clear demonstration of PMT's within-session and generalized effects. Combined, information from the literature review and empirical study of classroom-implemented PMT has the potential to inform future research and practice regarding how to improve prelinguistic social communication for children with or at risk for ASD as well as teacher training within a collaborative framework.

CHAPTER 2

STUDY 1: INTERVENTIONS TO IMPROVE PRELINGUISTIC COMMUNICATION FOR CHILDREN WITH AUTISM SPECTRUM DISORDERS:

A SYSTEMATIC REVIEW[1]

[1] Dubin, A. D., Lieberman-Betz, R., Ayres, K., & Lam, M. To be submitted to *Autism*.

Abstract

Impairments in social communication are core deficits of autism spectrum disorder (ASD) that are typically present early in life and impact development across several areas of functioning (American Psychiatric Association [APA], 2013). Early social communicative behaviors such as joint attention are frequently referred to as pivotal skills, which upon improvement may lead to a cascade of improvements in related behaviors (Koegel, Koegel, & Carter, 1999). Several variations of naturalistic behavioral interventions have been developed to target early social communicative skills (e.g., Prelinguistic Milieu Teaching [PMT, Yoder & Warren, 1998]); however, a systematic literature review examining the effectiveness of these interventions across different forms and functions of prelinguistic social communicative behaviors has not yet been conducted. The current review identified 11 single case design (SCD) and 13 group design evaluations of naturalistic behavioral interventions targeting prelinguistic social communication in young children with ASD. Three of the identified SCD studies and eight group design studies utilized methodologically rigorous designs and demonstrated a functional relation between the intervention and child prelinguistic social communication, with an even smaller subset also including adequate procedural fidelity information. Results of this systematic literature review provide information about for whom and what behaviors specific naturalistic behavioral interventions may be effective, details about the intervention, and characteristics of the implementation agent and setting. Such information may be useful to guide training of such interventions in schools. Additionally, information about study design elements that are lacking in the current research may help improve the quality of future research.

INDEX WORDS: autism spectrum disorder, systematic literature review, prelinguistic communication, intervention

Introduction

Children with autism spectrum disorders (ASD) present with significant social communication impairments that persist throughout development and interfere with functioning across several areas (American Psychiatric Association [APA], 2013). Deficits in joint attention (JA), or the ability to coordinate attention between an object or event and another person for purely social purposes (Bakeman & Adamson, 1984), are frequently presumed to be at the root of broad social communication impairments and associated problems (Kasari, Freeman, & Paparella, 2001; Mundy & Crowson, 1997). In typically developing children as well as children with ASD and other developmental disabilities, JA has been shown to be related to spoken language (e.g., Bates, Benigni, Betherton, Camioni, & Volterra, 1979; Loveland & Landry, 1986; McCathren, Warren, & Yoder, 1996; Mundy, Sigman, & Kasari, 1990; Watt, Wetherby, & Shumway, 2006), play (Mundy & Sigman, 1989; Whalen, Schreibman, & Ingersoll, 2006), imitation (Whalen et al., 2006), and social competency (Mundy, Sigman, & Kasari, 1994; Sigman & Ruskin, 1999).

Thus, JA may be classified as a pivotal skill, which when improved facilitates improvements across other related skills (Koegel, Koegel, & Carter, 1999; Mundy & Crowson, 1997; Schreibman, Stahmer, & Pierce, 1996), and is therefore an important target of early intervention (Mundy & Crowson, 1997; National Research Council [NRC], 2001). Interventions that target JA have potentially wide ranging effects that may serve to expand a child's opportunities to participate in and benefit from an array of educational and social experiences that may otherwise not be possible. In accordance with mandates for a free and appropriate education outlined in the Individuals with

Disabilities Education Act (IDEA, 2004) and research recommendations, children with ASD who are enrolled in public school and are not yet using spoken language to communicate should receive research-supported interventions targeting JA and related skills (e.g., gaze shifts, gesture use, vocalizations, use of coordinated attention to request) in the least restrictive environment (NRC, 2001; National Autism Center, 2015; National Standards Project, 2009).

Naturalistic behavioral interventions represent one class of interventions that may be particularly amenable to implementation in a variety of settings, including the classroom. Although there is no single agreed upon description of naturalistic instruction, naturalistic behavioral interventions share several components, including embedded instruction in the child's natural environment, systematic use of prompts (e.g., time delay; modeling), use of naturally occurring contingencies, following the child's lead, shaping, fading, and adult responsiveness (Kaiser & Trent, 2007; Schreibman et al., 2015). By definition, these interventions are aligned with NRC recommendations and IDEA mandates for instruction in the natural, least restrictive environment, which serves to promote generalized improvements in targeted skills (Stokes & Osnes, 1989). Additionally, several reviews indicate empirical support for the use of naturalistic behavioral interventions to improve a variety of social communication skills, including prelinguistic behaviors, for children with ASD (Goldstein, 2002; NRC, 2001; Prelock, Paul, & Allen, 2011; Schreibman et al., 2015; White et al., 2011).

Despite legal mandates, children with ASD are not consistently receiving naturalistic behavioral interventions or other types of research-supported instruction in schools (Agency for Healthcare Research and Quality [AHRQ], 2011; Morrier, Hess, & Heflin,

2010). For example, preschool special education teachers rarely provide systematic instruction in prelinguistic social communication skills such as JA and play for students with ASD who exhibit marked deficits in these areas compared with other preschool special education students (Wong & Kasari, 2012). Several possible reasons exist for the lack of systematic, research-based instruction provided to children with ASD in schools. First, teachers report a lack of knowledge of evidence-based interventions (Barnard, Knapp, & Neuharth-Pritchett., 2011; Kasari, Freeman, Bauminger, & Alkin, 1999) as well as lack of time and resources with which to learn more (Closs & Lewin, 1998). Additionally, several interventions with evidence of effectiveness have only been studied in clinical settings; additional research is required to better understand the efficacy and feasibility of implementing these interventions in the classroom (Kasari & Smith, 2013; Strain, Schwartz, & Barton, 2013).

An initial step towards overcoming barriers to implementation of research-supported naturalistic interventions for prelinguistic social communication in schools is to determine the state of the current research on such interventions for young children with ASD. A systematic review of this literature will provide information about the types of interventions that have been researched, the quality of the studies, evidence of behaviors affected by the interventions, and common components across effective interventions. Such a review may then serve as an easily accessible resource for practitioners and guide future intervention research. Despite the emphasis on intervention research targeting core ASD deficits and the importance of evidence-based practices, a systematic review of naturalistic interventions used specifically for

prelingiustic social communication skills across communicative functions has not yet been conducted.

As ASD is a low-incidence disorder, several intervention studies have been conducted using single case designs (SCD), which have often been considered separately from group design research when judging intervention quality. Examination of both types of experimental designs within one review will provide more comprehensive information regarding different intervention types. An additional benefit of synthesizing the current literature on existing interventions is to provide descriptions of components common across effective interventions. Given the absence of a single definition for what classifies an intervention as naturalistic, identifying common elements across different interventions may help operationally define naturalistic behavioral intervention. Additionally, these common elements may provide examples of strategies to be taught in teacher training programs in lieu of teaching several different full intervention packages. Providing instruction in components of effective interventions will equip future teachers with basic skills that may increase their ability to teach prelinguistic social communication skills to students with ASD.

A systematic review of naturalistic interventions used to promote prelinguistic social communication for children with ASD would also be useful for researchers. Evaluating the quality of the extant research will identify areas that require additional research. For example, identifying common components across effective interventions may facilitate component analyses to truly determine active ingredients. Additionally, synthesizing information about for whom interventions are effective, what behaviors have been improved, who typically implements the intervention, and where the

intervention has been implemented will allow for identification of interventions that may have a high likelihood of success in schools.

Purpose of the Proposed Review

The purpose of the current review is to synthesize findings from prior single case and group design research on naturalistic behavioral interventions targeting prelinguistic social communication skills to guide clinical applications and future research. The specific aims of the current review are as follows:

1. Identify the types of naturalistic interventions that have been used to target prelinguistic social communication skills (e.g., intentional communication, eye gaze, gestures) in children with ASD.
2. Gather and synthesize evidence for the quality of studies conducted on the interventions identified in question one using guidelines adapted from the Single-Case Analysis and Review Framework (SCARF; Ledford, Lane, Ayres, & Sandbank, 2015) and the What Works Clearinghouse (WWC; US Department of Education, 2013) evidence standards (Kratochwill et al., 2013). Examples of quality indicators include experimental control, reliability, and fidelity.
3. Investigate evidence for the effects of naturalistic prelinguistic social communication interventions for children with ASD while incorporating evidence of study quality. Results for the effects of interventions within each study will be examined focusing on features of external validity (e.g., characteristics of students benefitting from the intervention; specific behaviors that were impacted; implementation setting).

4. Identify common components used across interventions with demonstrated effects on prelinguistic social communication behaviors.

Method

Selection of Articles

The current review was based on a systematic search of empirical studies focused on naturalistic prelinguistic social communication interventions for children with ASD published in peer-reviewed journals between 2001 and 2015. PsycINFO and the Education Resources Information Center databases were searched using any combination of the following keywords: *child* or *student*, *autis** or *pervasive developmental disorder*, *nonverbal* or *prelinguistic*, *joint attention*, *social*, *communication*, *natural**, *behavior**, *intervention*, *treatment*, *teaching*, *therapy*, and *training*. The initial search yielded 726 studies. Abstracts and methods sections of studies obtained were screened according to the following inclusion criteria: (1) indication the study investigated an intervention aligned with Kaiser and Trent's (2007) description of naturalistic behavioral interventions; (2) at least one dependent variable included an observational measure of a prelinguistic social communication skill (i.e., initiating joint attention [IJA], initiating behavioral regulation [IBR], initiating social interaction [ISI], intentional communication [IC], proto-imperative, proto-declarative, gestures, gaze shifts, vocalization); (3) participants were children under the age of 8 diagnosed with or at-risk for ASD and significant communication delays (i.e., no consistent use of spoken language or prelinguistic behaviors for communicative purposes). Thus, studies of interventions for children with communication delays but not ASD were excluded. Studies investigating structured behavioral interventions (e.g., discrete trial training) were also excluded from

the review. In addition to studies obtained via searches of online databases, references of the articles that met inclusion criteria and prior intervention reviews were screened to increase the likelihood of including all relevant studies.

Descriptive Information

Upon collection of all relevant studies, articles were separated by design type (i.e., SCD or group design). Coding sheets designed by the primary investigator were used to collect descriptive information about each study (see Appendix A for detailed information about the descriptive information collected and coding sheets). Data were collected on intervention type (e.g., individual or group), implementation setting, person delivering the intervention, session length and frequency, total intervention length, key components, and targeted behaviors. Information about study participants (e.g., age range; demographic information; diagnoses) was also collected.

Evaluation Criteria

Identified studies were evaluated according to a number of features related to methodological rigor, quality and breath of measurement, and evidence of intervention effects using the WWC evidence standards (Kratochwill, et al., 2013) and SCARF (Ledford et al., 2015). The WWC evidence standards were developed for use with SCD and group design studies and are well-suited to assess internal validity (e.g., evidence of experimental control); however, they do not adequately address procedural fidelity and other factors related to external validity (Wendt & Miller, 2012; Wolery, 2013). As such, SCARF, which incorporates information about external validity, was used in conjunction with the WWC evidence standards to evaluate SCD studies. SCARF criteria were also adapted to assess external validity features of group design studies. Whereas several

criteria are consistent across group and SCD studies, due to differences between design types, several components within each feature differed slightly for SCD and group design studies. Regardless of design type, a 5-point numeric scale was used to rate each criterion (i.e., 4 = exemplary, 3 = acceptable, 2 = moderate, 1= minimal, and 0 = unacceptable). See Appendix A for operational definitions of ratings for each criterion for SCD and group design studies.

Methodological rigor of group and SCD studies was evaluated according to three elements that reflect internal validity (i.e., sufficiency of data, reliability of dependent variable measurement, and procedural fidelity). Information about study design (e.g., multiple baseline; alternating treatment) as well as timing and frequency of data collection was used to determine sufficiency of data for SCD studies. For group design studies, criteria for sufficiency of data included type of design (e.g., randomized control trial), sample size, and establishment of group equivalence. Reliability of dependent variable measurement was informed by the type, quality, and quantity of inter-rate reliability reported for observational measures as well as psychometric properties of standardized measures. Procedural fidelity was assessed in terms of the quality of the intervention description and procedural fidelity measurement.

Quality and breadth of measurement (i.e., external validity) was evaluated similarly for SCD and group design studies across seven criteria. Criteria included quality of outcome variable measurement (e.g., operational definitions for outcome measures; use of multiple sources and measures) as well as measurement of response generalization (e.g., measurement of behaviors not directly targeted by the intervention), stimulus generalization (measurement of target behaviors in different contexts), and maintenance

(e.g., length of time between intervention and follow-up; quantity of maintenance data). Information about participant descriptions (e.g., pre-intervention skills; age; diagnosis), condition or comparison group descriptions (e.g., operational definitions of baseline condition or comparison group treatments; operational definition of intervention; implementation settings), and social validity (e.g., clinical significance of effects) was also used to inform measurement quality and external validity ratings.

Group design and SCD studies were also evaluated according to the results of the intervention for those studies with adequate methodological rigor and measurement characteristics (i.e., average scores for methodological rigor and quality and breadth of measurement greater than or equal to 2), with an emphasis on studies that also received a score of at least 2 for procedural fidelity. Criteria regarding treatment effects for primary and ancillary variables as well as evidence of maintenance and generalization of gains were used with both design types. Detailed descriptions of effects for primary outcomes, secondary outcomes or collateral gains, and maintenance and generalization are presented for these studies. Study effect scores ranged from zero (i.e., no evidence of intervention effects) to four (i.e., consistent, clear evidence of moderate to large intervention effects). For group design studies, evaluation criteria for results also included the appropriate use of statistics and reporting of effect sizes. The WWC framework was used to determine evidence of intervention effects for SCD studies, as there is no agreed upon effect size estimate appropriate for use with SCD studies and the methodology for evaluating intervention effects using visual analysis has been cited as a strength of the WWC system (Wendt & Miller, 2012). Specifically, visual analysis of data presented in each study was used to assess the level, trend, and variability of data within and across phases as well as

the immediacy of effect, overlap, and consistency of data across similar phases to determine if a functional relation exists between the intervention and participant behavior change (Kratochwill et al., 2013).

Data Analysis

Ratings for each criterion were averaged across studies to provide information about the quality of study components for the extant intervention research. Information about quality of study components should identify areas of strength and weakness to guide future research. Ratings for each criterion were also summarized for each intervention category to compare study quality across interventions.

Interobserver Agreement

An independent reviewer rated 20% of the studies randomly selected from each design type according to the proposed descriptive information and evaluation criteria to provide an estimate of inter-rater reliability. For each study, an agreement was scored when both evaluators provided the same numeric rating for a criterion or similar descriptions for descriptive information (e.g., circled the same keywords for intervention type). The number of agreements was divided by the sum of total agreements plus disagreements and multiplied by 100 to determine percentage agreement. Reliability was above 80% for all extracted information (study quality ratings = 80%, study effects ratings = 84%, descriptive information = 100%).

Results

Research Designs

Twenty-six of the studies obtained during the initial search met inclusion criteria for the present review. Two of these studies (Kaale, Fagerland, Martinsen, & Smith.,

2014; Kasari, Paparella, Freeman, & Jahromi, 2008) were follow-up studies featuring the same participants as other included studies and thus not included in the full review. Additional information provided by these follow-up studies is summarized in the appropriate section below. Of the 24 remaining studies, 11 studies within 9 articles utilized SCD methodology and 13 studies were conducted using a group design. The majority of the SCD studies identified used variations of multiple baseline designs, including multiple baseline across participants (*n*=9) and multiple probe across behaviors (*n*=1). The other identified SCD study used an alternating treatments design. Twelve of the group design studies were randomized control trials (RCT). The other group design study used a pre-post design and was classified as quasi-experimental.

Participant Characteristics

Across all studies, a total of 317 children between 12 months and 8 years of age received interventions. The majority of studies (*n*=21) only included children diagnosed with autism. Three studies also included participants with PDD-NOS or displaying symptoms of ASD. Of the 15 studies that reported information about gender for the intervention group, males made up 33% to 100% of participants (*n*=236). Twelve studies reported information on race and ethnicity (see Table 2.1 for more detailed participant information).

The quality and quantity of information provided about inclusion criteria and participant characteristics varied widely across studies. All studies reported inclusion criteria or pre-intervention participant characteristics related to specific behavioral deficits targeted by the intervention (e.g., spontaneous use of fewer than ten words and/or low scores on standardized language assessments; limited use of vocalizations and/or

gestures). Other studies outlined inclusion criteria related to pre-requisite skills required for participation, including making eye contact in response to a communicative partner saying the child's name, "look," or other prompt (Jones, Carr, & Feeley, 2006; Kryzak & Jones, 2014), or non-verbal mental age > 8 months (Landa et al., 2011).

General Intervention Characteristics

Information about intervention characteristics is presented in Table 2.2. All of the studies featured in the present review investigated interventions delivered in a one to one format. Two of the studies focusing on teacher-implemented interventions also included group components, including strategies implemented weekly during group instruction (Dykstra, Boyd, Watson, Crais, & Baranek, 2012) and providing teachers with the option of using intervention strategies in small group or classroom format (Wong, 2013). Implementation settings included clinics (n = 7), clinic-based early intervention classrooms (n = 6), schools (in self-contained or inclusive classroom n = 4; pull out from classroom n = 2), the child's home (n = 2), or some combination of the aforementioned settings (n = 3; clinic and home [Vismara & Lyons, 2007; Wetherby & Woods, 2006]; home and school, [Kryzak & Jones, 2014]).

Eight of the studies evaluated interventions implemented by the primary researcher or others involved with the research (e.g., graduate or undergraduate research assistants, interventionists). The other studies evaluated interventions implemented by teachers or paraprofessionals (n = 9), parents (n = 5), teachers and parents (n = 1), and the child's therapist (n = 1). Thirteen studies reported specific information about the experience of those implementing the intervention, which ranged from no formal training or experience to 30 years of special education experience. The majority of studies

investigating interventions implemented by individuals outside of the research team, even those without specific information about the implementers, provided information about implementation training. All parent-implemented interventions featured supervision and coaching throughout the intervention to support procedural fidelity. All but two teacher-implemented studies (Jones et al., 2006; Kryzak & Jones, 2014) also featured ongoing intervention specific training. In the study conducted by Kryzak & Jones (2014), teachers were trained to 100% fidelity prior to intervention and Jones and colleagues (2006) included teachers who received ongoing training in applied behavior analysis separately from the study.

Across studies, different information was reported to describe intervention intensity, including frequency and length of intervention sessions, total number of sessions, and/or total duration of the intervention. These indicators of intensity also varied widely across interventions evaluated. All but two studies (Jones et al., 2006; Wetherby & Woods, 2006) reported information about the session length, which ranged from 10 minutes to 2.5 hours. Frequency of intervention sessions per day (range = 1 – 4) or week (range = 1 – 10) was reported in all but one study, although that study did report the total number of sessions the child participated in the intervention (Kryzak & Jones, 2014). Daily intervention implementation was expected in seven of the studies that involved parent or teacher training. Eighteen studies reported the total duration of time spent in intervention, which ranged from six days to one year.

Manualized interventions were utilized in twelve of the studies included in the present review. Interventions evaluated included Advancing Social-Communication and Play (ASAP; Dykstra et al., 2012); Early Social Interaction Project (ESI; Wetherby &

Woods, 2006), Interpersonal Synchrony (IS; Landa, Holman, O'Neill, & Stuart, 2011); Joint Attention Symbolic Play Engagement and Regulation (JASPER) treatment (Goods, Ishijima, Chang, & Kasari, 2012; Kasari et al., 2014; Kasari, Gulsrud, Paparella, Hellemann, & Berry, 2015; Lawton & Kasari, 2012), JASPER precursors involving joint attention instruction (Kaale, Smith, & Sponheim, 2012; Kasari, Freeman, & Paparella, 2006; Kasari, Gulsrud, Wong, Kwon, & Locke, 2010; Wong, 2013), Prelinguistic Milieu Teaching (PMT; Franco, Davis, & Davis, 2013; Yoder & Stone, 2006), interventions combining Pivotal Response Training (PRT) with other strategies (Harjusola-Webb & Robbins, 2012; Jones et al., 2006; Vismara & Lyons, 2007), Reciprocal Imitation Training (RIT; Ingersoll & Schreibman, 2006; Ingersoll, Lewis, & Kroman, 2007; Ingersoll, 2012), and interventions without formal names (Kryzack & Jones, 2014; Warreyn & Roeyers, 2014). All interventions incorporated several components aligned with descriptions of naturalistic interventions put forth by Kaiser and Trent (2007) and Schreibman and colleagues (2015). The following components were utilized in at least five of the studies reviewed:

1) *Following the child's lead*: providing instruction within child-directed activities or routines.
2) *Prompting*: systematic use of cues (e.g., verbal, model, gesture) to scaffold skill acquisition.
3) *Natural consequences*: providing reinforcement that is related to the child's communicative intent.
4) *Instruction embedded in routines*: providing instruction within activities that involve turn-taking between the child and instructor.

5) *Environmental arrangement*: manipulating the environment to create instructional opportunities.
6) *Time delay*: providing time for the child to respond prior to prompting a response.
7) *Linguistic mapping*: using words to label the child's presumed intent following prelinguistic communicative acts.

Nineteen studies evaluated child-directed interventions (i.e., ASAP [Dykstra et al., 2011], IS [Landa et al., 2011], JASPER or JASPER variations [e.g., Kasari et al., 2006; Lawton & Kasari, 2012], interventions combining PRT with other elements [e.g., Vismara & Lyons, 2007], and PMT [Franco et al., 2013; Yoder & Stone, 2006]), making following the child's lead the most frequently included component in studies reviewed. The other most frequently included components included use of some type of prompting (*n*=18), natural consequences (*n*=11), instruction embedded in routines (*n*=11), environmental arrangement (*n*=13), time delay (*n*=9) and linguistic mapping (*n*=5). Additional intervention components included play narration (e.g., Harjusola-Webb et al., 2011; Kasari et al., 2006; Ingersoll & Schreibman, 2006), language and play expansions (e.g., Harjusola-Webb et al., 2011; Kasari et al., 2014), balanced turns (e.g., Goods et al., 2013); imitating child behaviors (e.g., Ingersoll & Schreibman, 2006; Kasari et al., 2010), interspersing mastered and new tasks (e.g., Vismara & Lyons, 2007) and incorporation of short discrete trial training sessions prior to naturalistic instruction to prime target behaviors (Kasari et al., 2006).

Target Behaviors and Outcomes Measured

Twenty-one studies evaluated interventions that directly targeted prelinguistic communication skills and three studies measured prelinguistic communication skills as

collateral gains following interventions targeting imitation. Several of the studies directly targeting prelinguistic communication skills also concurrently targeted play skills (Dykstra et al., 2011; Goods et al., 2013; Kasari et al., 2014; Kasari et al., 2015; Wong et al., 2013). All studies included in the present review assessed outcomes related to prelinguistic communication skills (see Table 2.3); however, specific behaviors and how these behaviors were defined and measured varied across studies. Outcomes assessed included IJA (*n*=19), IBR (*n*=6), ISI (*n*=2), IC acts (*n*=1), and/or individual component behaviors such as gestures, gaze shifts, and vocalizations (*n*=9). Semi-structured observations (i.e., The *Early Social Communication Scale* [ESCS, Mundy et al., 2003] or *Communication and Symbolic Behavior Scale* [CSBS, Wetherby & Prizant, 1993]) were used to measure IJA, IBR, or ISI in several of the studies (e.g., Kasari et al., 2006; Landa et al., 2007). Studies that did not use the ESCS or CSBS created their own definitions of prelinguistic communicative behaviors (e.g., Jones and colleagues [2006] defined IJA as "independently directing adult's attention by alternating gaze and pointing within two seconds of the presentation of an interesting object or event," pp. 788). Most studies measured prelinguistic communicative behaviors using frequency counts or rate; however, three studies used partial interval recording (Dykstra et al., 2011; Ingersoll & Schreibman, 2006; Ingersoll et al., 2007) and two studies reported percentage correct responses (Jones et al., 2006; Kryzak & Jones, 2014).

Study Quality

Study quality ratings in the areas of rigor and quality and breadth of measurement are presented for SCD studies (Table 2.4) and group design studies (Table 2.5). Average study quality ratings across areas within SCD studies ranged from 1.18 to 3.82. Overall

strengths (i.e., elements with average ratings $\geq$ 2) in SCD studies included reliability, participant descriptions, dependent variable descriptions, condition descriptions, and measurement of response generalization. Average ratings of fidelity, sufficiency of data, social validity, stimulus generalization and measurement of maintenance all fell below 2. Average ratings on study rigor and measurement items across group design studies ranged from 1.00 to 4.00. Areas of strength for group design studies included reliability, sufficiency of data, participant descriptions, condition descriptions, dependent variable descriptions, stimulus generalization, and response generalization. Similar to SCD studies, weaker elements of group design studies included fidelity, social validity, and measurement of maintenance. Specific areas of strength and areas requiring more attention are described below.

Sufficiency of data. Sufficiency of data ratings reflect study design elements that allow for minimally biased results. For group design studies, these elements include establishment of group equivalence and use of appropriate statistics and sample size. All but one group design study received satisfactory ratings for sufficiency of data, as randomized controlled trials (RCT) comprised 12 of the 13 group design studies. Establishment of equivalent groups is inherent in RCT designs, and these studies also included an adequate number of participants for the statistics utilized. Sufficiency of data was more variable across SCD studies, which were evaluated based on the number of data points per condition, the timing of data collection for multiple baseline studies (i.e., concurrent or non-concurrent data collection), and whether or not additional information was necessary to demonstrate a functional relation. All eleven studies reported at least three data points per primary comparison condition. Of the ten multiple baseline or

multiple probe designs, only six began data collection simultaneously for all participants. All but two studies (Ingersoll et al., 2007; Vismara & Lyons, 2007) required more data points for the design to support detection of a functional relation, either because data points were not present immediately prior to introduction of the dependent variable or data were trending in a therapeutic direction prior to introduction of the dependent variable.

Reliability and procedural fidelity. Reliability of dependent variable measurement was assessed in all studies included in the present review, with all group design studies and 82% of SCD studies receiving satisfactory reliability ratings (i.e., point-by-point calculation of reliability for at least 20% of observations, reliability of at least 80% or kappa $\geq$ 0.6, and/or the use of standardized measurement tools with adequate psychometric properties). Reliability was assessed for at least 20% of observations in the majority of group (n=12) and SCD (n=10) studies. For group design studies, adequate reliability was reported via statistics (e.g., intra-class correlation) or the use of data collection instruments with satisfactory psychometric properties in all but one study. Blind coders and/or evaluators were also used in 12 out of 13 group design studies. Eight SCD studies reported adequate reliability values and two SCD studies used coders blind to condition to collect reliability data.

In contrast, evaluation of procedural fidelity was not conducted at the same level of rigor as reliability measurement across the majority of included studies. Whereas all SCD studies included some type of information regarding procedural fidelity, only three studies within the same article received satisfactory ratings. Harjusola-Webb and colleagues (2012) evaluated procedural fidelity via direct observation of at least 20% of

sessions in both primary conditions. Information about reliability of the procedural fidelity data was also included. Of the other SCD studies that included procedural fidelity information, nine reported at least 80% fidelity or other evidence of differentiation among conditions. In addition to Harjusola-Webb and colleagues, one other study reported fidelity data from both primary conditions (Vismara & Lyons, 2007) and one study collected fidelity data for at least 20% of sessions (Jones et al., 2006). No other SCD studies reported fidelity data separately by condition or evaluated reliability of procedural fidelity data.

Many group design studies similarly lacked information about procedural fidelity, with one study failing to discuss fidelity at all. Of the group design studies that included procedural fidelity information, seven provided evidence supporting intervention implementation (e.g., at least 80% of steps correctly implemented). Three of the seven studies collected fidelity data in at least 20% of sessions (Goods et al., 2013; Kaale et al., 2012; Landa et al., 2011), with the latter two studies also reporting information about reliability of fidelity data and use of evaluators blind to study condition or purpose.

Descriptive information. All SCD and group design studies received ratings of two or higher for participant and dependent variable descriptions, which indicates that these studies provided adequate information about the children receiving the intervention (e.g., standardized testing results, inclusion/exclusion criteria, information related to the target behaviors) and the outcomes being measured (e.g., operationally defined behaviors, use of examples/non-examples, use of psychometrically sound instruments). The majority of studies also included sufficient condition or comparison group descriptions (e.g., well-described intervention procedures, information about dosage, information about

treatments received by comparison group, baseline description). Comparison groups in the RCT studies included treatment-as-usual in the community, school, or early intervention program as well as other interventions (i.e., Picture Exchange Communication System [PECS], individual or group-based caregiver education, or symbolic play intervention). Only one study received unsatisfactory ratings for condition descriptions due to lack of information about baseline conditions, dosage, setting, and/or interventionist characteristics. In sum, almost all of the studies included enough detail about participants, conditions and/or comparison groups, and outcomes being measured for readers to determine for whom and what behaviors the intervention effects would likely generalize.

Social validity. Social validity was measured via blind raters of acceptability/feasibility of intervention implementation, acceptability of dependent variables, and importance of study results and/or normative comparisons in six SCD studies but no group design studies. Several studies (SCD $n = 9$; group $n = 9$) were thought to have some degree of potential social validity through use of either indigenous implementers (e.g., parents, teachers) or environments (e.g., homes, schools); however, implementers were only asked their opinion about feasibility and acceptability of the interventions in three group design studies and no SCD studies. Psychometrically validated measures of feasibility or acceptability were not included in any of the studies reviewed.

Generalization and Maintenance. Generalization was assessed in the majority of included studies, in terms of both measurement of dependent variables outside of the intervention context and measurement of behaviors not directly targeted within

intervention sessions. Group design studies lend themselves to evaluation of stimulus generalization, as dependent variables are typically measured outside of the instructional context both before and after intervention. All but one group design studies assessed generalization of behaviors to other people, environments, activities, and/or materials. Six SCD studies also evaluated stimulus generalization, either via probes throughout the study (n = 4), or within the context of a SCD (n = 2). In addition to measurement in a different setting, pre- and post-intervention assessments were often conducted by individuals different from those implementing the intervention using activities and materials also not present during intervention sessions.

Regarding response generalization, eight SCD studies and all group design studies taught behavioral tendencies (e.g., intentional communication, initiating joint attention) as opposed to discrete behaviors (e.g., eye contact, vocalization). Behaviors not directly targeted by the interventions (e.g., imitation, responding to joint attention) were evaluated in several studies included in the present review or follow-ups to included studies (i.e., Kaale, 2014; Kasari et al., 2008). Evidence for collateral effects is presented in the following section.

Five SCD studies and five group design studies collected information about maintenance of behavioral gains. All group design studies and four of the SCD studies evaluated gains maintained at least one month following intervention. Additionally, follow-up studies to two group design studies (Kaale et al., 2014; Kasari et al., 2008) included long-term maintenance data not provided in the initial study. Of these studies that measured maintenance, all but one SCD study measured maintenance on more than one occasion. No group design studies included repeated measures of maintenance.

Intervention Effects

Results presented in each study were rated on a zero to four scale to quantify the study's main, generalized, and maintenance effects, with scores of zero indicating no evidence of effects and four indicating strong evidence of effects. Study effects ratings and descriptive information about outcomes are presented in Tables 2.6 and 2.7. Studies that received rigor ratings suggesting the study design supported evaluation of outcomes are bolded on the tables and discussed in more detail below. Four SCD studies did not meet rigor criteria because data collection did not begin simultaneously for multiple baseline designs (Dykstra et al., 2012; Franco et al., 2013; Jones et al., 2006), and/or reliability of the dependent variables was not established (Dykstra et al., 2012). One group design study did not meet standards because group equivalence was not established prior to intervention (Wetherby & Prizant, 2006).

Results were inconsistent for seven SCD studies that used study designs and had sufficient data to support detection of a functional relation. Two studies that evaluated modifications of PRT reported results suggesting clear, immediate improvements in child expressive communication (i.e., overall use of gestures, vocalizations, words, and phrases directed at another person) following teacher-implemented intervention (Harjusola-Webb & Robbins, 2012) and clear albeit less consistently immediate improvements in child IJA following parent-implemented intervention using perseverative interests (Vismara & Lyons, 2007). Of note, Harjusola-Webb & Robbins' study of teacher-implemented intervention was the only SCD study that earned adequate procedural fidelity ratings. IJA was also found to increase for two of three participants following implementation of another intervention not explicitly labeled a modification of PRT that utilized similar

strategies and circumscribed interests (Kryzak & Jones, 2014). Additionally, results provided evidence for maintenance of effects for one participant for whom maintenance was assessed as well as inconsistent evidence of generalized effects during interactions with different people and materials and in different locations. Finally, RIT was evaluated in two SCD studies that measured prelinguistic social communication behaviors in addition to main effects related to imitation. Despite not being directly targeted by the intervention, a functional relation was demonstrated between RIT and increased coordinated joint attention (Ingersoll & Schreibman, 2006) as well as spontaneous use of gestures and gestures paired with verbalizations (Ingersoll et al., 2007), with some evidence of maintenance reported one-month post-intervention.

Over half of the eleven group design studies that met design standards reported results suggesting minimal to strong effects of the intervention on target prelinguistic communication outcomes, with effect sizes ranging from small to large (see Table 2.6 for more detailed information on effect size). Only three of these studies also reported adequate information about procedural fidelity (Goods et al., 2013, Kaale et al., 2012; Landa et al., 2011); effect sizes for this subset ranged from $d = 0.31$ to $d = 1.60$. Interventions evaluated in these studies included JASPER or an earlier version of the intervention that only targeted JA (Goods et al., 2013; Kaale et al., 2012; Kasari et al., 2006; Kasari et al., 2014; Lawton & Kasari, 2012; Wong, 2013), PMT (Yoder & Stone, 2006), and the IS curriculum (Landa et al., 2011). All but two studies (Goods et al., 2013; Kasari et al., 2015) reported results suggesting increased IJA following intervention. Additionally, evidence was provided for intervention effects on increased IBR (Yoder & Stone; 2006) and communicative gestures used for the purpose of requesting or joint

attention (Goods et al., 2013; Kasari et al., 2006; Lawton & Kasari, 2012). Gains in IJA were also observed following RIT despite not being directly targeted (Ingersoll, 2012). Evidence was inconsistent for effects outside of the intervention context. Several studies reported increases in IJA following intervention during classroom observations and/or caregiver/teacher-child interactions but not on a semi-structured assessment (i.e., ESCS) conducted by a novel adult (Kaale et al., 2012; Lawton & Kasari, 2012; Wong, 2013) In contrast, results in several studies suggested generalized improvements in showing (Lawton & Kasari, 2012) and overall IJA (Kasari et al., 2006; Kasari et al., 2014; Yoder & Stone, 2006) on the ESCS. Additionally, evidence of intervention effects for behaviors not directly targeted and other generalized tendencies was reported in evaluations of JASPER or related interventions (i.e., improvements in spoken language [Kasari et al., 2008], joint engagement [Goods et al., 2013; Kaale et al., 2012; Kasari et al., 2010; Kasari et al., 2014; Kasari et al., 2015], response to joint attention [RJA; Kasari et al., 2006; Kasari et al., 2010], and play behaviors [Kasari et al., 2010]) and the IS curriculum (i.e., increased positive affect [Landa et al., 2011]). Maintenance of behavioral improvements was reported for RIT (Ingersoll, 2012) as well as JASPER or related interventions (Kaale et al., 2014; Kasari et al., 2008; Kasari et al., 2014).

Overall, eight group design studies and three SCD studies demonstrated functional relations between the intervention and child outcomes utilizing methodologically rigorous designs. Additionally, despite failing to show consistent main effects, a few other studies showed some degree of generalization for those who did respond to the intervention. Interventions included JASPER, RIT, PMT, IS, and variations of PRT, all of which shared some common elements (e.g., following the

child's lead; systematic use of prompts) and were shown to be functionally related to improved child prelinguistic social communication skills (e.g., IJA, IBR, gestures).

Discussion

A systematic review of the literature was conducted to identify naturalistic behavioral interventions designed to improve prelinguistic social communication in children with ASD. SCD and group design studies were evaluated in terms of methodological quality, including aspects of internal and external validity. Intervention effects across studies were synthesized and reported in the context of study quality. A total of 11 SCD and 13 group design studies that met inclusion criteria were identified in the present review, which suggests research on naturalistic behavioral prelinguistic interventions is well-represented in the literature, albeit with variable degrees of methodological rigor. The majority of studies included children with ASD who were preschool aged or younger; however, across studies participant ranged in age from 12 months to 8 years. All of the interventions evaluated contained multiple components, many of which were common across several interventions (e.g., following the child's lead, systematic prompting, time delay, natural consequences). Interventions were implemented by trained clinicians, caregivers, graduate or undergraduate students, speech language pathologists, teachers, and teaching assistants/para-professionals. Training and experience of the individuals implementing the intervention varied across studies. Various prelinguistic social communication skills were measured, ranging from discrete behaviors (e.g., gaze shifts, gestures) to broad tendencies (e.g., expressive communication, IJA). Over half of the eight methodologically rigorous group design studies and three SCD studies that demonstrated functional relations between the

intervention and child outcomes presented evidence for generalization and maintenance of prelinguistic social communicative behaviors. Considering that interventions targeted core deficits of ASD (Kasari, Freeman, & Paparella, 2001) frequently considered pivotal behaviors (Koegel, Koegel, & Carter, 1999; Mundy & Crowson, 1997; Schreibman, Stahmer, & Pierce, 1996), even minor evidence of behavior change is promising. Results obtained in the present systematic review regarding the effects of naturalistic behavioral interventions on prelinguistic social communication skills are consistent with results from other reviews focused on communication more broadly (Goldstein, 2002; NRC, 2001; Prelock, Paul, & Allen, 2011) and JA skills specifically (White et al., 2011), thus providing further support to recommendations for the use of naturalistic behavioral interventions to teach a variety of skills to children with ASD (Schreibman et al., 2015).

Despite promising results, there were several methodological weaknesses across design types that warrant discussion. Within SCD studies, issues related to reliability of dependent variable measurement, systematic introduction of interventions, and adequacy of data presented within conditions and replications limited interpretation of intervention effects to only seven studies, three of which demonstrated a functional relation for primary variables of interest. Intervention effects on child outcomes were also demonstrated in eight of the twelve group design studies that utilized methodology that permitted the interpretation of intervention effects; however, the use of a pre-post design without a true comparison group precluded interpretation of intervention effects for one group design study. Across the majority of SCD and group design studies, information about procedural fidelity necessary to truly attribute participant outcomes to the intervention being studied was insufficient or completely missing. When limiting effects

interpretations to studies with adequate fidelity information, only one SCD study and three group design studies were found to demonstrate intervention effects. Furthermore, whereas most studies provided detailed information about intervention dosage, several studies that evaluated interventions implemented by parents and/or teachers reported an expectation but no documentation of daily implementation. Additional areas of weakness identified in some studies include descriptions of interventions lacking detail required for replication (e.g., implementer training and experience; examples of how strategies are utilized within intervention sessions), limited descriptions of child characteristics relevant to behaviors targeted by the intervention, and limited measurement of generalization and maintenance. Although not necessary for interpretation of effects, such information is important to understand to whom, what behaviors, and in what environments effects may generalize. It should be noted that several studies provided sufficient detail in these areas; however, as factors related to external validity are necessary to inform generalizability of results, their inclusion should be required for all studies. Finally, explicit measurement of social validity through normative comparisons and/or ratings of intervention feasibility and significance of results was absent from most studies. Improving upon these study design elements should help strengthen the evidence supporting the effectiveness of naturalistic behavioral interventions in improving prelinguistic social communication behaviors.

Implications

Results from several studies suggest that children with ASD and communication impairments can be taught prelinguistic communication skills using naturalistic behavioral strategies. Of the interventions examined in the present review, JASPER or

earlier incarnations focused specifically on JA instruction received the most research support. Evidence from eight RCT studies suggests that participation in JASPER and related JA interventions may lead to increased use of gestures for the purposes of IJA and requesting, coordinated gaze shifts, overall IJA and/or time spent jointly engaged for children ages 21 months to 6 years with ASD (Goods et al., 2013; Kaale et al., 2012; Kasari et al., 2006; Kasari et al., 2010; Kasari et al., 2014; Kasari et al., 2015; Lawton & Kasari, 2012; Wong, 2013). It should be noted that despite large effects for improved joint engagement in two of these studies, gains in IJA were minimal or nonexistent (Goods et al., 2013, Kasari et al., 2015), which authors report may be attributable to core deficits such as IJA requiring larger dosage of intervention. Although not as widely studied with children with ASD as the JASPER family of interventions, RIT, PMT, and two variations of PRT also appear to have similar positive effects on prelinguistic social communication targets (Harjusola-Webb & Robbins, 2012; Vismara & Lyons, 2007; Yoder & Stone, 2006). Evidence of improved IJA and gesture use was also provided in studies of RIT despite these prelinguisitic skills not being directly targeted (Ingersoll, 2012; Ingersoll et al., 2007; Ingersoll & Schreibman, 2006).

Overall, these studies demonstrated that parents, teachers, para-professionals, graduate and undergraduate students can be trained to implement naturalistic behavioral interventions in clinics, schools, and the child's home. Various factors were shared across many interventions with evidence of treatment effects from at least one methodologically rigorous study, including the emphasis on training and weekly supervision of individuals implementing the intervention, use of a treatment manual, and incorporation of several key naturalistic behavioral components. The majority of the interventions with research

support were child-directed and featured systematic prompting or time delay, instruction embedded in routines, environmental arrangement, and naturally occurring consequences. It should be noted that several studies utilizing the same interventions reported different specific strategies, which may be due to later studies that referenced treatment manuals not including as much detail regarding intervention strategies as earlier studies or those without a treatment manual. As such, it may be the case that some interventions utilized strategies that were not explicitly mentioned in the studies. Additional similarities across interventions with positive outcomes were related to dosage, with implementation occurring at relatively high dosages in many of the studies that demonstrated effects. Twelve interventions lasted at least two months with at least one hour of intervention per week (e.g., Goods et al., 2013; Yoder & Stone, 2006). Interventions conducted for durations shorter than two months typically featured two-five sessions per week (e.g., Kasari et al., 2006; Kaale et al., 2012) and/or the expectation of daily implementation (e.g., Lawton & Kasari, 2012; Harjusola-Webb & Robbins, 2012). Additionally, some of the elements within naturalistic behavioral interventions (e.g., following the child's lead) may result in slower skill acquisition, especially when compared with more directive interventions such as discrete trial training. However, these components serve to increase the generalizability and maintenance of skills learned and thus ideally lead to better long-term outcomes. It is to be expected that interventions must be conducted at high dosages to lead to generalized behavior change given that persistent deficits in IJA and related prelinguistic social communication behaviors are hallmarks of ASD. As the time, money, and other resources required for such intensive interventions are barriers for many families, the evidence supporting the use of indigenous implementers such as caregivers

and teachers provided by many of the studies reviewed is promising and should allow for high dosage implementation that is feasible and cost-effective.

There were no consistent differences in child characteristics between rigorous studies that did and did not demonstrate an intervention effect. Studies that reported positive outcomes generally included children who were at least 3 years old whereas the average participant age was younger than three years in the majority of studies with minimal or no effects. Several studies reporting positive outcomes included participants who engaged in at least five instances of pre-intervention IJA; however, other studies that reported positive outcomes included participants with similarly low frequencies of IJA to those studies that did not demonstrate intervention effects. Interestingly, Yoder & Stone (2006) reported that participants who received RPMT demonstrated greater improvements in IBR and IJA when compared with participants who received PECS training, but only if they engaged in relatively high rates of IJA prior to intervention. Additional research similar to that conducted by Yoder and Stone, in which participant outcomes are analyzed in the context of pre-intervention characteristics, is required to clarify participant characteristics that may be predictive of response to a particular intervention.

Considering these findings in the context of teacher training, the existing evidence supports training teachers in JASPER or PRT intervention packages (Goods et al., 2013; Harjusola-Webb & Robbins, 2012; Kaale et al., 2012; Lawton & Kasari, 2012; Wong, 2013). Although effects were also demonstrated for PMT and RIT when implemented in clinics or home settings (e.g., Ingersoll, 2012; Yoder & Stone, 2006), further research is required to evaluate their implementation in schools. Given that teachers often lack time

provided for training (Closs & Lewin, 1998), large intervention packages may not always be feasible. Although it is not possible to confidently determine which components were "active ingredients" in the studies reviewed, it may be helpful to train teachers to use the individual naturalistic behavioral strategies that were most frequently utilized in effective interventions (e.g., following the child's lead, systematic use of prompting and time delay) as an alternative when time and resources do not permit utilization of larger packages. Future research should include investigations of PMT and RIT in the classroom as well as component analyses to determine the naturalistic behavioral strategies or combination of strategies that are most likely to facilitate behavior change. These studies should report specific information about participant characteristics, with emphasis on strengths and weaknesses related to the target behavior (e.g., whether or not the student uses individual prelinguistic behaviors to communicate). Additionally, research should include measures of discrete as well as broad behaviors, as information about the specific strategies that lead to change in specific behaviors may lead to more efficient training. For example, the strategies required to teach gaze shifting to a child with minimal use of eye contact or other prelinguistic communication skills may be different from those required to teach IJA to a student who exhibits prelinguistic communication skills but only uses them to request. Finally, studies should include measures of social validity to gather information about the acceptability and feasibility of training and implementation in the classroom.

Limitations

There are a few limitations of the current review worth considering when interpreting the findings. First, the inclusion criteria were relatively broad and resulted in studies varying widely in the degree of behavioral versus naturalistic components. For example, evaluations of interventions that featured a variety of naturalistic and behavioral strategies (e.g., JASPER; PMT) and interventions that only used two components (e.g., systematic prompting and following the child's lead) all met inclusion criteria despite implementation likely looking quite different. Perhaps naturalistic behavioral interventions may exist on a spectrum that ranges from more behavioral to more naturalistic, or perhaps the inclusion criteria were too broad and not all of the studies included truly represent naturalistic behavioral interventions. Of note, the majority of rigorous studies demonstrating effects included three or more key intervention components, representing both behavioral (e.g., prompting) and naturalistic (e.g., following the child's lead) strategies. Also related to inclusion criteria, although it was specified that the study must empirically evaluate an intervention that targeted a prelinguistic social communication skill, there was no criterion related to usage of a design type that would permit detection of a functional relation between the intervention and specific outcomes related to the target behavior. Future reviews should specify inclusion criteria that limits studies to those with designs that allow for demonstration of a functional relation between the intervention and target behavior of interest for that review.

Second, when coding quality of studies using SCARF, the same rating was occasionally given when an element was completely left out of a study and when an element was included but not addressed adequately. For example, studies that measured

procedural integrity but did not demonstrate 80% fidelity and studies that made no reference to fidelity both received zero points for procedural integrity. As neither study demonstrated that the intervention was conducted as intended, these similar ratings provided accurate information in terms of evaluating study methodology. However, in making recommendations for future research, some studies receiving the same scores for different elements may require different recommendations (e.g., include a measure of fidelity versus do something to improve fidelity).

A third limitation relates to comparing effects across studies, which was not possible due to the inclusion of SCD and group design studies and information missing from studies. As the current review was designed to provide information about naturalistic behavioral interventions currently in use and a general description of design quality and effectiveness as opposed to comparing the relative effectiveness of naturalistic behavioral interventions as one would in a meta-analysis, effect sizes were not calculated or compared across studies. Furthermore, no current effect size estimate used with SCD research is without limitations, nor are the effect sizes currently in use always comparable across SCD types or to effect sizes used in group design research (e.g., Campbell, 2013; Parker, Vannest, & Davis, 2011; Vannest & Ninci, 2015). Thus, evaluating intervention effects based on visual analysis for SCD studies and statistical analysis for group design studies was considered the most appropriate means of presenting evidence about the overall effects of naturalistic behavioral interventions in the current review. Related, a direct comparison of quality cannot truly be made between group and SCD studies, as criteria differed slightly across design types to account for different ways in which studies were conducted. These criteria may have differed in

stringency and resulted in inflated scores for group design studies. For example, group design studies received credit for using psychometrically sound instruments even when reliability statistics were not reported; however, SCD studies only received credit if reliability statistics were reported. Additionally, reliability and procedural fidelity statistics were sometimes reported as ranges and sometimes reported as averages. Studies that only reported averages often received higher ratings for procedural fidelity and reliability than studies that only reported ranges. For example, a study would receive points for reporting average reliability or procedural fidelity of 80% without reporting information about the range; however, a study that only reported a range of 78% to 99% would not receive points despite potentially having a similar average percentage reliability or procedural fidelity as the study that only reported the average. Thus, procedural fidelity and reliability ratings may be inflated for those studies that provided less detailed information. Finally, the current review may be missing useful information due to restricting studies to those published in peer reviewed journals. Expanding inclusion criteria to dissertations and unpublished findings may limit potential publication bias.

Conclusion

Despite methodological flaws apparent in several studies, results of the present review suggest that naturalistic behavioral interventions can be used to teach JA and associated prelinguistic social communication skills to young children with ASD. Furthermore, evidence exists for the generalization and maintenance of these skills following intervention. Given the use of multi-component interventions and variance in definitions and measurement of target outcomes, it is difficult to determine what

components produced effects for whom and for what behaviors. Overall, it appears that interventions implemented by individuals trained to criterion and exposed to ongoing coaching or supervision featuring some combination of naturalistic and behavioral components (e.g., systematic prompting; natural consequences; environmental arrangement) may lead to improvements in prelinguistic social communication behaviors for young children with ASD when implemented in relatively high dosages. Future research conducted utilizing rigorous methodology should focus on evaluating specific components that may serve as "active ingredients" in promoting behavior chance as well as specific child characteristics that may lead to differential responsivity to interventions.

Table 2.1

Participant Descriptions

Study	N (age)	Gender (% M)	Race/ Ethnicity	Diagnosis	Other Reported Participant Characteristics
Dykstra 2011	3 (44-58 mos)	33	33.3% H, AS, W	Autism	Limited vocalizations and gestures; MSEL AE: VR=43-46, RL=31-47, EL=29-36; ADOS total scores range=15-21 (all autism)
Franco 2013	6 (5-8 years)	83	40% H; 20% AS; 20% PI; 20% W	Autism	REEL-3 language age (months): EL = 5-9, RL = 5-12; CARS autism severity scores in moderate to severe range
Goods 2013	7 (3-5 years)	NR	<50% W	Autism	Avg MSEL AE: MA=17.21, RL=12.86, EL=10.86; avg ESCS freq: IJA=2.14, IBR=1.71
Harjusola 2012	3 (37-44 mos)	100	NR	Autism	VABS age ranges (months): RL = 8-15, EL = 9-16; communicated primarily via vocalizations and gestures; CARS scores in severe range
Ingersoll 2006	5 (29-45 mos)	60	NR	Autism	Bayley MA=15-29; CDI language age=8-25; CARS severity=mild/mod-severe; avg SLO % CJA=30.6
Ingersoll 2007	5 (34-49 mos)	100	NR	Autism	Bayley MA range=16-31; CDI language age range=16-29; CARS ASD severity range = mild/mod-severe; imitation deficits
Ingersoll 2012	14 (27-47 mos)	93	64% W	Autism	Avg Bayley NVMA = 20.88; avg PLS-4 age = 17.3; avg ESCS IJA freq < 3
Jones 2006	5 (2-3 years)	100	NR	Autism or PDD-NOS	Bayley MA range = 8 – 18 mos; PLS-3 ranges: RL = 6-12 mos, EL = <9 – 11 mos
Kasari 2006	20 (3-4 years)	75	81% W	Autism	Avg MSEL AE: MA = 26.29, RL=20.55, EL = 20.6; avg ESCS freq: show=0.10, CJA=7.25, point=13.15, give=3.65
Kasari 2010	19 (21-30 mos)	79	53% W	Autism	Avg MSEL MA = 19.83; avg MCI IJA freq=3.0; RJA freq=.42; % JE=30.26
Kasari 2014	52 (2-5 years)	83	31% W	ASD	Avg MSEL AE: MA=26.3, RL=22.1, EL=20.1; avg ESCS IJA freq=9.4; avg ADOS severity=6.4-7.7 (mods 1-3); “low resourced”

Table 2.1 continued

Study	N (age)	Gender (% M)	Race/ Ethnicity	Diagnosis	Other Reported Participant Characteristics
Kasari 2015	43 (2 left early) (22-36 mos)	81	7% H; 63% W; 9% AS; 21% O	ASD	Avg MSEL DQ=68.0; Reynell avg MA: RL= 16.09, EL=14.09; IJA freq=4.84 (>50% did not engage in IJA pre-intervention)
Kryzak 2014	3 (2-8 years)	100	NR	Autism	Inclusion criteria: demonstrate EC in response to hearing name, "look," or visual prompt
Landa 2011	24 (21-33 mos)	83	79% W	Autism	Avg pre-tx CSBS IJA = 2.29; avg MSEL t-scores: VR = 27.5; EL = 23.92
Lawton 2012	9 (3-5 years)	NR	44% W	Autism	Avg MSEL MA=30.3,; avg ESCS IJA freq=1.67
Vismara 2007	3 (26-38 mos)	100	33% AS; 67% W	Autism	VABS age ranges (mos): comm = 11-19, social = 15-17; <10 communicative words
Warreyn 2014	18 (3-7 years)	78	NR	Autism or PDD-NOS	Avg WPPSI-R FSIQ=78.94; avg Reynell language age = 4.27 years; avg pre-tx JA=1.46
Wetherby 2006	17 (12-24 mos)	88	24% H 18% AA 65% W	Autism or PDD-NOS	Social comm difficulties observed on CSBS; avg MSEL scores: NVDQ = 81.98, VDQ = 73.55; avg VABS comm score = 77.06
Wong 2013	14 (3-6 years)	86	50% H; 43% AA; 7% W	Autism	Avg MSEL AE: MA=36.25, RL=38.55, EL = 29.73; avg ESCS IJA freq=10.94; avg CARS=35.9
Yoder 2006	17 (1.9-3.5 yrs)	86	22% AA 69% W 8% O	Autism or PDDNOS	Avg MSEL MA = 18.6 months; avg pre-tx ESCS freq: IJA = 2, IBR = 11; avg pre-tx turn-taking freq = 2

Note. Studies identified by last name of first author and year.
Age equivalent scores all presented in months
Dx = diagnosis; NR = not reported; AS = Asian American; AA = African American; H = Hispanic American; MA = multiracial; PI = Pacific Islander; W = White; O = other; Avg = average; comm = communication; MSEL = Mullen Scales of Early Learning; AE= age equivalent; EL = expressive language; ESCS = Early Social Communication Scale; CI = circumscribed interest; hr = hour; IC = intentional communication; IJA = initiating joint attention; JA = joint attention; MA = mental age; mo = month; NVDQ = nonverbal developmental quotient; NVMA = nonverbal mental age; PLS-3 = Preschool Language Scale-3rd Edition; PLS-4 = Preschool Language Scale – 4th Edition; REEL-3 = Receptive and Expressive Emergent Language Scales, Third Edition; RL = receptive language; VABS = Vineland Adaptive Behavior Scale; SLO = Structured Laboratory Observation; CJA = coordinated joint attention; VR = visual reception; yr = year.

Table 2.2

Intervention and Study Descriptions

Intervention	Study	Delivery Agent		Setting	Duration & Intensity	Key Intervention Components						
		Title	Experience			CD	SP	NC	ER	EA	TD	LM
ASAP*	Dykstra 2011*	Teacher, TA, SLP	1-17 years; 3 hr initial training; cont. coaching	SC class room	5-7 weeks (≥ 40-min 1:1 & group sess/week)	X	X	X	-	-	-	-
ESI	Wetherby 2006	Parent	Trained by SLP / early child ed specialist	Home, clinic	1 year (~ 2 home sess/week; daily use expectation)	-	X	X	X	X	X	-
IS	Landa 2011	Ix	NR	Clinic-based class	6 months (4 2.5-hour sessions/ week)	X	X	X	X	X	-	X
JA intervention	Kasari 2006*	Ed psych GS	Exp. w/ autism; cont. training & supervision	Clinic EIP	5-6 weeks (5 30-min sess/week)	X	X	-	X	X	-	-
JA intervention (replication / modification of Kasari 2006)	Kasari 2010*	Parent	Training, cont. coaching by ed psych GS	Clinic	8 weeks (3 30-min sessions/ week)	X	-	-	-	X	-	-
	Kaale 2012*	Teacher	Varied; 3 day training + wkly supervision	School	8 weeks (2 20-min sess/day, 5 days/week)	X	X	X	X	-	-	-
	Wong 2013*	Teacher	1-30 years; 1 hr training/week	School	8 weeks (child exposure unclear)	X	X	-	X	X	-	-
JASPER	Lawton 2012*	Teacher; para	Avg=12.8 years Multi-months training + wkly supervision	School (inc & SC)	6 weeks (2 30-min sess/week; expectation of daily use)	X	X	-	X	X	X	X

Table 2.2 continued

Intervention	Study	Delivery Agent		Setting	Duration & Intensity	Key Intervention Components						
		Title	Experience			CD	SP	NC	ER	EA	TD	LM
JASPER	Goods 2013*	Ed psych GS	Exp. w/ autism	School (pull out)	12 weeks (2 30-min sessions/ week)	X	-	-	X	-	X	-
	Kasari 2014*	Parent	Cont. coaching by trained clinicians	Home	12 weeks (2 1-hour sess/week)	-	X	-	-	X	-	-
	Kasari 2015*	Parent	Cont. coaching by trained clinicians	Clinic	10 weeks (2 30-min sess/week)	X	X	-	X	X	-	-
PMT	Yoder 2006	Ix, para	Masters-level or bachelors w/ cont supervision	Clinic	6 months (3 20-min sessions/ week)	-	X	X	X	-	-	-
	Franco 2013*	SLP/ BCBA	Prior experience w/ PMT	Home	14 sessions (2 25-min sess/wk)	X	X	X	X	X	-	X
PRT + other elements	Jones 2006	Teacher, TA	NR	Clinic-based school	26-157 total IJA sessions (1-4 sessions/day)	-	X	X	-	-	X	-
	Vismara 2007*	Parent	Trained by 1st author	Home /clinic	12 weeks (2 2.5-hr sess/wk; daily use expectation)	X	-	X	-	-	-	-
	Harjusola 2012*	Teacher, SLP	3-10 years; RT-trained; training + cont. PF	Clinic pre-school	3-9 weeks (1 10-40-min sess/ week; daily use expectation)	X	-	-	-	X	X	-
	Warreyn 2014*	Child's usual therapist	Written training & optional 1-day seminar	Clinic	4.5-5 months / 24 sessions (2 30-min sess/wk)	X	X	X	X	X	X	-

Table 2.2 Continued

Intervention	Study	Delivery Agent		Setting	Duration & Intensity	Key Intervention Components						
		Title	Experience			CD	SP	NC	ER	EA	TD	LM
Prompts w/in CIs	Kryzak 2014	Parent & teacher	Teacher (>1 yr EI); trained to 100% accuracy by 1st author	Home & school	21-67 10-minute sessions total	X	X	X	-	-	X	-
RIT	Ingersoll 2006	Under grad students	Trained to 90% fidelity by 1st author	Clinic	10 weeks (8 20-min sessions/ week)	X	X	-	-	-	-	X
	Ingersoll 2007	Under grad students	Trained to 90% fidelity by 1st author	Clinic	10 weeks (3 20-min sessions/ week)	X	X	-	-	-	-	X
	Ingersoll 2012	Grad & under grads	Trained to 90% fidelity by 1st author	Clinic	10 weeks (3 1-hour sessions/ week)	-	X	-	-	-	-	-

Note. Studies identified by last name of first author and year.
* = manualized; ASAP = Advancing Social-Communication and Play ; ESI = Early Social Interaction Project; IS = Interpersonal Synchrony; JA = joint attention; JASPER = Joint Attention and Symbolic Play Engagement and Regulation treatment; PMT = Prelinguistic Milieu Teaching; PRT = Pivotal Response Training; CI = circumscribed interests; RIT = Reciprocal Imitation Training; CD = child directed; SP = systematic use of prompts; NC = natural consequence; ER = instruction embedded in routines; EA = environmental arrangement; TD = time delay; LM = linguistic mapping; cont. = continuous; TA = teaching assistant; SLP = speech language pathologist; SC = self-contained; sess = sessions; ed = education; Ix = interventionist; NR = not reported; psych = psychology; GS = graduate student; Exp. = experience; EIP = early intervention program; para = paraprofessional; inc = inclusion; RT = Responsive Teaching; PF = performance feedback; CI = circumscribed interest

Table 2.3

Descriptions of target prelinguistic social communicative behavior by article

	Discrete Behaviors			Aggregate	Communicative Function			
Author	Gestures	Vocalize	Gaze Shift	IC	IJA	IBR	Other	Undefined
Dykstra et al 2012				X[C]	X[C]	X[C]	X[C]	
Franco et al 2013				X				X
Goods et al 2013				X*[C]	X*[C]	X*[C]		
Harjusola-Webb & Robbins 2012	X[C]	X[C]						X[C]
Ingersoll & Schreibman 2006			X*		X*			
Ingersoll et al 2007	X			X	X			
Ingersoll 2012				X*	X*			
Jones et al 2006				X	X			
Kaale et al 2012				X[C]*	X[C]*			
Kasari et al 2006				X[P]*	X[P]*			
Kasari et al 2010				X[P]	X[P]			
Kasari et al 2014				X*	X*			
Kasari et al 2015			X*					
Kryzak & Jones 2014				X	X			
Landa et al 2011				X*	X*			
Lawton & Kasari 2013	X[C]*		X[C]*	X[C]*	X[C]*			
Vismara & Lyons 2007				X	X			
Warreyn & Roeyers 2014				X	X	X		
Wetherby & Woods 2006	X*	X*	X*	X*	X*	X*	X*	
Wong 2013	X[C]*			X[C]*	X[C]*			
Yoder & Stone 2006				X*	X*	X*		

Note. *= measured using Communication and Symbolic Behavior Scales, Early Social Communication Scales, or Structured Laboratory Observation; [C] = measured in classroom and/or during teacher-child interaction; [P] = measured during caregiver-child interaction; no label = measured during sessions and/or other unstructured observation.
Comm = communication; Bx = behaviors; IC = intentional communication; IJA = initiating joint attention; IBR = initiating behavioral requests

Table 2.4

Single Case Design Study Quality

		Rigor			Quality and Breadth of Measurement						
Study	Design	Reliability	Fidelity	Data	Social Validity	Participant Description	DV Description	Condition Description	Stimulus Generalization	Response Generalization	Maintenance
Harjusola-Webb 2012 (gesture)	MB-P	3	3	2	1	4	3	3	0	0	0
Harjusola-Webb 2012 (voc)	MB-P	3	3	2	1	4	3	3	0	0	0
Harjusola-Webb 2012 (combo)	MB-P	3	3	2	1	4	3	3	0	4	0
Vismara & Lyons 2007	Alt-Tx	4	1	3	1	4	4	1	4	4	0
Ingersoll et al 2007	MB-P	3	1	3	1	4	4	4	3	2	4
Ingersoll & Schreibman 2006	MB-P	3	1	2	1	4	3	4	3	4	4
Jones et al 2006	MP-B	3	1	1	2	4	4	3	2	3	4
Franco et al 2013	MB-P	3	1	1	2	4	3	4	0	4	4
Kryzack & Jones 2014	MP-P	3	1	2	1	2	4	4	4	0	2
Dykstra et al 2012 (group)	MB-P	1	0	1	1	4	2	3	3	4	0
Dykstra et al 2012 (full)	MB-P	1	0	1	1	4	2	3	0	4	0
Average Criterion Rating		2.73	1.38	1.81	1.18	3.82	3.18	3.18	1.73	2.64	1.64

Note. Studies identified by last name of first author and year.
DV = dependent variable; MB-P = multiple baseline across participants; Alt-Tx = alternating treatments; MP-B = multiple probe across behaviors; MP-P = multiple probe across participants

Table 2.5

Group Design Study Quality

		Rigor			Quality and Breadth of Measurement						
Study	Design	Reliability	Fidelity	Data	Social Validity	Participant Description	DV Description	Comparison Description	Stimulus Generalization	Response Generalization	Maintenance
Goods et al 2013	RCT	3	2	3	1	4	4	4	4	3	0
Ingersoll et al 2012	RCT	3	1	4	0	4	3	4	na	2	3
Kaale et al 2012	RCT	3	4	4	1	4	4	4	4	2	0
Kasari et al 2006	RCT	4	1	4	0	4	4	3	4	3	0
Kasari et al 2010	RCT	4	1	4	2	4	4	4	0	3	3
Kasari et al 2014	RCT	4	0	4	2	4	4	4	4	3	3
Kasari et al 2015	RCT	4	0	4	1	4	4	4	2	4	3
Landa et al 2011	RCT	4	4	4	0	4	4	3	4	4	3
Lawton & Kasari 2012	RCT	4	1	4	1	4	4	4	4	3	0
Warreyn & Roeyers 2014	RCT	4	0	3	1	4	3	2	4	2	0
Wetherby & Woods 2006	Quasi	4	0	1	1	4	4	2	4	4	0
Wong 2013	RCT	4	0	4	2	4	4	3	4	3	0
Yoder & Stone 2006	RCT	4	1	4	0	4	4	4	4	2	0
Average Criterion Rating		3.85	1.23	3.62	1.00	4.00	3.85	3.46	3.5	3.0	1.47

Note. DV = dependent variable; RCT = randomized control trial; Quasi = quasi-experimental design

Table 2.6

Intervention Outcomes: Single Case Design Studies

Tx	Study	Tx Effects: Main Effects	Tx Effects: Generalization	Tx Effects: Maintenance	Participant Outcomes / Key Findings
PRT Variations	**Harjusola-Webb 2012-G**	**0**	**0**	**0**	**1/3 children clearly increased use of gestures upon introduction of intervention**
	Harjusola-Webb 2012-V	**0**	**0**	**0**	**2/3 children demonstrated increased use of vocalizations upon introduction of intervention**
	Harjusola-Webb 2012-C	***3***	***3***	***0***	***All children demonstrated increased expressive communication upon introduction of intervention***
	Jones 2006	3	4	4	All 5 children increased IJA upon tx introduction w/ evidence of maintenance and generalization to novel stimuli; gains delayed for 2 children.
PMT	**Vismara 2007**	**1**	**2**	**0**	**All 3 children increased IJA upon tx introduction; gains evident using PI & NP; gains delayed for 1 child**
	Franco 2013	4	4	4	All children increased IC following PMT introduction; IC rate remained higher than baseline 6 weeks post-PMT.
ASAP	Dykstra 2012 (group)	0	1	0	No clear improvements in social communication skills upon introduction of group intervention.
	Dykstra 2012 (full)	1	2	0	Social communication and play skills improved upon introduction of individual intervention
RIT	***Ingersoll 2006***	***na***	***2***	***2***	***4/5 children increased CJA upon introduction of RIT; effects generalized to SLO for 3/5 children, 2/5 children demonstrated generalization to caregiver***
	Ingersoll 2007	***na***	***2***	***2***	***All children increased gesture use; 3 children increased use of gestures with verbalizations, effects delayed for 2 children; all children generalized gains.***
Other	**Kryzack 2014**	**1**	**2**	**2**	**2/3 children clearly increased IJA upon tx; some evidence of generalization to novel people, settings, and activities.**

Note. Studies identified by last name of first author and year
Treatment effects ratings ≥ 2 indicate at least 3 clear demonstrations of effect.
Bolded studies received an average Rigor rating of at least 2. Italicized studies also had at least 3 clear demonstrations of effect.
PRT = Pivotal Response Training; PMT = Prelinguistic Milieu Teaching; ASAP = Advancing Social-Communication and Play; RIT = Reciprocal Imitation Training; IJA = initiating joint attention; tx = treatment; G=gestures; V=vocalizations; C=combined expressive communication; ESCS = Early Social Communication Scale; voc = vocalization; RIT = Reciprocal Imitation Training; CJA = coordinated joint attention; SLO = Structured Laboratory Observation; PI = perseverative interest; NP = nonperseverative interest

Table 2.7

Intervention Outcomes: Group Design Studies

Tx	Study	Comparison Groups	Effects Ratings: Main Effects	Effects Ratings: Generalization	Effects Ratings: Maintenance	Participant Prelinguistic Social Communication Outcomes
JASPER	***Goods 2013***	***TAU (30h ABA/week)***	***3/0****	***2***	***0***	***JASPER > control post-tx classroom IBR (d=1.51); NS differences in classroom IJA and ESCS IJA/IBR***
	Kasari 2014	***Group CEM***	***2***	***4***	***4***	***JASPER > CEM IJA (f=0.14) improvement***
	Kasari 2015	**PEI**	**0**	**0**	**0**	**NS group differences in IJA**
JA Intervention	***Lawton 2012***	***Typical education***	***4***	***3***	***0***	***JASPER > control post-tx classroom IJA (d=1.85); NS differences on ESCS***
	Kaale 2012	***Typical preschool***	***3***	***2***	***0****	***Tx > control post-tx IJA during teacher-child play (d=0.44); NS differences for ESCS IJA***
	Kasari 2006	***Symbolic play tx; control***	***3***	***4***	***0****	***Tx > control post-tx IJA (EF = 1.50)***
	Kasari 2010	***Waitlist control***	***0***	***4***	***0***	***NS group differences in IJA***
	Wong 2013	***Symbolic play tx; control***	***2***	***4***	***0***	***Tx > control IJA growth rate (β=-0.09, SE = 0.04, p = .03).***
ESI	Wetherby 2006	TAU (only post-tx comparison)	4	4	0	Significant pre-post gains in several social communicative behaviors (e.g., CSBS rate of communicating, IJA, IBR, gestures)
IS	***Landa 2011***	***Typical EIP***	***1***	***3***	***0***	***IS group significantly increased IJA pre- to post-tx (d = 1.59); NS group differences in post-tx IJA***
PMT	***Yoder 2006***	***PECS***	***3***	***2***	***0***	***Children in RPMT group with ≥ 7 pre-tx IJA exhibited greater IJA gains post-tx. (ΔR^2=.36, 95% CI=.12-.94).***

Table 2.7 continued

Tx	Study	Comparison Groups	Effects Ratings: Main Effects	Effects Ratings: Generalization	Effects Ratings: Maintenance	Participant Prelinguistic Social Communication Outcomes
RIT	***Ingersoll 2012***	***TAU in the community***	***na***	***4***	***4***	***RIT > control post-tx ESCS IJA (η^2=0.16).***
PRT	**Warreyn 2014**	**TAU**	**0**	**1**	**0**	**NS group differences post-tx IJA**

Note. Studies identified by last name of first author and year
Bolded studies received an average Rigor rating of $\geq$ 2. Italicized studies demonstrated at least a moderate treatment effect.
*=Study received a rating of 3 for IBR and 0 for IJA.
**=Information from follow-up studies increases maintenance score to 4; NS = non-significant; Tx = treatment; ES = effect size; CI = confidence interval; JASPER = Joint Attention Symbolic Play Engagement and Regulation intervention; JA = joint attention; ESI = Early Social Interaction Project; IS = Interpersonal Synchrony; PMT = Prelinguistic Milieu Teaching; RIT = Reciprocal Imitation Training; PRT = Pivotal Response Training; TAU = treatment as usual; ABA = applied behavior analysis; CEM = ; PEI = ; PECS = Picture Exchange Communication System

CHAPTER 3

STUDY 2: AN INVESTIGATION OF THE EFFECTS OF PRELINGUISTIC MILIEU TEACHING IMPLEMENTED IN A CLASSROOM FOR PRESCHOOLERS WITH OR AT RISK FOR AUTISM SPECTRUM DISORDER[1]

[1] Dubin, A. H., Lieberman-Betz, R., Ayres, K., & Zawoyski, A. To be submitted to *Autism*.

Abstract

Much research exists supporting the efficacy of naturalistic behavioral interventions on increasing social communication skills for children with autism spectrum disorder (ASD), however; these evidence based interventions are not consistently utilized in preschool classrooms. Prelinguistic Milieu Teaching (PMT; Yoder & Warren, 1998) was used to teach early intentional communication (i.e., purposeful and coordinated use of vocalizations, gestures, and eye contact) to three preschool students with or at risk for ASD. The present study extends prior research demonstrating the effects of PMT in increasing intentional communication (e.g., Yoder & Warren, 1998; Yoder & Stone, 2006) through implementation in a preschool special education classroom, measurement of collateral gains related to PMT targets, and measurement of maintenance and generalization of gains. Teacher use of naturalistic behavioral strategies and student communication during interactions with their teacher were also explored. Results indicate students increased their rates of intentional communication upon introduction of PMT. These gains maintained over time for two students. Teachers were observed to use strategies both consistent and in conflict with PMT. Present study results have implications for future research and practice regarding teacher training and the efficacy and feasibility of implementing PMT in preschool classrooms.

INDEX WORDS: autism spectrum disorder, intentional communication, prelinguistic milieu teaching

Introduction

Early social communicative behaviors that involve coordinated attention between an object and another person emerge within the first year of life for typically developing children (Adamson & Bakeman, 1985). At the same time, children begin to communicate with purpose as they learn that these behaviors, including vocalizations, gestures, and eye contact, evoke responses from adults (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979). The purposeful and coordinated use of these prelinguistic behaviors, often classified as intentional communication (Warren et al., 2006), can serve the pragmatic functions of showing or labeling (i.e., proto-declarative function), requesting (i.e., proto-imperative function) and initiating and responding to social interaction bids (Bruner, 1981). Behavioral manifestations of prelinguistic social communication skills for the aforementioned pragmatic functions are commonly referred to as responding to joint attention (RJA), initiating joint attention (IJA), initiating behavior regulation/requests (IBR), and responding to behavior requests (RBR) (Siebert, Hogan, & Mundy, 1982).

Prelinguistic intentional communication provides the basis for the development of spoken language in typically developing children and children with developmental disabilities (Watt, Wetherby, & Shumway, 2006; Brady, Marquis, Fleming, & McLean, 2004; Calandrella & Wilcox, 2000; McCathren, Yoder, & Warren, 1999; Toth, Munson, Meltzoff, & Dawson, 2006). The relation between prelinguistic intentional communication and spoken language is at least partly due to parent responsivity, as parental responsiveness to child communication promotes more advanced language development (Tamis-Lemonda, Kuchirko, & Song, 2014; Brady, Marquis, Fleming, &

McClean, 2004; Calendrella & Wilcox, 2000). Additionally, parents are more likely to respond to children's intentional communication than earlier pre-intentional forms of communication lacking coordinated attention (Yoder & Munson, 1995; Yoder, Warren, Kim, & Gazdag, 1994). The interrelationship between prelinguistic intentional communication, parental responsiveness, and language development are well situated within the transactional model of development, whereby development occurs through reciprocal interactions between a child and environmental contexts (Sameroff, 1975).

Given the role of prelinguistic intentional communication in eliciting parental responsiveness, which subsequently serves to facilitate more advanced social communication development, the transactional model serves to highlight the importance of teaching prelinguistic intentional communication to children who have not yet acquired those skills, such as children with or at risk for autism spectrum disorder (ASD). Given core joint attention (JA) deficits in ASD, prelinguistic intentional communication for the purposes of sharing attention is often more impaired than intentional communication for requesting (Loveland & Landry, 1986; Mundy, Sigman, Ungerer, & Sherman, 1986; Paparella et al., 2011; Stone, Ousley, Yoder, Hogan, & Hepburn, 1997); however, children with ASD use fewer and less complex forms of intentional communication than typically developing children and children with other developmental delays across all pragmatic functions (Mundy, Sigman, & Kasari, 1990; Sigman & Ruskin, 1999). When compared to typically developing children and children with other developmental disabilities, children with ASD evidence deficits in several components of prelinguistic intentional communication, including non-word vocalizations (e.g., Chawarska et al., 2007; Maestro et al., 2001; Plumb & Wetherby, 2013), communicative

gestures (e.g., Shumway & Wetherby, 2009; Maestro et al., 2001; Osterling & Dawson, 1994; Baranek, 1999), and eye gaze (e.g., Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Charman et al., 1997; Wetherby et al., 2007; Stone et al., 1997).

Relations Between Prelinguistic Communication and Other Behaviors

Deficits in the separate and combined use of prelinguistic communicative behaviors not only underlie spoken language but also several other related areas that are also impaired in ASD. Research exists supporting the relation of these pivotal behaviors to several developmental outcomes (e.g., spoken language, play, imitation) for typically developing children and children with ASD and other developmental disabilities (e.g., Bates et al., 1979; Toth, Munson, Meltzoff, & Dawson, 2006; Mundy & Gomes, 1998; Kasari, Freeman, & Paparella, 2001; Jones & Carr, 2004).

Language. It is well established that prelinguistic intentional communicative behaviors are precursors for language development, as much research support exists for the concurrent and predictive relation of IJA and language in typically developing children (e.g., Mundy & Gomes, 1998; Mundy et al., 2007; Bates et al., 1979) and children with disabilities (e.g., Dawson et al., 2004; Toth et al., 2006; Thurm, Lord, Lee, & Newschaffer, 2007; Sigman & Ruskin, 1999; Sigman & McGovern, 2005; Siller & Sigman, 2008; Charman et al., 2003). In children with ASD, rate of early communicative acts and JA have been found to be the strongest predictors of spoken language one year later (Shumway & Wetherby, 2009). Additionally, several intervention studies have demonstrated improvements in expressing and comprehending language following interventions that target IJA (Jones, Carr, & Feely, 2006; Kasari, Paprella, Freeman, & Jahromi, 2008; Whalen, Schreibman, & Ingersoll; 2006; Yoder & Stone, 2006a).

Play. Children with ASD are less likely to engage in pretend play and exhibit less varied play behaviors as compared to typically developing children (Barton & Wolery, 2010; Kasari, Freeman, & Paparella, 2006; Sigman & Ungerer, 1984; Stone et al., 1990; Williams et al., 2001). Deficits in play skills may be related to JA impairment (Jones & Carr, 2004), as results from extant research suggest positive correlations between several play skills and JA (Mundy & Sigman, 1989; Toth et al., 2006). Additional support for the relation of JA with play is provided by intervention studies demonstrating collateral gains in play following JA instruction (Whalen, Schreibman, & Ingersoll, 2006; Yoder & Stone, 2006a; Kasari, Freeman, & Paparella, 2006).

Imitation. Compared with typically developing children and children with developmental disabilities, children with ASD show deficits in imitation (Charman et al 1997; Stone, Ousley, & Littleford, 1997; Stone et al., 1990). Results from prior research conducted with children with ASD suggest correlations between JA impairment and deficits in vocal and motor imitation with and without objects (e.g., Abrahamsen & Mitchell, 1990; Carpenter, Pennington, & Rogers, 2002; Meltzoff & Moore, 1994; Rogers, Hepburn, Stackhouse, & Wehner, 2003; Toth, Munson, Meltzoff, & Dawson, 2005). In children with ASD, improvements in imitation skills have been observed following JA interventions (Whalen, Schreibman, & Ingersoll, 2006).

In sum, developmental and intervention research support the classification of JA and related early social communicative behaviors as pivotal skills, which highlight the importance of early social communication interventions for children with or at risk for ASD. Without such intervention, impairments in social communication will likely persist or worsen, which may increase the risk of problem behaviors and also diminish

opportunities for school involvement (Sigafoos, Arthur-Kelly, & Butterfield, 2006). Fortunately, results from several intervention studies have shown that interventions targeting prelinguistic social communication may be effective in improving targeted and associated non-targeted behaviors (National Research Council [NRC], 2001; White et al., 2011).

Early Social Communication Interventions for Children with ASD

Considering the transactional effects of prelinguistic intentional communication and vast learning opportunities afforded by JA and other social communicative behaviors such as requesting, early intervention with a focus on prelinguistic social communicative behaviors is recommended for children with ASD (Mundy & Crowson, 1997). Replicated evidence exists suggesting greater improvements in symptoms with early intervention (NRC, 2001), which further emphasizes the need to address social communication deficits in young children with or at risk for ASD.

Fortunately, several interventions exist with research support for improving JA and other social communicative behaviors in children with ASD and other developmental delays (NRC, 2001; Prelock, Paul, & Allen, 2011; White et al., 2011). Early intensive behavioral interventions (EIBI), which include highly structured instruction through manipulating antecedent and consequence variables, have been shown to promote gains in early social communication behaviors for children with ASD (Warren et al., 2011). However, improvements observed following EIBI often fail to generalize outside of the instructional context (e.g., Kaiser & Trent, 2007; Prizant & Wetherby, 2005; White et al. 2011). Shortcomings inherent in highly structured behavioral interventions and the movement toward providing instruction in the least restrictive environment have

prompted a shift toward more naturalistic and developmental interventions (Ledford & Wolery, 2011; Sowden, Perkins, & Clegg, 2011). Naturalistic interventions are considered a viable alternative to EIBI for teaching early social communication skills to children with ASD (Kaiser & Trent, 2007; NRC, 2001; White et al., 2011), as they include components thought to facilitate generalization and maintenance of gains, including instruction embedded in the natural environment and use of natural consequences (Stokes & Baer, 1977). Several variants of naturalistic social communication interventions exist, which share several common elements, including the use of behavioral principles (e.g., prompting hierarchies; instruction using preferred items; time delay; reinforcement) and developmental strategies, including following the child's lead, expanding child responses, and contingent imitation (White et al., 2011).

One example of a manualized naturalistic communication intervention is Prelinguistic Milieu Teaching (PMT; Yoder & Warren, 1998), which is based on the transactional model of communication development and uses behavioral strategies to target early developing behaviors used to request and share attention. The primary goal of PMT is to increase the frequency and complexity of prelinguistic intentional communication, including the separate and combined use of coordinated eye gaze, gestures, and vocalizations thought to provide a basis for and facilitate language learning (Yoder & Warren, 1998). PMT is the first component in Milieu Communication Teaching (MCT), a set of interventions that use similar strategies to target increasingly complex communicative behaviors (Fey et al., 2006). Principles of MCT include following the child's lead, environmental arrangement, teaching within well-established routines, and putting words to the child's presumed communicative intent (i.e., linguistic

mapping). PMT instruction initially teaches prelinguistic behaviors for the purpose of requesting, as research has suggested that proto-imperative communication is often less impaired in children with ASD (e.g., Paparella et al., 2011; Mundy & Crowson, 1997), more observable and easy to reinforce (Mundy & Crowson, 1997), and thus easier to facilitate through intervention (Bondy & Frost, 1995). Once a child has acquired the combined use of gestures, vocalizations, and coordinated attention to an adult for the purpose of requesting, these same behaviors are then targeted for the purpose of sharing attention.

Empirical support for PMT. Over twenty years of research has been conducted to investigate the effects of PMT on intentional communication and associated behaviors in children with developmental disabilities, including children with ASD. The two earliest studies were conducted using single case design methodology to examine PMT's effects on intentional communication for a total of 9 children ages 20 to 30 months with developmental delays across studies (Warren, Yoder, Gazdag, Kim, & Jones, 1993; Yoder, Warren, Kim, & Gazdag, 1994). Warren and colleagues found generalized improvements in intentional communication for the purposes of requesting for 4 out of 5 participants and generalized improvements in IJA for the single participant for whom IJA was targeted (1993). Similar results suggesting generalized increases in intentional communication for requesting were obtained by Yoder and colleagues (1994). Promising results from single case design studies led to a larger group design study comparing PMT with Responsive Small Group (RSG) for 58 children ages 17 to 36 months of age with developmental disabilities, including two children diagnosed with an ASD (Yoder & Warren, 1998). Children were randomly assigned to either PMT or RSG, which involved

play between a trainer and three children. During RSG sessions, the trainer played alongside the children and responded to any communicative acts; however, no demands or prompts to respond were used. Although PMT was not shown to have a main effect on intentional communication, results indicated PMT was more effective than RSG for children with highly responsive mothers (Yoder & Warren, 1998). Specifically, children with highly responsive mothers demonstrated greater increases in rate and number of intentional communication acts for the purposes of requesting and sharing attention (Yoder & Warren). Results from follow up studies suggested that increases in intentional communication observed for children with highly responsive mothers maintained six months post-intervention (Yoder & Warren, 1999) and showed signs of further increase at 12 months post-intervention (Yoder & Warren, 2001). The second follow up study conducted by Yoder and Warren (2001) also identified parent education as a predictor of response to PMT. Replicated findings demonstrating the importance of parental responsivity led to the addition of a responsivity education component (RE) in many subsequent investigations (Yoder & Warren, 2002; Yoder & Stone, 2006a; Fey et al., 2006; Fey, Yoder, Warren, & Bredin-Oja, 2013).

Studies of PMT for children with ASD. Yoder and Stone (2006a, 2006b) conducted the first studies of PMT with the RE component (RPMT) focusing on improvements in PMT targets and associated behaviors (i.e., spoken language) for children with ASD. They compared RPMT to the Picture Exchange Communication System (PECS) using a randomized group design with two to five-year-old children. Children who received PECS training demonstrated better immediate spoken language outcomes (i.e., increased frequency and rate of spoken words); however, these gains were

not maintained six months post-treatment (Yoder & Stone, 2006a). Pre-treatment variables were found to moderate effects of both interventions for spoken language and prelinguistic intentional communication outcomes. Specifically, children with low levels of initial object exploration who received RPMT as opposed to PECS showed greater spoken language gains 6 months post-treatment. Additionally, whereas children with low initial levels of IJA who received PECS demonstrated greater increases in requesting, improvements in turn taking, commenting, and JA were found following RPMT for children with higher initial levels of IJA (Yoder & Stone, 2006b).

As deficits in prelinguistic communication can persist past early childhood in individuals with ASD, Franco, Davis, and Davis (2013) recently examined the effects of PMT for five- to eight-year-old children (n=6) using single case design methodology. Similar to prior research with younger children, Franco and colleagues found evidence of increased number of intentional communication acts from baseline to intervention, which maintained four to six weeks post-treatment for most participants. Results provide initial support for the use of PMT with older children in the home.

Overall, results from previous studies suggest PMT with and without the RE component can improve prelinguistic social communication skills for some children when conducted in clinics or the child's home (Fey et al., 2006; Fey, Yoder, Warren, & Bredin-Oja, 2013; Franco et al., 2013; Warren et al., 1993; Yoder & Stone, 2006a, 2006b; Yoder, et al., 1994; Yoder & Warren, 1998, 1999, 2002). In contrast to studies conducted in home and clinical settings, limited support exists for the efficacy of PMT implemented in the child's school. The majority of school-based studies have focused on Milieu Teaching (MT), the MCT component used to improve communication for children

who already exhibit some spoken language (e.g., Christensen-Sandfort & Whinnery, 2013). To date, the implementation of PMT in a preschool classroom has been studied once in a single case design study that measured a teacher's ability to implement PMT and subsequent effects on intentional communication for a 3-year-old student with developmental disabilities (McCathren, 2000). Using a multiple baseline across behaviors design, results suggested the teacher was able to implement PMT with fidelity, which resulted in gains in intentional communication for the single participant (McCathren). McCathren recommended further investigation of PMT in the classroom, as replications of the obtained results are necessary to provide evidence of PMT's effects on children with different characteristics. Additionally, it is not yet understood how to best train teachers with varying teaching styles, attitudes, and levels of experience in PMT strategies.

In addition to measuring directly targeted PMT outcomes, several studies have evaluated PMT's impact on collateral gains or non-targeted outcomes (e.g., spoken language; object interest). Evidence suggests PMT's impact spans beyond targeted outcomes, as improvements following PMT have been observed for spoken language (Fey, et al., 2013; McCathren, 2000; Yoder & Warren, 2002; Yoder & Stone, 2006a) and variables related to play (McCathren, 2000; McDuffie, Lieberman, & Yoder, 2012). Results from research conducted with children with developmental delays, including ASD, suggested increases in the frequency and variety of words used following PMT (Yoder & Warren, 2002; Yoder & Stone, 2006a; McCathren, 2000). Similarly, Fey and colleagues (2013) found evidence of child spoken language improvements that generalized to play samples conducted in a location different from treatment with the

child's mother using different toys and activities. In addition to spoken language, increases have been observed in symbolic play and object interest (i.e., the number of toys with which children use spontaneous, differentiated play actions) following PMT (McDuffie, et al. 2012; McCathren, 2000). Of note, these collateral gains were shown to generalize across people, materials, settings, and activities.

Limitations of past PMT studies. Despite promising results for PMT implementation in clinics and child homes for targeted and non-targeted behaviors, inconsistencies exist across studies, which have been attributed to a variety of factors, including maternal responsivity, child pre-intervention characteristics (e.g., levels of object interest and IJA), child diagnosis, and dependent variable measurement (Fey et al., 2013; Yoder & Stone, 2006a, 2006b; Yoder, Warren, & Hull, 1995; Yoder & Warren, 1998, 1999, 2002). For example, children with Down syndrome demonstrated benefits from PMT in one study (Fey et al., 2006) but not another (Yoder & Warren, 1998). Additionally, pre-intervention levels of object interest and IJA moderated the efficacy of PMT compared to another communication intervention, PECS, such that children with higher initial levels of IJA and lower initial object interest had higher rates of communication growth in PMT as compared to PECS (Yoder & Stone, 2006b). In contrast, children with developmental disabilities not including ASD responded to PMT better when they had lower initial rates of IJA (Yoder & Warren, 2002). Intentional communication gains have also been limited to children with highly responsive mothers in some studies (e.g., Yoder & Warren, 1998, 1999). Inconsistent findings may also be attributable to measurement differences, such as investigating overall intentional communication gains or separately investigating intentional communication based on

function (e.g., to request; to share attention) and/or form (e.g., coordinating attention using gestures or vocalizations). For example, Fey and colleagues (2006) found that rate of overall intentional communication increased significantly following PMT; however, rates of child requesting and showing were not found to be significantly improved when investigated separately.

Other aspects of prior study designs may further impede clear interpretations of the effects of PMT. Whereas group design studies investigating PMT featured strong methodology, including random assignment of participants to PMT and comparison groups, only two studies used a treatment as usual control group (Fey et al., 2006; Yoder & Warren, 2002). Several group design studies compared PMT with another treatment (Yoder & Warren, 1998, 2002; Yoder & Stone, 2006) or compared PMT at different intensity levels (Fey et al., 2013). Without a true control group, it is difficult to conclusively attribute gains in intentional communication to PMT or other variables (e.g., maturation). Thus, further research using designs that can demonstrate causality are required to add replicated evidence of PMT's effects on intentional communication.

Additionally, inconsistent results exist regarding maintenance of gains. In 6- and 12-month follow up studies, Yoder and Warren reported accelerated intentional communication development for participants with responsive mothers who received PMT (1999, 2001). Maintenance of gains was also observed in a later study of RPMT (Yoder & Warren, 2002) and a study investigating PMT with older children with ASD (Franco et al., 2013). In contrast, gains in intentional communication were no longer observed six or more months post-treatment in other studies that measured maintenance (Fey et al., 2013; Yoder & Stone, 2006a).

Avenues for future research. Given evidence for PMT's effects on prelinguistic social communication skills, further research should be conducted regarding the implementation of PMT in a classroom setting. According to the U.S. Department of Education EDFacts Data Warehouse (EDW), 8.9% of the 753,697 three to five-year-old students receiving special education services in 2014-2015 school year were served under the autism eligibility category, which represents the third largest preschool special education category behind speech language impairment (43.7%) and developmental delay (37%) (EDW, 2015). Preschool classrooms are natural environments for many young children with or at risk for ASD, in which evidence-based instruction to remediate core deficits is required by law (Individuals with Disabilities Act [IDEA], 2004). Despite legal mandates, research suggests few teachers use evidence-based instruction with students with ASD (Morrier, Hess, & Heflin, 2010) and core deficits (e.g., JA; symbolic play) are infrequently targets of instruction (Wong & Kasari, 2012). One potential reason for lack of systematic instruction in early social communication is lack of teacher knowledge of research-supported interventions for students with ASD (e.g., Barnard et al., 2011; Kasari, Freeman, Bauminger, & Alkin, 1999), which is at least partly attributable to lack of time and resources for accessing such information (Closs & Lewin, 1998).

More research is necessary to determine how to best train teachers in naturalistic communication interventions like PMT (Kaiser & Trent, 2007). School psychologists may be well suited to increase the use of research-supported interventions such as PMT through teacher training and consultation (Hoagwood & Johnson, 2003; Lerman, Vorndran, Addison, & Kuhn, 2004; Williams, Johnson, & Sukhodolsky, 2005); however,

more information on classroom-implemented PMT would be helpful to guide teacher training. To better promote the use of research-supported interventions in schools, it is important that research be conducted in the classrooms where the intervention will be used (Kasari & Smith, 2013). Research examining the efficacy and feasibility of conducting PMT in preschool special education classrooms is consistent with recommendations in prior MCT studies (Christensen-Sandfort & Whinnery, 2013; McCathren, 2000) and may serve as a first step in designing teacher-training programs that may assist in increasing the use of research-supported interventions in schools.

Additionally, more research on PMT is necessary to replicate effects on spoken language and play behaviors, and investigate other potential collateral gains. Candidate behaviors for investigation include imitation and RJA, which are both related to PMT targets and therefore may be indirectly impacted through interventions. To date, imitation and RJA have not been measured in PMT research. Accumulated evidence exists for the association between imitation and IJA, the latter of which is a PMT target (e.g., Rogers et al., 2003). Additionally, PMT includes strategies in which imitation is both promoted (i.e., imitating child behaviors) and required (i.e., use of model prompts), which further supports the importance of measuring participant imitation skills before and after PMT. Regarding RJA, the PMT manual indicates high levels of JA are required for a child to benefit from the intervention (Fey et al., 2006); however, both RJA and IJA are often impaired in children with ASD (Wetherby, Watt, Morgan, & Shumway 2007; Landa, 2007). As such, multiple strategies are used to increase child engagement, (e.g., following the child's lead; use of routines; imitating the child). Evidence exists supporting increases in RJA following reciprocal imitation of child acts (Ingersoll &

Schreibman, 2006; Ezell et al., 2012), which suggests the potential for at least one PMT strategy to increase RJA. Additionally, research indicates IJA emerges after RJA in typically developing children (Moore & Dunham, 1995), which has prompted many interventions to target RJA prior to IJA (e.g., Whalen & Schreibman, 2003). However, deficits in the developmental progression of JA behaviors in children with ASD and the effects of IJA intervention on RJA are both understudied areas. Thus, research evaluating the effect of PMT on RJA has the potential to provide preliminary evidence of additional collateral gains as well as inform the order in which different JA skills are taught in interventions.

Whereas PMT has been widely studied over the past two decades, further evaluation is required to better understand the effects of PMT on specific types of prelinguistic behaviors used for different functions (i.e., requesting and sharing attention) and replicate and extend research on collateral gains following PMT. Additionally, given demonstrations of effectiveness in the home and clinic settings as well as the IDEA mandate for research supported instruction for students with ASD, research is necessary to understand PMT implementation in a classroom.

Study Purpose

Overall, results from studies investigating PMT have been promising for improving intentional communication and related skills for children with ASD and other developmental delays ranging in age from 18 months to eight years (e.g., Yoder & Warren, 1998; Yoder & Stone, 2006a,b; Franco, Franco, & Davis, 2013). However, further research is necessary to replicate and extend findings from prior studies. The current study sought to expand the evidence base for PMT through (a) implementation in

a preschool special education classroom, (b) comprehensive measurement of child behaviors related to PMT targets and potential collateral gains in spoken language, object interest, imitation, and RJA, (c) measurement of maintenance and generalization of gains, and (d) measure of teacher attitudes and behaviors as a preliminary step toward training teachers to implement PMT within the context of consultation with school psychologists. Specific questions investigated in the current study include:

1. Does classroom-implemented PMT increase the use of PMT targeted behaviors (i.e., intentional communication for the purposes of requesting and sharing attention) in preschoolers with ASD, or those demonstrating ASD symptomatology?
2. Do increases in PMT targeted behaviors generalize to other people (i.e., teachers and/or paraprofessionals) and activities (e.g., play routines) and maintain over time?
3. Do collateral behaviors not directly targeted by PMT (i.e., spoken language, object interest, imitation, and RJA) change following intervention? Information obtained regarding imitation and RJA is considered exploratory, as these collateral gains were only measured via pre-post assessment.
4. Do changes in collateral behaviors not directly targeted by PMT (i.e., spoken language and object interest) generalize to other people and activities and maintain over time?
5. Which strategies typically used by preschool special education teachers are compatible and incompatible with PMT? Additionally, do preschool teachers

incidentally acquire behaviors compatible with PMT strategies through informal observation of PMT implementation?

It was hypothesized that, consistent with prior evaluations of PMT, children would show evidence of increased frequency of intentional communication for the purposes of requesting and sharing attention, increased object interest, and increased spoken language use. Also consistent with past research, these gains were expected to generalize across people and activities. Although imitation and RJA have not been evaluated in prior research, it was expected that collateral gains in these areas would occur because of their relation with targeted behaviors and PMT procedures. Finally, with respect to the first part of question five, it was hypothesized that teachers would exhibit some indirect strategies consistent with PMT (e.g., providing natural consequences), as results from prior research suggest limited systematic use of direct teaching strategies (e.g., prompting; linguistic mapping) consistent with PMT (Smith, Warren, Yoder, & Feurer, 2004; Wong & Kasari, 2012). The second part of question five is exploratory, thus there is no a priori hypothesis about teacher acquisition of PMT strategies over the course of the study. However, information gathered about teacher behaviors will inform future research and practice regarding teacher training within a collaborative framework.

Method

Participants

Recruitment. Three students and either their teacher or paraprofessional were recruited from two preschool classrooms in the southeastern United States. Two students were served in a self-contained public preschool special education classroom and the

third participant was served in a collaborative classroom within a private school focused on inclusive education for children with ASD. Inclusion criteria for students included: (a) child age between 3 and 6 years; (b) eligibility for special education based on state requirements; (c) characteristics of ASD as reported by the child's teacher on the *Gilliam Autism Rating Scale, Third Edition* (GARS-3; Gilliam, 2013) and confirmed by the primary investigator using the *Childhood Autism Rating Scale, Second Edition* (CARS-2; Schopler, Bourgondien, Love, & Wellman, 2010); (d) minimal verbal abilities (i.e., fewer than 10 spontaneous communicative words produced during pre-intervention assessments); (e) Individual Education Program (IEP) objectives related to functional communication; (f) no known hearing or uncorrected vision impairment; and (g) parent permission to participate in the study. No specific inclusion criteria were required of teachers aside from teaching a student enrolled in the study and consenting to participate. Teachers who consented to participate in the study selected students who were likely to meet inclusion criteria. Consent forms were sent to these three students' parents, all of whom provided consent for their child to participate in the study. Pseudonyms are used to identify all participants.

Child participants. Three preschool special education students from two schools met inclusion criteria and participated in the study. Demographic information is presented in Table 3.1. Justin (age 4 years, 10 months) attended a private, inclusive preschool program that served typically developing children and children with ASD and other developmental disorders. He was eligible for special education under the category of Autism and Speech-Language Impairment. Between the ages of two and three years, Justin began receiving speech, occupational therapy, and applied behavior analysis

services, all of which were continued over the course of the present study. According to parent and teacher report, he did not communicate using spoken language; however, he was learning to communicate using an iPad. During a classroom observation prior to data collection, Justin was observed walking around the classroom and gathering toys. He did not initiate communication toward his teachers or peers nor did he engage in any functional play.

Felicia (age 4 years, 5 months) and Michael (age 4 years, 3 months) were both students in a public, self-contained special education preschool classroom. They were eligible for special education under the categories of Significant Developmental Delay (SDD) and Speech-Language Impairment. Felicia's parents reported she communicated using spoken language during early development but experienced a regression around 18 months of age and currently does not use any spoken language or gestures to communicate. She had received early intervention services, speech therapy, and occupational therapy between the ages of 17 and 36 months; however, she was not receiving outside services during the course of the study. She engaged in relatively high rates of eye contact with the teacher and teaching assistants in the classroom and occasionally pointed at items in the classroom; however, the function of her communication was typically unclear. Felicia was also observed to engage in high rates of vocal stereotypy and exhibit little interests in toys aside from a small trampoline. Michael also received early intervention services, speech services, and occupational therapy services between the ages of two and four years. He continued to receive speech and occupational therapy services for the duration of the study. Although parents reported that Michael had a vocabulary of 15 spoken words, some of which were used

communicatively, he used fewer than 10 spontaneous, functional words across pre-baseline assessments. Michael was observed to infrequently label items using spoken language in the classroom; however, he did not integrate words with other communicative behaviors nor did he appear to engage in requesting or other functional communication. Additional information about each participant's intellectual functioning, language abilities, and autism symptomatology is located in Table 3.2.

Teacher/paraprofessional participants. Ms. Brown taught in the public self-contained classroom attended by Michael and Felicia. She held a master's degree in special education and had three years of preschool special education teaching experience. Mr. Jones was a high school graduate with just under one year of experience working as a paraprofessional in the private, inclusive preschool classroom that Justin attended. Mr. Jones was selected for participation in the study rather than the classroom teacher due to spending more one-on-one time with Justin than the teacher. Ms. Brown and Mr. Jones both reported experience teaching children with ASD and communication delays as well as the use of instructional strategies consistent with PMT (e.g., embedded instruction, environmental arrangement, linguistic mapping).

Setting and Materials

Baseline probe, intervention, maintenance, and generalization sessions took place in a 1:1 format in an area of the child's classroom separate from other students. The self-contained preschool classroom had 10 students, one teacher, and two paraprofessionals. There was one teacher and one paraprofessional in the collaborative classroom. The number of students served in the collaborative classroom ranged from 3-6 students depending on the day of the week.

The primary investigator conducted all pre- and post-intervention assessments and maintenance sessions. Baseline probes and PMT instructional sessions were conducted by the primary investigator twice per week. A special education master's student who had been trained in PMT by the primary investigator served as secondary clinician and conducted PMT sessions once per week. Information obtained through teacher-report and initial observations was used to select highly preferred toys to be used during baseline probes, maintenance and PMT sessions (see Table 3.3 for more detailed description of toys and routines used with each participant). The primary investigator provided two sets of toys that were rotated across sessions to decrease the likelihood of satiation and increase consistency across different participant's sessions. Each set included toys that might encourage child commenting (e.g., toys that light up, move, or make noise; cause and effect toys), at least one highly preferred toy for each participant, and pairs of similar toys that the primary investigator used to imitate the child's play. Due to the importance of following the child's lead in PMT, classroom toys were sometimes used when requested by the child during baseline and intervention sessions. A larger variety of only classroom toys were used during generalization sessions to increase the likelihood that generalization sessions represented typical student-teacher interactions. Pre-baseline and post-intervention assessments took place in a small room in the child's school using novel toys unavailable in the child's classroom or during intervention sessions. Across conditions, a research assistant video recorded all sessions for data collection purposes.

Response Definitions and Direct Observation Recording Procedures

Data were collected from video recordings of sessions. Target child behaviors were recorded using INTERACT (Mangold, 2015), coding software that allows hierarchical coding of behaviors that occurred simultaneously or sequentially (see Appendix E for detailed coding instructions). Teacher behaviors were coded using data sheets created for the study (see Appendix F).

Child behaviors. Consistent with prior research on PMT, the primary child behavior targeted for the purposes of the current study and used to make decisions regarding introduction of PMT to subsequent participants and mastery criteria was the rate of unprompted intentional communication (IC) acts and two-component pre-IC acts coded per session. Rate was chosen as the metric because although the majority of baseline and intervention sessions lasted 20-minutes, the duration of 15 sessions was reduced (length of shortened sessions ranged from 15 to 19 minutes) due to changes in the classroom schedule. IC was defined as any communicative act (i.e., act containing a gesture or vocalization combined with coordinated attention to an object and person or use of spoken words) used for the purposes of requesting or initiating joint attention (IJA). To create a variable sensitive to incremental changes in participants' intentional communication behaviors, two-component pre-IC acts (i.e., combined use of vocalizations and eye contact or gestures) were coded and incorporated into intervention decisions by aggregating with the number of IC acts to create a single variable. See Table 3.4 for more detailed definitions of variables that were measured, including IC, requesting, IJA, and collateral gains.

All IC acts, components of IC acts, and several collateral behaviors (i.e., spoken language, and object interest) and the time at which they occurred were coded using INTERACT during baseline, intervention, generalization, and maintenance conditions. Two additional potential collateral behaviors, motor imitation and responding to joint attention (RJA), were measured at pre- and post-intervention. During baseline, generalization, and maintenance probes, only independent responses were recorded. During intervention sessions, an average of one teaching episode occurred per minute (Fey et al., 2013). As such, PMT targets, which included IC acts or components (e.g., gaze shift) selected for each participant based on pre-intervention performance, were recorded as prompted or independent. A prompted response included any IC act or component performed by the child within 3 seconds of any type of adult prompt (e.g., verbal, model, gesture, physical). An independent response included any IC act performed by the child that was not preceded within 3 seconds by an adult prompt. Given that object interest was not directly targeted through PMT, it was not explicitly prompted during intervention sessions. Thus, the same procedures used during baseline, generalization, and maintenance probes were used to code object interest during PMT sessions.

Teacher behaviors. Teacher behaviors were operationally defined based on behaviors compatible (i.e., environmental arrangement, linguistic mapping, following the child's lead, use of prompts, and initiation of routines) and incompatible (i.e., directing child) with PMT strategies (see Table 3.5). Data on following the child's lead were collected using 15-second interval momentary time sampling. All other teacher behaviors were coded using minute-by-minute event recording. Teacher behavior data

were collected during generalization probes conducted in baseline, intervention, and maintenance conditions. Rate of teacher behaviors was aggregated in baseline, intervention, and maintenance conditions to compare strategy use across conditions, as the number of generalization sessions varied across children.

Formal Measures

In addition to behaviors coded during baseline, intervention, maintenance, and generalization probes, child and teacher information was collected pre-baseline and post-intervention to characterize the participants, and further assess generalization and collateral gains. The nine additional measures are described below:

Demographic information and treatment history. Parents of eligible participants completed the Demographic and Treatment Questionnaire developed by the investigators to provide information about demographic variables (e.g., parent age, education status) prior to baseline probes, which were used to describe the participants in a manner consistent with the extant PMT literature (e.g., Yoder & Warren, 1998). The questionnaire also collected information about past and current interventions received by the child and family (e.g., in-home applied behavior analysis, speech therapy). The Demographic and Treatment Questionnaire was only administered pre-intervention.

ASD symptomatology. ASD symptomatology was measured via parent, teacher, and clinician ratings.

Parents completed the *Pervasive Developmental Disorders Behavior Inventory, Parent Report* (PDDBI; Cohen & Sudhalter, 2005) prior to baseline probes. The PDDBI is a parent rating scale designed to assess ten domains of ASD symptomatology and associated areas (e.g., social pragmatics, expressive language, adaptive functioning). The

PDDBI demonstrates adequate internal consistency (*Mdn* composite α = .93), temporal consistency reliability (*Mdn* composite *r* = .97), and has demonstrated concurrent validity with the CARS. Additionally, PDDBI subscale scores have been shown to vary with developmental changes and thus may be sensitive to treatment effects (Cohen, Schmidt-Lackner, Romanczyk, & Sudhalter, 2003). Information obtained from the PDDBI was used to provide a parent rating of autism severity and associated problems.

Teachers completed the *Gilliam Autism Rating Scale, Third Edition* (GARS-3; Gilliam, 2013) prior to baseline probes to provide a rating of autism severity. The GARS-3 is a third-party rating scale designed to measure behaviors that are symptomatic of ASD (i.e., stereotyped behaviors, communication difficulties, social interaction, and developmental disturbances). The GARS-3 demonstrates adequate internal consistency (α > .85 across subscales), test-retest reliability (*r* > .80 across subscales), concurrent validity with the Autism Behavior Checklist (ABC; Krug, Arick, & Almonst, 1978), and discriminates between children with autism and children with other disabilities (Gilliam, 2013).

The *Childhood Autism Rating Scale, Second Edition* (CARS-2; Schopler et al., 2010) is a rating scale designed to identify children with ASD through direct behavioral observation. The CARS-2 distinguishes children with ASD from children with other developmental disorders and provides information on ASD severity. It has evidence of adequate internal consistency (α = .94), interrater reliability (*r* = .71), and correlates with independent clinical diagnosis (*r* = .80; Schopler et al., 1988). The primary investigator completed the CARS-2 prior to baseline probes to confirm teacher-reported ASD symptomatology.

Teacher knowledge and experience. Prior to baseline probes, teachers of child participants completed the Teacher Questionnaire developed by the primary investigator to provide information about their teaching experience, experience working with students with ASD, knowledge of PMT, and current strategies for teaching communication skills. The questionnaire also collected information about the participating students' daily schedule, IEP objectives, and preferred items and activities to help plan PMT sessions. Additionally, following PMT implementation, teachers were asked if they attended any professional development trainings over the course of the study to account for potential alternative causes for change in teacher behavior.

Cognitive functioning. The *Mullen Scales of Early Learning* (MSEL; Mullen 1995) is an assessment designed to measure cognitive and motor development in children from birth to 68 months through performance across five scales, including Visual Reception, Expressive Language, Receptive Language, Fine Motor, and Gross Motor. Scores from all scales except Gross Motor together comprise the Early Learning Composite. The MSEL manual reports median split half internal consistency of over 0.75 for all composites and subscales. Test-retest reliability of over 0.80 was reported when administered to children 1-24 months of age and 0.70 for children ages 25-56 months of age. The Mullen was administered prior to baseline probes to provide an estimate of participant cognitive and language functioning.

Social communication skills. The *Early Social Communication Scales – abridged* (ESCS-abridged; Mundy et al., 2003) was administered prior to baseline probes and post-intervention to characterize each participant's use of intentional communication and related behaviors, create intervention goals, and explore generalization of gains to

different activities in a more structured setting. The ESCS-abridged is a structured observational assessment composed of several activities and adult prompts intended to elicit communication. Examples of behaviors coded include RJA, IJA, and initiating behavioral requests. Interrater reliability estimates range from r = .61 to r = .94 for all coded behaviors (Mundy et al., 2003).

Imitation. The *Motor Imitation Scale* (MIS; Stone, Ousley, & Littleford, 1997) was administered prior to baseline probes and post-intervention to explore collateral gains in imitation in a structured setting. The MIS is a structured motor imitation assessment that evaluates the child's ability to imitate adult-modeled actions with and without objects. Responses are scored on a 0-2 point scale (2=passing, 1=emerging/partial imitation, 0=failure/no response). The MIS demonstrates adequate interrater reliability (Cohen's kappa=.80), internal consistency (r=.87 [total MIS score]; r=.54 – r=.88 [body imitation, object imitation, meaningful tasks, and non-meaningful task subscore]), and test-retest reliability (r=.80 [total MIS score]).

Unstructured classroom play sample. A 10-minute classroom observation during play activities was conducted prior to baseline probes. The play sample was videotaped and scored to provide descriptions of the child's play and other behaviors during unstructured play activities in the classroom (e.g., toys used, social interactions, unprompted spoken language). Information collected via the play sample was used to characterize participants, confirm inclusion criteria (i.e., less than ten spontaneous communicative words used), and plan intervention goals (e.g., determine if play expansion was necessary; identify typical means of communication).

Reliability

Interobserver agreement (IOA) was calculated for each child and teacher target behavior. The primary investigator served as the primary coder and trained two research assistants, one of whom was blind to study hypotheses to reduce bias, to 75% reliability criterion on the coding system. The 75% reliability criterion was chosen because it reflects an acceptable level of agreement given the complexity of the data collection system (Cooper, Heron, & Heward, 2007). The primary and secondary coders independently coded 29%-33% of baseline sessions, 22%-25% of intervention sessions, and 25%-33% of generalization sessions randomly selected for each participant. The percentage of sessions coded for reliability differed across participants due to variations in the number of sessions in each condition. If IOA fell below 75% for two consecutive sessions, the secondary coder was provided with refresher training on the coding system.

Because data were collected within minute intervals, IOA was calculated using the point-by-point method, in which the number of agreements (i.e., intervals in which both observers recorded the same frequency of behaviors) were divided by number of agreements plus disagreements and multiplied by 100. During baseline, IOA total IC ranged from 60%-100% across functions (i.e., IBR, IJA, and other) and participants with a mean agreement of 82%. Baseline mean agreement for two component pre-IC was 91% (range 90%-93%). IOA was also adequate for collateral gains during baseline (spoken language IOA range 90%-100% [mean = 97%]; object interest IOA range 80%-100% [mean = 94%]). Average agreement for total IC during treatment was 73% (60%-94%) for total IC, 80% (70%-95%) for two-component pre-IC, 92% (80%-100%) for object interest, and 92% (53%-100%) for spoken language across participants. For all generalization sessions, average agreement ranged from 75% to 100% across teacher

variables. Average agreement during generalization was 83% (range = 50% - 100%) for child IC, 80% (range = 70% - 90%) for two-component pre-IC, 100% for spoken language, and 92% (75% - 100%) for object interest.

Procedural fidelity data were collected by the same independent observers for the baseline and intervention sessions used for reliability coding, plus additional sessions to ensure fidelity was assessed for at least 20% of sessions conducted by each clinician. Thirty-five percent of all baseline sessions were coded for fidelity. Procedural fidelity for baseline was assessed using 15-second momentary time sampling for adult behaviors that should occur (i.e., clinician engagement with child and/or toys) and tallying instances of adult behaviors that should not occur (i.e., prompting communication, linguistic mapping, initiating routines, environmental arrangement). The percentage of intervals with correctly implemented baseline procedures ranged from 97% to 100% across all interventionists and participants. Additionally, no components of PMT were observed during baseline sessions coded for fidelity.

Procedural fidelity for PMT sessions was collected on accurate implementation of teaching episodes based on necessary elements described in the Milieu Communication Training (MCT) manual (Fey et al., 2006). Specifically, each teaching episode was coded for appropriate use of prompting (e.g., 3-5 second time delay between presentation of the enabling context and provision of verbal, model, and/or physical prompts), linguistic mapping, and providing the natural consequence of the child's communicative act. Procedural fidelity was calculated for 22% to 28% of PMT sessions for each participant. The percentage of correctly implemented teaching episodes ranged from 85% to 100% (mean = 90%) across interventionists. Considering the specific elements of

teaching episodes, prompting hierarchies were used appropriately in 99% of teaching episodes. High percentages of correctly implemented linguistic mapping (mean=98%) and provision of natural consequences (mean=100%) were also observed across teaching episodes.

Additionally, information on clinician use of various PMT strategies (e.g., initiation of routines, environmental arrangement, following the child's lead) was collected. Clinicians followed the child's lead for an average of 97% of each session (range = 92% - 100%) and attempted to initiate an average of 18 routines per session (range = 3 – 31). On average during sessions, clinicians linguistically mapped child communicative acts 11 times (range = 1 – 19), provided natural consequences 23 times (range = 1- 73), and arranged the environment to promote communication 9 times (range = 1 – 21). As there is no recommended amount of PMT strategies that should be used in each session, information about clinician strategy use served as a standard with which to compare teacher strategy use.

Experimental Design

Four conditions (baseline, intervention, generalization, and maintenance) were implemented within the context of a multiple probe across participants design (Horner & Baer, 1978) to investigate the effectiveness of PMT in increasing intentional communication of minimally vocal children with or at risk for ASD. Multiple probe designs involve repeated measurement of dependent variables across baseline and intervention conditions for each participant. Repeated baseline measurement and staggered intervention introduction across participants provided inter-subject replication of effect and allowed for detection of history and maturation threats to internal validity.

Three participants were recruited, as one demonstration of effect with at least two replications of effect is necessary to demonstrate a functional relation between PMT and behavior change (Horner et al., 2005). Care was taken to equate baseline probes and intervention sessions across all variables except the independent variable, PMT. This study was approved by the University of Georgia Institutional Review Board (IRB).

Procedures

General Procedures. Baseline, intervention, and maintenance sessions were 20-minutes each and conducted in a 1:1 format with the child and either the primary investigator or secondary clinician. The primary investigator conducted two sessions per week and the secondary clinician conducted one session per week to promote across-person generalization. Generalization probes were 10-minutes each and conducted in a 1:1 format with the child and teacher. Baseline data collection occurred concurrently for all participants, during which time generalization was probed at least once per participant. Baseline data collection occurred continuously for the first participant until stable responding was established for at least three consecutive data points. Baseline levels of responding were probed intermittently (i.e., every 3-5 data points and once before starting each subsequent participant) for the rest of the participants. PMT intervention was introduced for the first participant once a stable baseline was established. Once participant one met predetermined criteria (i.e., visible and stable increase in level or trend of intentional communication and two component pre-intentional communicative acts), intervention began for the second participant following stable baseline responding for at least three consecutive data points. Intervention was introduced to the remaining participant in the same manner. Data were collected during the entirety of each baseline

and intervention session, consistent with past PMT research (e.g., Yoder et al., 1993). Additionally, generalization was probed twice per participant during intervention. Immediately following completion of the intervention phase, data were collected to assess generalization. Maintenance data were collected three weeks after intervention completion in intervention settings for Justin and Michael. Maintenance data were also collected in the generalization setting for Michael. Unfortunately, Mr. Jones took a leave of absence and was unavailable during maintenance data collection. Maintenance data were not collected for the third participant, whose intervention sessions lasted until the last week of school. Descriptions of the conditions are as follows:

Pre-baseline assessments. Information was collected prior to baseline probes on child characteristics (i.e., cognitive functioning, early social communication, play, and imitation skills) and teacher characteristics (i.e., teacher experience and knowledge/use of PMT strategies) via direct observation (i.e., Unstructured Classroom Play Sample and CARS-2), structured assessments (i.e., Mullen, ESCS-abridged, and MIS), and parent and teacher questionnaires. Pre-baseline data were used to characterize participants and select intervention goals.

Baseline probes. Baseline probes occurred in the classroom with the primary investigator and secondary clinician, with at least one generalization probe taking place with the child's teacher. The purpose of baseline probes was to determine the child's pre-intervention levels of intentional communicative behaviors and establish experimental control to evaluate intervention effects. During baseline sessions with the PMT clinician, the clinician engaged in play with the child and several preferred toys. Communication was not directly prompted or encouraged, although the clinician maintained engagement

with the child (e.g., imitated child's play; responded to child initiations). The generalization probe provided information about the child's baseline use of communication in non-intervention conditions and the teacher's pre-intervention use of communicative strategies. Baseline condition length varied by child, consistent with a multiple probe design.

Intervention. PMT was implemented by the primary investigator of the study and two graduate students in special education, all of whom have experience teaching communication to young children with developmental disabilities. Each child participated in two sessions per week with the primary investigator and one session per week with one of the two secondary clinicians. PMT sessions were conducted three days per week for 6 weeks using activities embedded in play between the child and primary investigator.

During intervention sessions, milieu teaching strategies were used to teach prelinguistic communicative behaviors. Environmental arrangement was used to create opportunities for communication (e.g., requesting an unreachable toy; pausing during a social routine). Following the child's lead (e.g., providing natural consequences for the child's requests) and social routines (e.g., pushing a toy back and forth) were employed to maintain child engagement and provide contexts for communication during highly motivating interactions. Linguistic mapping was used to put words to the child's presumed communicative attempts, which may lead to incidental language acquisition.

The primary investigator and secondary clinicians targeted specific child IC behaviors through a series of teaching episodes within each session. Teaching episodes consisted of a hierarchy of prompts, including time delay (i.e., waiting 3-5 seconds for a

child to perform an IC act), verbally directing the child to perform an IC act, modeling the target act, and physically guiding a child to perform an IC act when appropriate, which were systematically applied to teach IC acts. Initially, prompts were used to teach intentional communication for the purpose of requesting. Upon consistent, independent child requesting, the clinician began to model IJA using gestures the child had been using for the function of requesting for the purpose of teaching IJA. Teaching episodes were implemented approximately once per minute during intervention sessions (Fey et al., 2013). Mastery criterion for successful completion of PMT was two consecutive sessions during which a child independently initiated two IC acts per minute, as children exhibiting this rate of IC are considered ready for interventions targeting linguistic communication (e.g., Milieu Training).

During intervention, at least one generalization probe was conducted per month to measure the child's use of social communication behaviors taught during PMT using only classroom materials with the teacher or paraprofessional. As in the baseline condition, generalization probes were also used to measure teacher use of PMT strategies.

Post-intervention. Upon completion of PMT, a selection of pre-intervention measures was re-administered, including the ESCS-abridged, MIS, and a teacher questionnaire of social validity.

Maintenance. Three weeks after PMT completion, two of the participants received an additional PMT session with the primary clinician to collect follow up data on target child behaviors and collateral gains. Generalization data were also collected for one participant during maintenance using generalization probe procedures. Unfortunately, the second teacher was unavailable three weeks post-PMT due to a family

emergency, which precluded measurement of generalization during follow up for the other participant. Maintenance data were not collected for the third participant due to the school year ending.

Social Validity

Social validity was measured in three ways. First, children's IEP objectives were reviewed to see how many were targeted through PMT. Second, one of the teachers completed a survey post-intervention assessing her attitudes toward PMT (e.g., effectiveness, intrusiveness in the classroom, ease of implementation). Mr. Jones took a leave of absence at the end of the school year and was thus unable to complete the survey. Finally, teacher use of PMT strategies was assessed via direct observation across baseline and intervention conditions. Data on baseline and intervention frequency of PMT strategies used by teachers were reported to assess incidental acquisition of strategies, which will inform feasibility of training teachers to implement PMT.

Analyses

Data collected on target child behaviors during baseline, intervention, and maintenance sessions were graphed and analyzed using visual analysis. Specifically, the level (i.e., magnitude represented by the number of occurrences of the behavior during sessions), trend (i.e., the slope of data points across sessions), and stability (i.e., variability or change of level or trend) of data points for each target behavior were compared within and across conditions. Identification of a functional relation between PMT and given target variables required relatively stable baseline level and trend and a visible increase in level, trend and/or variability of data points for that variable upon introduction of PMT. Additional information about collateral gains and teacher use of

PMT strategies was collected via pre-post assessments. Given the small sample size, information obtained via pre-post assessments will be considered exploratory and used to guide future research.

Results

Intentional Communication

As sessions varied slightly in length (15:00-20:00 minutes) due to a variety of factors (e.g., changes in classroom schedule, student testing), information about intentional communication and related variables is presented as number of acts per minute. Figure 3.1 presents information on the number of combined intentional and two-component pre-intentional communication acts per minute for all three participants across baseline, intervention, generalization, and maintenance conditions. Rate of IC and two-component pre-intentional communication acts per minute is presented separately in Figure 3.2.

During baseline, Justin's rate of combined IC and two-component pre-IC acts per minute ranged from 0.05 to 0.07 (mean = 0.06), which reflects an average of 0.04 IC acts (range = 0.00-0.07) and 0.02 two-component pre-IC acts (range = 0.00-0.07) per minute. Upon introduction of PMT, Justin exhibited an immediate albeit small increase in rate of two-component pre-IC and a more delayed increase in IC rate. He engaged in an average rate of 1.15 combined IC and two-component pre-IC acts per minute during the PMT condition (range = 0.10-2.50), which reflects average rates of 0.60 IC and 0.55 two-component pre-IC acts per minute. His engagement in both IC and pre-IC acts was highly variable across sessions (IC range = 0.10-1.55; two-component pre-IC range = 0.10-1.20). Of note, increases were observed across all communicative functions (see Figure

3.3). The majority of Justin's IC acts during PMT sessions served the function of requesting, while IC acts used for the purpose of initiating joint attention and other functions accounted for an average of 30% and 20% of all acts respectively. Justin's rate of engagement in IC decreased slightly at follow-up to 0.80 IC acts and 0.40 two-component pre-IC acts per minute; however, it remained higher than rates observed during baseline. Justin's rate of IC and two-component pre-IC acts during the baseline generalization probe was similar to that observed during regular baseline sessions (0.10 per minute). His rate of engagement in IC and two-component pre-IC acts increased during PMT generalization probes (mean = 1.9, range = 1.30-2.50). Increased use of IC for the purposes of initiating joint attention and requesting was also observed across activities and settings, as represented by increases in ESCS scores from pre-baseline to post-intervention (see Table 3.5).

Michael's IC and two-component pre-IC rates during baseline were variable yet below mastery criteria across all sessions. He engaged in an average rate of 0.74 IC and two-component pre-IC acts per minute (range = 0.59-0.90), which reflects an average of 0.65 IC acts (range = 0.46-0.80) and 0.09 two-component pre-IC acts (range = 0.00-0.15) per minute. Michael's rate of engagement in two-component pre-IC acts per minute remained low upon introduction of PMT (mean= 0.24, range = 0.10-0.56). In contrast, Michael's rate of IC sharply increased immediately upon introduction of PMT and remained high across the entire condition (mean = 1.70, range = 0.95-2.60). Overall, he engaged in an average combined IC and two-component pre-IC rate of 1.94 acts per minute (range = 1.15-2.80) and met mastery criteria by the twelfth session. Increases were observed both in rate of requesting and rate of initiating joint attention. On average,

87% of Michael's IC acts during baseline served the purpose of sharing attention with the interventionist and 13% occurred for the purpose of requesting. During the PMT condition, an average of 50% of Michael's IC acts were used to request, 48% for the purpose of sharing attention, and 2% for other purposes. At follow-up, Michael continued to demonstrate a mastery level rate of 2.65 IC acts per minute. Generalization across individuals as represented by Michael's rate of communication during probes with his teacher was not observed. He engaged in relatively similar rates of IC and two-component pre-IC across baseline, intervention, and follow-up generalization probes. Increased communication across settings and activities was also not observed, as Michael's rate of IJA and IBR per minute remained relatively stable across ESCS administrations (see Table 3.6).

Felicia exhibited an average rate of 0.23 IC and two-component pre-IC acts per minute (range = 0.10-0.76), which reflects her engagement in 0.07 IC acts per minute (range = 0.00-0.28) and 0.16 two-component pre-IC acts per minute (range = 0.00-0.48) during baseline. There was a slight decreasing trend in IC and pre-IC acts initially across sessions, which stabilized during the five sessions conducted prior to PMT implementation. Upon introduction of PMT, Felicia's rate of IC and pre-IC acts per minute immediately increased and continued to slowly increase across the majority of sessions (combined IC and two-component pre-IC acts mean = 1.20, range = 0.42-2.06). She engaged in an average rate of 0.68 IC acts per minute (range = 0.20-1.56) and 0.51 two-component pre-IC acts per minute (range = 0.16-1.15). During baseline, the majority of Felicia's IC acts served purposes outside of requesting or sharing attention (average percentage of other IC acts = 62.5%), with 25% serving the purpose of sharing attention

and 12.5% serving the purpose of requesting. Whereas increases were observed across all functions of IC acts during PMT, the largest increase was in requesting. The average proportion of IC acts used for requesting increased significantly upon introduction of PMT (67%), while the average proportions of IC acts used for initiating joint attention (12.5%) and other purposes (20.5%) decreased. Felicia's improvement did not generalize across individuals, as her rate of IC and two-component pre-IC remained relatively stable across baseline and PMT generalization probes with her teacher. Similarly, she did not generalize gains in IC for the purpose of initiating joint attention to different activities and settings, as represented by relatively stable scores across ESCS administrations (see Table 3.5). Some generalization in use of IC for the purpose of requesting was observed, as Felicia engaged in a slightly higher rate of IBR during the ESCS at post-intervention (0.41 per minute) than at pre-baseline (0.25).

Collateral Gains

Improvements in social communication and play variables that were not directly targeted during PMT sessions were assessed via repeated measurement across conditions (see Figure 3.4) or pre-post measurement on the Early Social Communication Scale (ESCS) and Motor Imitation Scale (MIS).

Spoken Language. Rate of spoken language was measured during baseline and PMT sessions. The average baseline rate of spoken language during baseline ranged from 0.00 (Justin and Felicia) to 0.75 (Michael). Michael exhibited an immediate yet small increase in spoken language upon PMT introduction. He averaged 1.49 spoken words per minute during the PMT condition and continued to engage in high rates of spoken language at follow up. Justin engaged in some instances of spoken language

during two PMT sessions; however, otherwise both his and Felicia's rate of spoken language remained at baseline levels throughout the entire study.

Object Interest. The number of objects with which students engaged was also measured during baseline and PMT sessions. Average object interest ranged from approximately 4 (Michael and Felicia) to 6 (Justin) during baseline. All three participants exhibited levels of object interest similar to baseline during PMT implementation.

Imitation. Potential collateral gains in imitation both with and without objects was assessed pre-baseline and post-intervention using the MIS (see Table 3.6). Increases in correctly imitated actions without objects were observed for Justin and Michael. Justin also exhibited an increase in the percentage of correctly imitated actions with objects from pre- to post-intervention; however, Michael's imitation of action with objects decreased post-PMT. The number of actions with and without objects that Felicia correctly imitated also declined from pre-baseline to post-intervention.

Response to Joint Attention. Changes in responding to joint attention (RJA) were evaluated using the ESCS (see Table 3.6). Improvement in RJA from pre-baseline to post-intervention was observed for Justin, who responded to 9 of 14 RJA probes before baseline and all 14 probes following PMT. The other two students engaged in similar levels of RJA on both administrations of the ESCS.

Social Validity

All students had IEP goals consistent with PMT goals of increasing communicative abilities. Several of the student's objectives were addressed during PMT sessions (e.g., request highly preferred items using verbalizations and/or gestures; communicate for the purpose of commenting).

In addition to reviewing children's IEP goals, Michael and Felicia's teacher filled out a social validity survey following the intervention. Information was not provided by the paraprofessional who worked with Justin due to a family emergency. Ms. Brown reported that PMT sessions did not interfere with typical classroom activities, that she was interested in using PMT strategies in the future, and that other teachers would benefit from using such strategies with their students. Regarding student progress, Ms. Brown reported that she believed PMT was effective in improving both Michael and Felicia's social communicative behaviors; however, the extent of these improvements differed across the two students. According to Ms. Brown, Felicia appeared to benefit more from PMT than Michael. See Table 3.7 for additional social validity rating information.

Unfortunately, neither teacher was able to observe any PMT session. Since any change in teacher behavior from baseline to intervention cannot be attributed to the present study, average teacher behaviors were aggregated across conditions to provide information about teacher behaviors consistent and inconsistent with PMT without training (see Table 3.8). Both teachers followed the students' leads for the majority of each session; however, they also engaged in high levels of directing students' behavior. Both teachers prompted communication several times per session and attempted to engage students in routines. Teachers engaged in minimal environmental arrangement, linguistic mapping, and provision of natural consequences.

Discussion

The current study examined the efficacy and feasibility of using PMT with preschoolers with or at risk for ASD in their classrooms. Previous research has demonstrated improvements in intentional communication and related social communication skills following PMT for children with ASD and other developmental delays (e.g., Yoder & Warren, 1998; Yoder & Stone, 2006a,b; Franco, Franco, & Davis, 2013). Limited research has been conducted to evaluate the use of PMT in preschool classrooms, which are primary natural environments for many young children with ASD. As such, the current study attempted to replicate findings from previous research conducted in clinical settings or the child's home by implementing PMT with three children showing symptoms of ASD in preschool classrooms.

Justin and Felicia engaged in stable, low rates of intentional communication at baseline. Michael exhibited slightly higher rates of intentional communication across baseline sessions; however, it was still significantly lower than the suggested mastery criteria of two intentional communication acts per minute. Furthermore, all three participants engaged in similarly low rates of pre-intentional communication containing more than one communicative behavior (e.g., combined use of vocalizations and eye contact). As such, initial goals for all children involved increasing the frequency of individual communicative behaviors as well as the combined use of such behaviors.

All three participants increased their engagement in multi-component pre-intentional and intentional communication during PMT, albeit at different rates. Michael's rate of intentional communication immediately increased upon PMT introduction and he reached mastery criteria within twelve sessions. Interestingly, the majority of Michael's communication included spoken language. Although he met study

inclusion criteria of engaging in fewer than ten spoken words for the purpose of requesting or commenting during baseline, his rapid acquisition of additional communicative words during PMT sessions suggests that MT may have been a more appropriate intervention for him. In contrast, Justin and Felicia's improvements were more gradual. Both children exhibited small increases in intentional and two-component pre-intentional communication when they began PMT; however, they required several sessions before exhibiting relatively consistent higher rates of intentional communication. Delays in responding appeared to be at least partially attributed to difficulties in finding activities and routines that were motivating in which to create enabling contexts for communication. Additionally, all three children had difficulty attending to one toy or activity for an extended period, and attentional difficulties may have been exacerbated by other activities going on in the classroom during PMT sessions.

One secondary goal of the current study was to examine collateral behaviors that may have improved with PMT implementation despite not being directly targeted. Given prior research suggesting collateral improvements in spoken language following PMT (Yoder & Stone, 2006a) as well as research suggesting an association between PMT targets and a variety of social communication and play behaviors (e.g., Mundy & Sigman, 1989; Shumway & Wetherby, 2009; Whalen, Schreibman, & Ingersoll, 2006), the present study examined potential collateral improvements in spoken language, object interest, responding to joint attention, and imitation. Aside from Michael, who began the study with some spoken language, students did not exhibit increases in spoken language over the course of PMT implementation. Neither Justin nor Felicia met mastery criteria to move on to an intervention targeting spoken language by the end of the study. It is

possible that a certain level of prelinguistic communication must be achieved prior to observing collateral improvements in linguistic communication, as children in previous research demonstrating such gains typically exhibited more post-intervention intentional communication than exhibited by Justin and Felicia (e.g., Kasari, Paparella, Freeman, & Jahromi, 2010; Whalen, Schreibman, & Ingersoll, 2006).

All three children exhibited varying levels of object interest throughout baseline and PMT sessions, which suggests that PMT had no impact on the number of objects with which the children played. Importantly, sessions with higher object interest were frequently those in which it was difficult to engage the student with a given object for enough time to create routines and subsequent opportunities to communicate. In contrast, low levels of object interest within a given session often reflected sustained interest in few objects, which lent itself to creating more opportunities to communicate and therefore higher rates of communication. Perhaps more informative indicators of overall gains in play would include sustained engagement with objects and variety of actions used in addition to the number of objects with which a child plays.

Finally, improvements in imitation following PMT were observed for two of the three participants and increased RJA was observed for one participant. As information regarding imitation and RJA was collected via pre-post assessment, it is not possible to conclude that these collateral gains were a direct result of PMT. Although variable, results support further research on collateral improvements in RJA and imitation following interventions targeting intentional communication.

Another secondary goal was related to the alignment between teacher behaviors and PMT strategies. Teacher behaviors were probed several times throughout baseline

and intervention to detect any incidental changes due to observing PMT sessions; however, both teachers reported that they were unable to observe any sessions. As such, information about teacher strategy use without training can instead inform the intensity of training that is likely necessary to promote teacher use of PMT strategies in the classrooms. Both teachers attempted to create routines with their students and spent the majority of each session following the student's lead; however, percentages varied widely and both teachers also directed the students' activities more than PMT interventionists. Additionally, both teachers often used repeated verbal prompts and rarely used other types of prompts (e.g., model, gesture) regardless of the students' responsiveness. When students were responsive, their intentional communication was infrequently reinforced with the natural consequence or linguistically mapped. Altogether, information collected about teacher behaviors suggests that whereas many PMT strategies are already within their repertoires, direct training is likely necessary for teachers to consistently engage in these strategies when targeting intentional communication.

Clinical Implications

All three preschoolers demonstrated improved use of prelinguistic intentional communication, albeit at varying rates, upon participation in PMT. These results are consistent with previous research on PMT conducted in clinics or the child's home, and thus provide preliminary support for the use of PMT to teach prelinguistic communicative behaviors to preschoolers with symptoms of ASD in the classroom. There were perks to implementation in the classroom, including the availability of a wide array of toys with which the students were familiar and may have had pre-existing routines or preferred ways of playing. It was often the case during PMT sessions that students would

request a classroom toy rather than the novel toys introduced by the researchers. Whereas introducing novel toys is likely useful to create opportunities for IJA, initial use of familiar toys facilitated engagement in routines and thus the creation of opportunities for requesting. Similarly, the importance of spending time creating routines at the onset of PMT and conducting frequent preference assessments throughout PMT implementation to ensure the student will be motivated and have the opportunity to engage in intentional communication cannot be overemphasized. Teachers spend a significant amount of time with the students and therefore should have more insight into the students' preferences than a clinician who may only see them a few times per week. As such, students may respond more quickly to PMT implemented by teachers, who can apply PMT strategies within routines that are already being used in the classroom. These potential benefits of classroom-based, teacher-implemented PMT paired with preliminary evidence of at least some degree of teacher engagement in strategies congruent with PMT provide support for training teachers in PMT.

Possible drawbacks to implementation in a classroom also bear mentioning, including the introduction of variables that may have been implicated in the participants' variability in responding, including distractions (e.g., other classroom activities occurring simultaneously with sessions) and interruptions to the typical schedule. These variables may impact students differently depending on how long they are able to sustain attention and their tolerance to change. Although it is not possible to analyze statistically within the current study design, variable responding may also be attributable to pre-intervention characteristics (e.g., rate of IJA), which has been the case in previous research conducted in other settings (e.g., Yoder & Stone, 2006a). Information about pre-intervention

characteristics, including the student's tolerance of change and distractibility, may be helpful in adapting the intervention to individual students to increase likelihood of responding (e.g., conducting shorter, more frequent sessions; conducting sessions during times when the student is less likely to be distracted; conducting sessions within the context of a preferred activity rather than removing the child from that preferred activity to conduct a session; increasing overall intervention duration).

Information about challenging behaviors exhibited by students may also be helpful for intervention planning. Data were not collected on challenging behavior in the current study; however, Justin and Felicia were both observed to engage in challenging behaviors (i.e., self-injurious behavior and physical aggression) that interfered with intervention sessions. For example, Justin occasionally engaged in physical aggression toward the clinician when she used environmental arrangement to provide opportunities for communication. Of note, the highest rates of physical aggression occurred during the sessions an iPad, a highly preferred item, was used; however, these were also the only sessions in which Justin used spoken language to request. Justin was, however, able to engage in intentional communication rather than physical aggression when the clinician blocked access to other preferred items or activities (e.g., books, stuffed animals). It may have been helpful to increase Justin's fluent use of intentional communication prior to introducing a highly preferred item to increase the likelihood he would use intentional communication rather than physical aggression to request. For children with histories of engagement in challenging behavior, it may be useful to conduct a functional behavior assessment prior to PMT implementation to inform additional strategies that may be necessary during intervention sessions (e.g., use of extinction; reducing time delay before

prompting to ensure use of intentional communication is easier than engagement in challenging behavior). In fact, a previous study that examined the effectiveness of milieu therapy combined with functional communication training conducted functional analyses as part of the pre-intervention assessment process (Mancil, Conroy, & Haydon, 2008). Mancil and colleagues included participants whose challenging behavior served a tangible function and found positive intervention effects for concurrent acquisition of communication skills and reduction of challenging behaviors.

Limitations and Directions for Future Research

Several limitations should be considered when interpreting the results of the present study. Although positive effects were observed for all participants, these results were delayed for two of the participants, so the possibility that improvements were due to factors outside of the intervention cannot be excluded. However, delayed responding has been reported in prior PMT research (Yoder, Warren, Kim, & Gazdag, 1994) and may relate to the need to also measure other behaviors required to teach intentional communication within the PMT framework (e.g., play skills and routines; individual components of intentional communication). Future research measuring such precursor behaviors may be helpful in uncovering more immediate effects of PMT. Additionally, it is unclear what specifically led to improvements given the use of an intervention package rather than examining individual components separately. Component analyses should be conducted to determine the extent to which each PMT strategy and combinations of strategies contribute to gains in intentional communication. A better understanding of the active ingredients of PMT may help improve the efficiency of training so that time is not wasted on potentially ineffective or less effective components.

Another limitation of the present study involves the individuals implementing the intervention. Graduate students with extensive training and experience in naturalistic behavioral interventions and working with students with ASD served as interventionists to examine the feasibility of implementing PMT in a classroom prior to training teachers. Additionally, the current study included only three children and two teachers. The small sample size and implementation by trained graduate students rather than natural implementers (i.e., teachers) limit the generality of findings. Replications and larger scale studies where teachers are trained to implement PMT with their students are necessary to better understand the effects of classroom-implemented PMT on the intentional communication of preschoolers with ASD.

Additional limitations of the present study involve constraints imposed by implementing PMT in schools. It was not possible to extend the intervention for those who did not meet mastery criteria or measure maintenance for all students because of the school year ending. Furthermore, school breaks and days off led to gaps in intervention implementation. Such constraints are unavoidable when working within a school; however, if possible it would be useful to begin studies earlier in the school year to increase the amount of time children may be exposed to the intervention. The two students who did not meet mastery criteria would have likely benefited from additional intervention sessions as well as the more frequent implementation of shorter-length sessions. As such, future research should examine individualization of total treatment duration as well as session length and frequency for children with different pre-treatment characteristics. Additionally, future research should collect follow up data after more

time has passed (e.g., at 6- or 12-months) and on more than one occasion to provide better information about maintenance of skills.

Finally, the current study cannot be classified as providing strong evidence of PMT effects according to the What Works Clearinghouse (WWC) evidence standards because the baseline condition for one of the participants only contains three data points. As this was an applied research study conducted in the second half of the school year, the minimum number of data points necessary for WWC moderate evidence were collected in order to ensure there would be enough time to demonstrate three replications of intervention effects. Of note, baseline responding occurred at stable, low levels for the one participant with only three baseline data points, which increases confidence of intervention effects on his prelinguistic social communication; however, future studies that collect at least five data points per primary comparison condition are required to provide strong evidence of intervention effects according to the WWC criteria.

Despite limitations, the present study provides preliminary evidence for the efficacy and feasibility of implementing PMT in a preschool classroom. These findings can be used to inform future research on PMT implemented in the school environment, including training teachers to implement PMT and individualizing intervention components based on pre-intervention child characteristics.

Table 3.1

Student Participant Descriptions

Child	Age (yrs; mos)	Gender	Race/ Ethnicity	Eligibility	Education Setting / Current Interventions
Felicia	4;5	Female	White	SDD, SLI	Self-contained preschool special education classroom; private OT
Michael	4;3	Male	African American	SDD, SLI	Self-contained preschool special education classroom; private speech therapy and OT
Justin	4;10	Male	White	Autism, SLI	Inclusive preschool classroom; ABA at school, private speech therapy and OT

Note. yrs = years; mos = months; SDD = significant developmental delay; SLI = speech language impairment; OT = occupational therapy; ABA = applied behavior analysis.

Table 3.2

Pre-Intervention Assessment Scores

Student	Age (yrs; mos)	Mullen Scales of Early Learning AE				Autism Severity	
		Visual Reception	Fine Motor	Receptive Language	Expressive Language	CARS-2 total	GARS-3 Autism Index
Felicia	4;5	10 mos	14 mos	8 mos	6 mos	47.5	4
Michael	4;3	27 mos	18 mos	6 mos	13 mos	37	6
Justin	4;10	29 mos	24 mos	34 mos	6 mos	43.5	4

Note. yrs = years; mos = months; AE = age equivalent (months); CARS-2 = Childhood Autism Rating Scale, Second Edition; GARS-3 = Gilliam Autism Rating Scale, Third Edition

Table 3.3

PMT Session Routines and Activities

Participant	Routine/Activity
Felicia	*Pin toy*: put pin toy on student's hands and arms; removed pin toy and paused to evoke communication. *Trampoline*: said"123 jump!" and held student's hands as she jumped on a trampoline; paused and let go to evoke communication. *Snack*: provided preferred snacks in a closed, transparent container upon communication. *Playdoh*: took turns playing with playdoh; blocked access to evoke communication. *Bouncing*: held student's hands as she bounced on a ball; paused to evoke communication. *Brush*: lightly brushed student's hair or pressed a brush onto her hands and arms; paused to evoke communication *Spinning lights*: blocked access to switch to evoke communication.
Michael	*Pretend food*: took turns feeding and pretending to eat food; blocked access to food to evoke communication. *Number puzzles*: took turns removing and inserting puzzle pieces; blocked access to pieces or puzzle to evoke communication. *Bouncy balls*: took turns pushing a button to make balls in a toy bounce; blocked access to button to evoke communication. *Pin toy*: placed foam numbers on a pin toy and paused for child to communicate prior to providing access.
Justin	*Books*: read story and paused to evoke communication before continuing. *iPad*: took turns playing various games. *Shape sorter*: took turns placing shapes into the sorter. *Number and letter puzzles*: took turns removing and inserting puzzle pieces; blocked access to pieces or puzzle to evoke communication. *Spinning lights*: blocked access to switch to evoke communication. *Stuffed animals*: chased student around classroom with stuffed animals; paused and withheld stuffed animals to evoke communication. *Dump truck*: took turns putting items into a dump truck and dumping them out; blocked access to truck and/or crashed into truck to evoke communication.

Table 3.4

Child Target Behaviors

PMT Targets	Definition
Intentional Communication (IC)	Sum of communication acts for the purposes of requesting or IJA by (a) combining a gesture or vocalization with coordinated attention to an object or person or (b) using spoken words.
Requesting	IC act that directs another to give a desired object, perform an action, continue routine or social interaction, or give comfort.
Initiating Joint Attention (IJA)	IC act that attempts to direct an adult's attention toward an object for social purposes (e.g., adult attention, commenting on or labeling object). IJA can only be coded when access to the object is not restricted.
IC Components	**Definition**
Gaze Shift	Any instance during which the child shifts their gaze from an object to an adult and makes eye contact with the adult for at least 2 seconds.
Vocalization	Discrete phonation, other than words or word approximations, produced by the child.
Gesture	Motor act performed by the child, including pointing, showing, reaching, giving or other descriptive or conventional action (e.g., head nod; wave).
Collateral Gains	**Definition**
Spoken Language	Spontaneous, intelligible spoken words not immediately preceded (i.e., more than 3 seconds after) by an adult model. Each unique word spoken by the child should be recorded.
Object Interest	Number of different toys the child plays with using non-imitative, differentiated actions that demonstrate understanding of the toy's function (e.g., feeding a doll with a spoon rather than shaking the spoon).

Table 3.5

Teacher Target Behaviors

Teacher Behavior	Definition
Environmental Arrangement	Any time a situation is created to increase probability of child IC (i.e., placing a preferred item within child's line of sight but out of reach, interrupting a routine, giving child toys that are missing parts)
Linguistic Mapping	Any time the teacher uses developmentally appropriate language to put presumed meaning to the child's communicative act (e.g., saying "ball" when the child points to a ball). Each communicative act labeled by the teacher counts as one instance of linguistic mapping, regardless of the number of words used (e.g., "ball" and "you want the ball" would both count as 1 instance)
Following Child's Lead	Any time the teacher uses a non-directive action related to an activity or object in which the child is currently engaged (e.g., engaging in a routine involving the toy child is playing with; playing alongside child with similar toys/actions). The child does not have to be actively engaged with the teacher to code Following the Child's Lead (e.g., teacher could be imitating child's actions without child's attention).
Providing Natural Consequences	Any instance the teacher responds to child IC by complying with the child's communicative intent (e.g., providing the object the child requested).
Directing Child	Any time the teacher places a demand on the child or instructs the child to do something unrelated to the object or activity in which he or she is currently engaged (e.g., telling the child to roll the ball while he or she is playing with the car). This behavior would be considered incompatible with PMT.
Initiating a routine	Any instance where the teacher attempts to establish turn-taking activity with the child. To count as initiating a routine, the teacher must clearly try to take a turn using an activity or object the child is engaged with in that moment (e.g., inserts teacher turn into child's play) but the child does not have to reciprocate.
Use of prompts	Any instance where the teacher uses time delay (pause of at least 5 seconds) or verbal, model, or physical guidance to prompt child communication.

Table 3.6

Performance on the ESCS and MIS at Pre- and Post-Intervention.

		Pre-Intervention	Post-Intervention
Motor Imitation Scale (% correct)			
Object Imitation	Felicia	25%	6.3%
	Michael	50%	25%
	Justin	68.8%	75%
Action Imitation	Felicia	0%	6.3%
	Michael	31.3%	37.5
	Justin	37.5%	50%
Early Social Communication Scale			
Rate of IJA/minute	Felicia	2.02	1.94
	Michael	0.20	0.50
	Justin	.19	0.47
Rate of IBR/minute	Felicia	0.25	0.41
	Michael	0.39	0.33
	Justin	0.24	1.20
RJA (# correct of 14)	Felicia	6	6
	Michael	7	8
	Justin	9	14

Note. ESCS = Early Social Communication Scale; MIS = Motor Imitation Scale; IJA = initiating joint attention; IBR = initiating behavior requests; RJA = responding to joint attention.

Table 3.7

Ms. Brown Social Validity Questionnaire Responses

Item	Response (Felicia)	Response (Michael)
I believe PMT has been effective in increasing student use of intentional communication to request and share attention.	Agree	Neutral
I believe PMT has been effective in improving the student's other social communicative behaviors (e.g., imitation, play, responding to other's attempts to share attention).	Agree	Agree
I believe PMT has been effective in helping the student reach at least some of his/her IEP goals.	Neutral	Neutral
PMT sessions in the classroom did not interfere with typical class activities/instruction of other students.	Strongly Agree	Strongly Agree
PMT had an overall positive effect on the student's behavior in the classroom.	Agree	Neutral
I would be interested in using PMT in my classroom for students with communication delays in the future.	Agree	Agree
I believe other teachers would benefit from using PMT with their students.	Agree	Agree

Table 3.8

Teacher/Paraprofessional Behaviors

	Average Number/Percentage per Session (range)						
	Follow Lead	Direct	Routine	Linguistic Map	Natural Consequence	Environmental Arrangement	Prompt Comm.
Ms. Brown	89.4% (80-98)	13.3 (6-25)	4.7 (1-7)	1.6 (0-6)	3.1 (0-7)	2.9 (0-7)	38.7 (19-57)
Mr. Jones	81.67% (68-94)	24.7 (14-31)	1.7 (1-3)	0.3 (0-1)	1.7 (0-3)	1.7 (0-2)	12.67 (3-23)

Note. Comm = communication

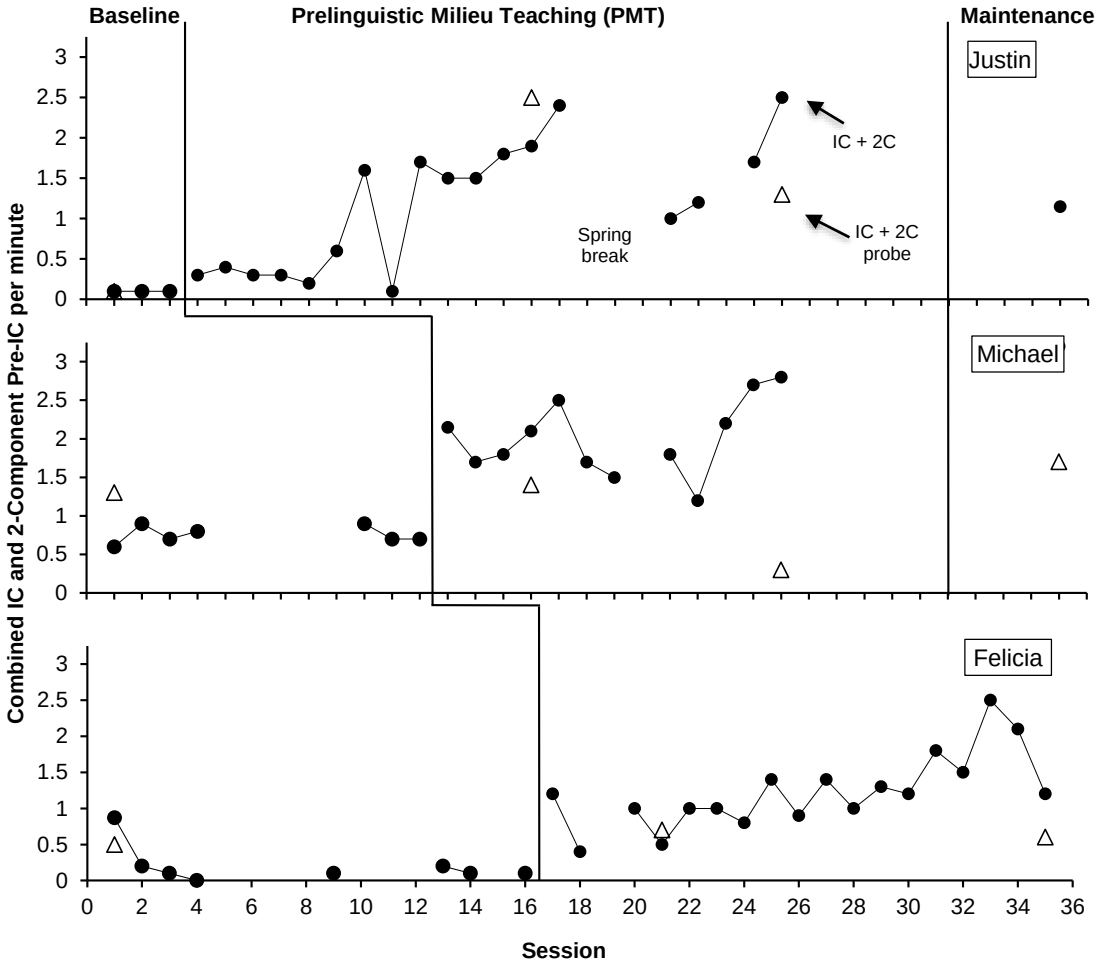

Figure 3.1. Participant rate of independent communicative acts across conditions. Filled-in circle data points represent combined rate of intentional communication and 2-component Pre-IC per minute during baseline, PMT, and maintenance sessions. Open triangle data points represent combined rate of IC and 2-component Pre-IC per minute during generalization probes with the child's teacher/para-professional. IC = intentional communication, 2C = 2-component pre-intentional communication

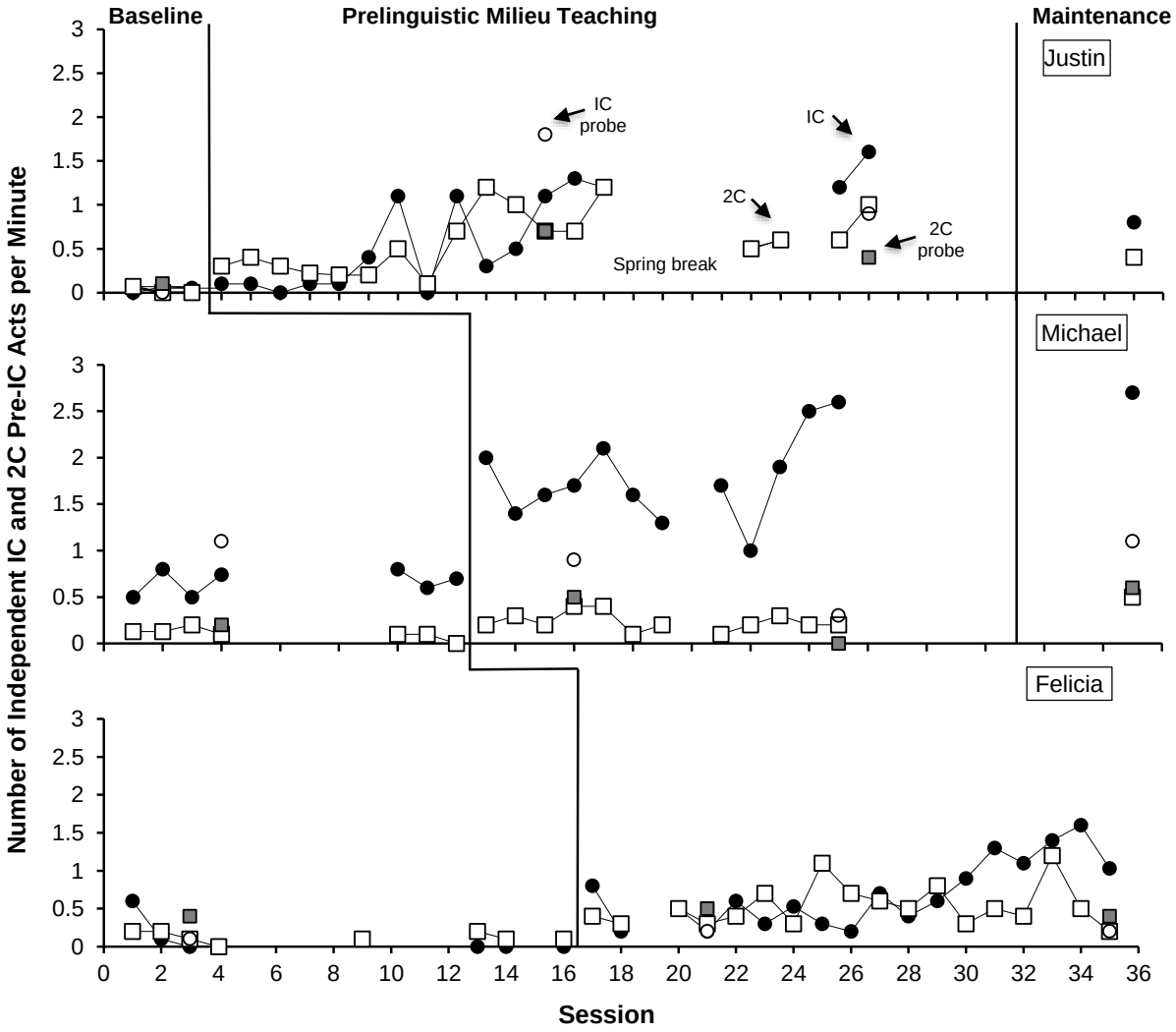

Figure 3.2. Participant rate of independent IC and 2-component pre-IC acts across conditions. Filled-in circle data points represent rate of IC per minute and open square data points represent rate of 2C Pre-IC per minute during baseline, PMT, and maintenance sessions. Open circle data points represent rate of IC per minute and filled-in square data points represent rate of 2C Pre-IC per minute during generalization probes. IC = intentional communication, 2C = two component.

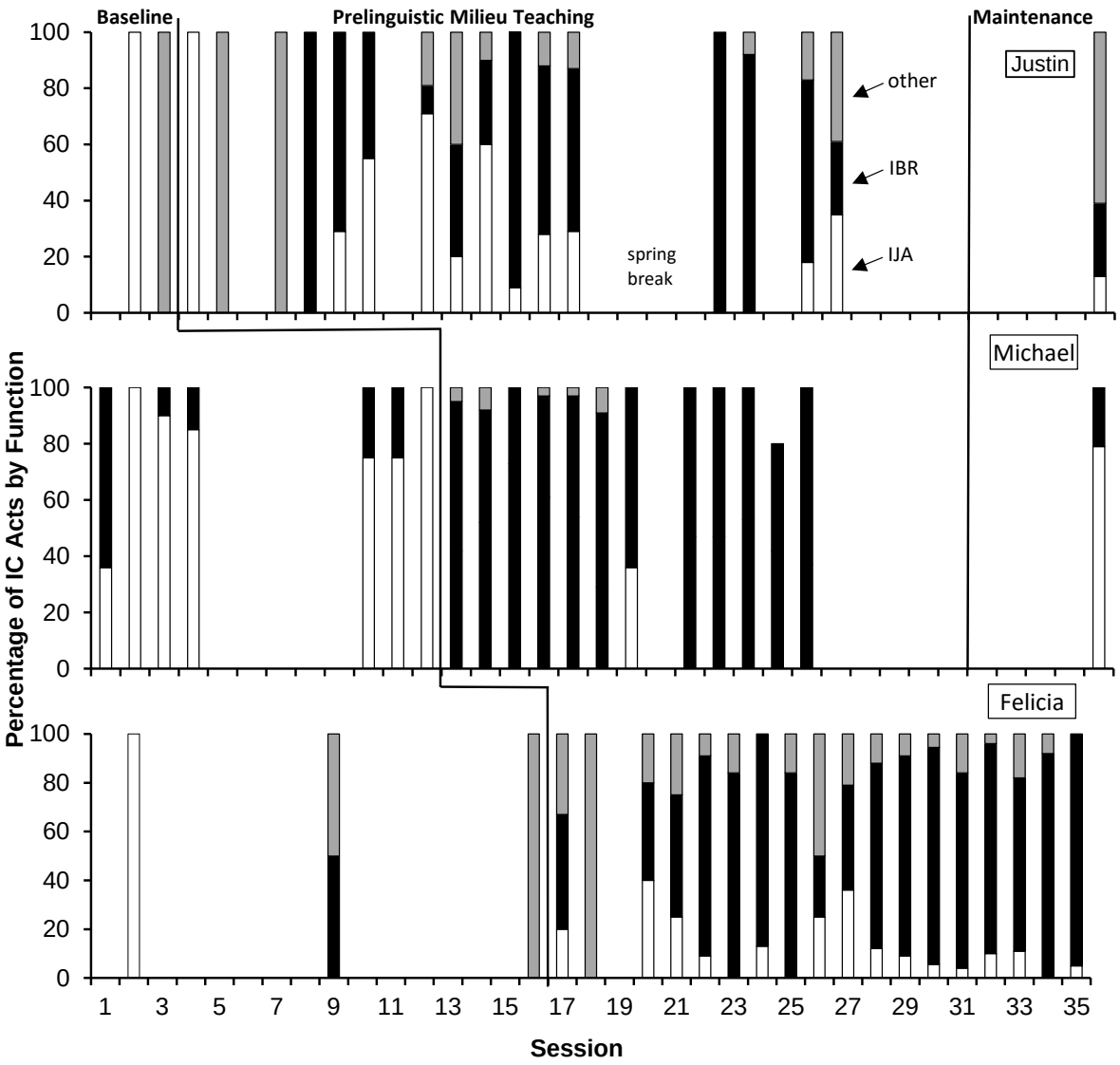

Figure 3.3. Function of IC acts used during sessions. IC acts were used for the purposes of initiating joint attention (IJA), initiating behavioral requests (IBR), and other functions.

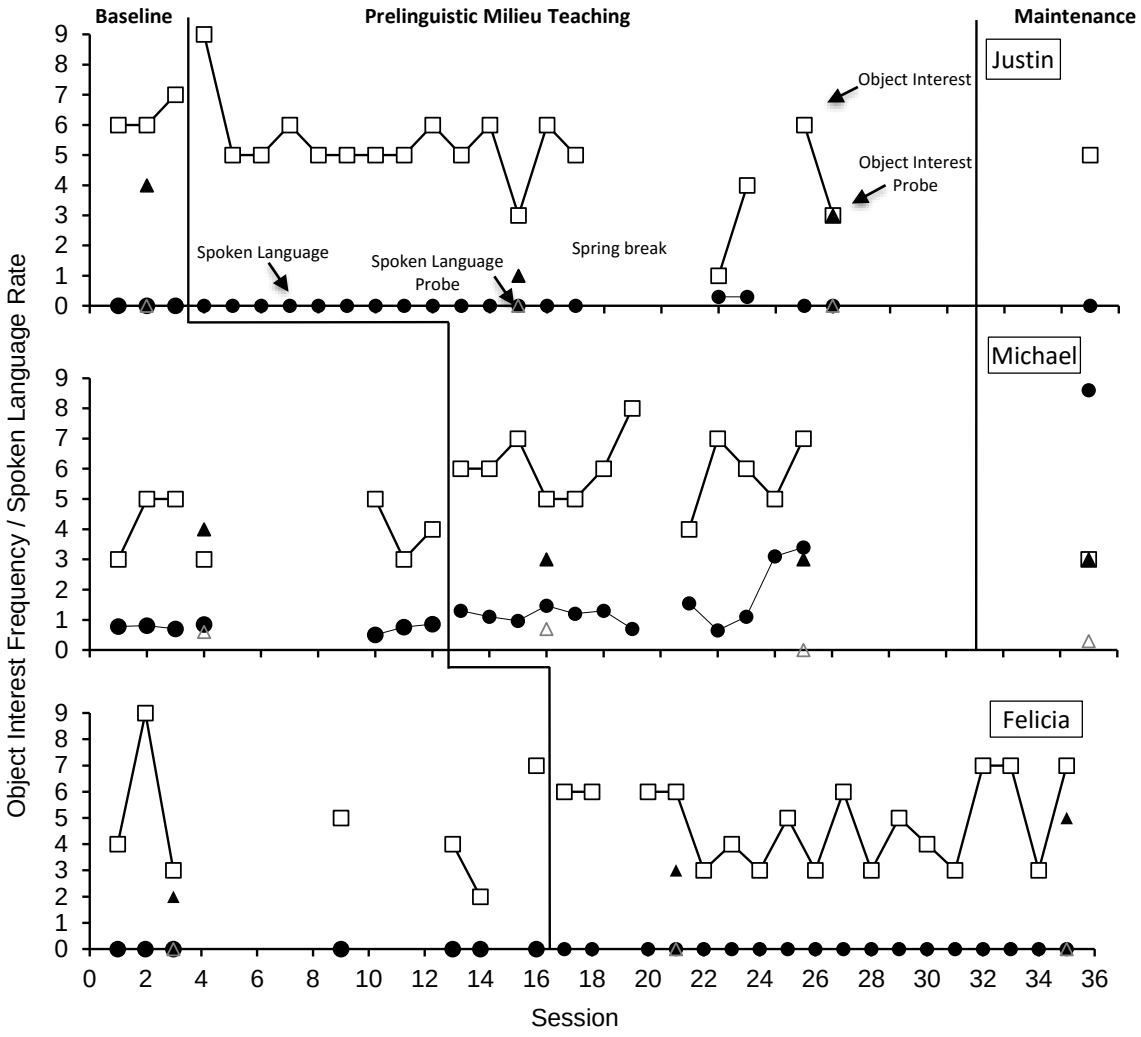

Figure 3.4. Participant collateral gains across conditions. Filled-in circle data points represent rate of spoken language per minute during typical baseline and PMT sessions. Open triangle data points represent rate of spoken language per minute during probe sessions. Open square data points represent the number of different objects with which the child was engaged during sessions. Filled-in triangle data points represent child object interest during probe sessions.

CHAPTER 4

GENERAL DISCUSSION

Given the rising number of students being diagnosed with autism spectrum disorder (ASD) and requiring special education services (CDC, 2014; OSEP, 2009), it is imperative that schools are equipped to provide interventions appropriate to provide maximum benefit to these students. It is recommended that research-supported interventions targeting socially significant skills are implemented in the natural environment (IDEA, 2004; National Autism Center [NAC], 2015; National Research Council [NRC], 2001). Early social communication skills (e.g., initiating joint attention [IJA]), frequently delayed or absent in children with ASD, are classified as pivotal skills that upon improvement may lead to an improved developmental trajectory for a child (Koegel, Koegel, & Carter, 1999; Mundy & Crowsen, 1997; Schreibman, Stahmer, & Pierce, 1996). Naturalistic behavioral interventions that target early social communication skills have the potential to provide lasting and far-reaching effects for children with ASD and thus align well with IDEA and recommendations from related organizations. Thus, the overall goal of the studies presented was to provide comprehensive information about such interventions through conducting a systematic literature review and an empirical investigation of a naturalistic behavioral intervention in preschool classrooms.

The purpose of the systematic literature review was two-fold. First, information was distilled from studies such that practitioners could easily identify interventions that

were effective for specific behaviors within a given student population. Descriptions of implementer and student characteristics, setting in which the intervention had been implemented, and intervention components were also provided to assist with determining the appropriateness of the intervention for a given setting, practitioner, and student. Second, information was extracted about study quality to inform interpretations of effects and guide future research. Results from the systematic review suggest that although evidence exists in the SCD and group design literature to support the use of naturalistic behavioral interventions across settings (e.g., home, school, clinics) to improve prelinguistic social communication skills, additional research using rigorous methodology is necessary. One key methodological element missing from several studies was procedural fidelity data, which are necessary to truly determine a functional relation between an intervention and behavior change. Moving forward, detailed intervention descriptions and measurement of procedural fidelity should be included in studies of naturalistic behavioral interventions. Additionally, two specific avenues of research particularly applicable to schools should be pursued. First, additional investigations of naturalistic behavioral interventions should be conducted in classroom settings. Second, component analyses could be used to identify key naturalistic behavioral strategies within larger intervention packages that are most likely to promote behavior change given limited time and resources provided for teacher training.

Study two addressed the need for additional research on the implementation of naturalistic behavioral interventions in schools through the evaluation of Prelinguistic Milieu Teaching (PMT) in preschool classrooms within the context of a multiple baseline design across participants. Graduate students implemented PMT with three four-year-old

preschool students diagnosed with or displaying symptoms of ASD in a public self-contained preschool special education classroom and in an inclusive preschool classroom located within a private school for children with ASD. All three students increased their engagement in intentional communication (IC) upon the introduction of PMT; however, rates of improvement differed across participants. Minimal evidence was provided for increases in non-targeted behaviors (e.g., spoken language) or improvements in targeted behaviors across settings and people. Whereas teachers were observed to engage in high levels of directing child play, they also engaged in several behaviors consistent with PMT (e.g., initiating routines, prompting communication). Furthermore, social validity ratings from one teacher suggested that PMT sessions were not disruptive to classroom programming and that PMT may have helped students make gains related to communication goals. Altogether, findings from this initial investigation of PMT in preschool classrooms are promising and provide a basis for further research on classroom-implemented PMT, including training teachers to implement PMT and modifying elements (e.g., session length, materials) based on individual student characteristics.

A vast research base supports the importance of early social communication skills in the development of broad academic, social, and related skills for individuals with ASD (e.g., Koegel et al., 1999). The need for interventions that target these skills in school cannot be overstated; however, the limited resources provided for training in schools must also be considered. Findings from the present study have implications for research and practice, including the need for continued research on naturalistic behavioral interventions and components implemented in classrooms to determine feasible and

effective means of improving prelinguistic social communication skills for students with ASD.

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Descriptive Coding			
Citation	Author/year/title		**Design**
Purpose/Study Questions	General synopsis circle design type→		Group SCD
Participants (N=)			
Age range/Avg age: age range and/or mean (standard deviation)	Other participant info (e.g., demographics, pre-tx characteristics): race/ethnicity, IQ/ mental age, information about receptive/expressive language, adaptive skills, tx history, etc		
Dx: primary diagnosis of children in the study (should be ASD/autism or indication of red flags for ASD)			
Inclusion criteria: List inclusion criteria (even if not specifically labeled as such, if there are certain clear criteria list here)	Exclusion Criteria: list if specified		
INTERVENTION			
Type/Description (circle all that apply)	Naturalistic Behavioral Developmental Social/Pragmatic Other Circle any of the above terms if they are used in the article's intervention description.		
	Notes: write any additional information about the intervention that isn't captured in other sections (e.g., name of intervention, specific routines/activities used, requirements for the intervention [e.g., certain materials, training])		
Components (circle all that apply)	Env arrangement Child directed Time delay Routines Natural consequences Prompt Linguistic map Narrate play Other: list	Notes: any additional info about components of treatment	
Implemented by	clinician /researcher parent teacher grad student other list other	**Implementer experience**	Title/certification, years of experience, training, education - degree/major
Setting	Home Clinic School Other: if in school, note if it took place in the classroom or other areas		
Frequency/Duration	___ sessions (____min)/week & /day if multiple sessions/day	**Total Tx Length**	Months/#sessions
Mastery Criteria (to start new participant)	Note if the authors report a general criteria to "graduate" or discontinue; for SCD-MB also describe the criteria for introducing the intervention to subsequent participants		
Generalization or Maintenance plan?	Note any aspects of the intervention specifically designed for foster generalization (e.g., multiple implementers, use of multiple stimuli) or maintenance even if not explicitly stated as such		
DESCRIPTION OF COMPARISON CONDITIONS GROUP [GROUP DESIGN] or CONDITION [SCD]			
For SCD, describe **BASELINE** here (including length, potential tx components occurring, procedure) For group, describe comparison group – is info presented on comparison participants (like demographics, etc); are groups equal (and if not, how different), what (if any) tx are they receiving, are comparison participants			

MEASURES								
Descriptive (pre-tx)	List measures used to describe participants but not measured again post-tx (e.g., intelligence tests, measures of adaptive functioning/language/social communication, parent ratings, etc)							
Dependent Variable(s) Time(s) key: **B** – baseline **Tx** – during treatment (mark C if measured continuously & P if intermittent probe) **Pr** – pre-baseline **Po** – post-baseline **G** – generalization **M** - maintenance	**Definitions:**	**Measure**	**Time(s) of DV Measurement**					
			B	**Tx**	**Pr**	**Po**	**G**	**M**
	List all of the observable measures of child behavior outcomes; provide brief definitions for DVs relevant to the review if defined in study (i.e., initiating joint attention/proto-declarative/comment; initiating behavior requests/proto-imperative/requesting, intentional communication, gesture, gaze shift, vocalization) List the measure corresponding to each DV (note if multiple measures used for the same DV [e.g., measured IJA in a mother child play sample and on the CSBS]); also list when the measure was used/when the DV was measured →							
Results		**Other Notes**						
Briefly describe results applicable to the DVs in the systematic review; list effect sizes (if reported) and statistical analyses used		Note anything that may be important but was not covered elsewhere on the coding sheet						

SINGLE SUBJECT DESIGN QUALITY RATINGS			
Criteria	**Y**	**N**	**Definitions**
RIGOR			
1) Does evidence exist for reliability of dependent variables (DV)?			
1 Do authors report DV reliability data? If yes, go to next question. If no, answer no for remaining questions.	**1**	**0**	**Dependent Variable Reliability Data**: Data collected by an independent 2nd observer, usually referred to as interobserver agreement (IOA) or interrater reliability (IRR) data. **Primary Comparison Conditions**: The 2 conditions in the study for which decisions about a functional relation can be made, usually baseline and intervention conditions. If multiple comparisons are possible (and of
2 Do authors report collection of agreement data in both primary comparison conditions and for at least 20% of sessions overall?	**1**	**0**	
3 Are DV reliability data (e.g., IOA data) calculated on a point-point basis, and is agreement higher than 80% (or higher than 0.6 Kappa)?	**1**	**0**	
4 Was agreement data collected by observers who were blind to study conditions and/or purpose?	**1**	**0**	
2) Does evidence exist for reliability of independent variables (IV)? (FIDELITY)			

1 Do authors report any data related to fidelity of implementation? If yes go to next question. If no, finish section.	**0**	**0**	**Fidelity of Implementation Data**: Assessments of the degree to which researchers engage in behaviors consistent with planned procedures. (Also called procedural fidelity, treatment integrity, IV reliability) **Differentiation Between Conditions**: Usually authors report fidelity data as % correct. Sometimes other data can be used to show differences between conditions exist (e.g., teachers prompted an average of 0.1 per session in baseline and an average of 10 times per session during intervention)
2 Do authors report the use of self-report fidelity only? If yes, finish section. If no, go to next question.	**0**	**0**	
3 Do authors report fidelity data suggesting fidelity of more than 80% or evidence of differentiation between conditions? If yes go to next question. If no, finish section.	**1**	**0**	
4 Do authors report collecting fidelity in both primary comparison conditions (e.g., baseline and intervention)? If yes go to next question. If no, finish section.	**1**	**0**	
5 Do authors report fidelity data collection in at least 20% of sessions? If yes go to next question. If no, finish section.	**0**	**0**	
6 Do authors report fidelity data separately for each primary comparison condition? Note: 100% fidelity & explicit collection in both conditions meets this criterion. If yes go to next question. If no, finish section.	**1**	**0**	
7 Do authors (a) collect agreement data on fidelity assessments (e.g., 2 observers assess fidelity and compare their assessments to get a % of agreement) or (b) are data collected by observers blind to study condition or purpose?	**1**	**0**	
3) Do sufficient data exist?			
1 Do at least 3 data points exist in each primary comparison condition?	**1**	**0**	**Simultaneously**: For the purposes of coding, simultaneously refers to beginning data collection for all tiers within the first 3 sessions (for multiple baseline/probe).
2 Is the design a multiple baseline or multiple probe design?	**0**	**1**	
3 Did data collection begin simultaneously during initial baseline/probe conditions? Select "no" if not a multiple baseline or multiple probe design.	**1**	**0**	
4 Are more data points needed due to trends in the intended direction for the next condition or because data differentiation has not been sufficiently established (e.g., there are 3 data points but 1st 2 overlap)? NOTE: select "yes" if <3 data points are present in any condition, or if ≥1 data points are not present immediately before implementation of intervention. If "no" go to next question, if "yes" finish section.	**0**	**0**	
5 Do at least 4 data points exist in each primary condition, *OR* in conditions with 3 data points is one of the following true: all points at baseline or ceiling levels, data reached a criterion level, or no overlap w/ adjacent conditions is present?	**1**	**0**	
6 Do at least 5 data points exist in each primary condition, *OR* (same as 6)?	**1**	**0**	
Criteria	**Y**	**N**	**Definitions/Notes**
QUALITY AND BREADTH OF MEASUREMENT			
4) Does evidence exist for ecological and social validity?			
1 Do authors report feasibility/acceptability ratings via interviews, questionnaires or surveys?	**1**	**0**	**Normative Comparisons**: The use of data from individuals who do not evidence the same target problem as the study participants (usually typically developing individuals), used to determine to what extent the participant's behaviors are similar (e.g., did improvements lead to normative levels of behavior)?
2 Do authors report psychometric data for the interviews, questionnaires, or surveys; OR do they provide a citation to another source that shows acceptable psychometric data?	**1**	**0**	
3 Do authors report 1 or more of the following: (1) blind raters of importance of results, acceptability/feasibility of procedures, or acceptability of DVs, (2) normative comparisons?	**1**	**0**	

4 Do authors report use of typical environments and/or use of indigenous implementers or social partners?	**1**	**0**	**Typical Environments**: Settings in which the individual would be served if he/she weren't part of the research study. **Indigenous implementers/social partners**: Implementers of the intervention or individuals who are the recipient of target behaviors are those in the individual's usual environment (e.g., teachers, parents, peers, siblings).
5) Are participant descriptions sufficient? **NOTE:** if design includes a single participant, include ONLY that participant in this assessment, even if other participants are included in different designs in the same article.			
1 Do authors report demographic information, including age and diagnosis, for all participants?	**1**	**0**	**Inclusion criteria**: characteristics that must be present in order for an individual to participate in a study. **Pre-intervention behaviors**: behaviors typically used by participant, related to current intervention (e.g., for a social competence intervention, authors may report typical social behaviors an individual engaged in during unstructured time with peers)
2 Do authors report formal test results (e.g., IQ, language, achievement)?	**1**	**0**	
3 Do authors report general information about participants (e.g., educational placement, problem behaviors, functional repertoire of behaviors, areas of strengths and weaknesses)?	**1**	**0**	
4 Do authors report inclusion criteria or pre-intervention behaviors for all participants?	**1**	**0**	
6) Are condition descriptions sufficient?			
1 Are *procedures* for both primary comparison conditions adequately described? NOTE: business as usual baseline is not sufficient without operationalized procedures; only choose "yes" if conditions can be replicated by other researchers based on descriptions.	**1**	**0**	**Dosage**: Information regarding how often sessions occurred and for how long they lasted (e.g., number of minutes, trials, or opportunities).
2 Is *dosage* adequately described? NOTE: select "no" if response to #1 above is "no"	**1**	**0**	
3 Is setting described for both primary conditions (i.e., if relevant: location, individuals in environment, physical characteristics)?	**1**	**0**	
4 Are implementers adequately described in terms of training and demographic characteristics? NOTE: only choose "yes" if readers can determine characteristics of implementers who are likely to be similarly successful with implementing the intervention. If researchers are named as implementers, choose "yes" (criterion is met).	**1**	**0**	
7) Are dependent variable (DV) descriptions sufficient?			
1 Do authors describe observable characteristics of DVs (e.g., operational definitions)?	**1**	**0**	**Examples and Non-Examples**: authors describe at least 1 behavior that would or would not fit a definition (e.g., if social initiation was the target behavior, authors might name tapping a peer on the shoulder as an example and saying the name of a toy as a non-example.
2 Do authors provide examples and/or non-examples of target behaviors?	**1**	**0**	
3 Do authors adequately describe the measurement system (e.g., counts, duration, 5-s partial interval system, 15-s momentary time sampling)?	**1**	**0**	
4 Do authors describe how measurement system was used (e.g., data collected by implementers or someone else? Were data collected in-vivo, via audio/video)?	**1**	**0**	
8) Is there sufficient evidence to evaluate generalization across stimuli (*Stimulus Generalization*)			
1 Do authors report assessment of a target behavior performed (a) in a context (b) with materials (c) with social partner different than training? If the answer to any of these 3 questions is yes, go to next question. If the answer is no for all 3 questions, finish section.	**0**	**0**	**Stimulus generalization**: authors assess performance of a target skill in a non-instructional context w/ $\geq$ 1 change in stimuli (e.g., different

2 Do authors measure this generalization in post-tests only (no pre-test comparisons)? If yes, finish section. If no, go to next question.	**1**	**0**	implementer, social partner, materials, or setting). EX: authors teach a child to respond to a wave from a peer by waving during structured routines & during pre-post tests measure whether child responds to a wave when she enters classroom in the morning; authors teach child to read sight words on notecards & during pre-post tests measure whether child reads words in a book.
3 Do authors measure generalization in pre-post test only? If yes, finish section. If no, go to next question.	**2**	**0**	
4 Do authors measure this generalization in the context of a single case design, but with < 3 data points per condition? If yes, finish section. If no, go to next question.	**3**	**0**	
5 Do authors measure stimulus generalization in the context of a single case design with at least 3 data points per condition?	**4**	**0**	
Criteria	**Y**	**N**	**Definitions/Notes**
9) Is there sufficient evidence to evaluate generalized behavior change?			
1 Do authors (a) measure a behavior that is a *generalized tendency*, either in addition to the primary outcome of interest or as the primary outcome (b) teach 1 specific behavior/type of behavior but measure a different behavior as a measure of response generalization? If the answer for either question is yes, go to next question. If both questions are answered no, finish section.	**0**	**0**	**Response Generalization**: the authors measure change in behavior(s) that are related to but distinct from target behavior. EX: authors teach child to initiate to peers but also measure change in child's response to peers; teach child to read sight word but also measure if child can spell word; teach communicative skill but also measure if there is a change in problem behavior.
2 Do authors measure response generalization in post-tests only (no pre-test comparisons)? If yes, finish section. If no, go to next question.	**1**	**0**	
3 Do authors measure response generalization in pre-post tests only? Next question.	**2**	**0**	
4 Do authors measure response generalization in the context of a single case design, but with < 3 data points per condition? If yes, finish section. If no, go to next q.	**3**	**0**	
5 Do authors measure response generalization in SCD with at least 3 data points per condition?	**4**	**0**	
10) Is there sufficient evidence to evaluate maintenance of behavior change?			
1 Do authors report evidence of continued behavior change, during post-intervention sessions?	**0**	**0**	
2 Is this maintenance measured on more than one occasion? Note: select "no" if response to M1 above is "no"	**1**	**0**	
3 When is maintenance measured? Write # in parentheses in score column: 1) not reported (0), 2) immediately following completion of intervention (1), 3) at least 1 week but less than 1 month following intervention (2), one or more months after intervention completion (3). NOTE: select "not reported" if response to M1 above is "no".			
Evaluation of Effects			
11) Primary outcomes: Which best characterizes the study's effects (select 1)? ***See next page for additional guidance*			
1 Visual analysis suggests there is ≥ 1 non-effect or contra-therapeutic effect (ATD: data paths undifferentiated, mostly overlapping data).	0		This framework is designed for analysis of SINGLE STUDIES. Articles may include multiple studies; these should be evaluated separately. A study is a stand-alone single case design with a single dependent variable. Studies may include single or multiple participants. For ATD studies, assess each condition in comparison to single other conditions, if these comparisons match your research questions.
2 Visual analysis suggests **< 3 effects**, with 1 non-effect (ATD: some data overlap, overlap does not decrease over time)?	1		
3 Visual analysis suggests **≥3 effects**, with ≥ 1 non-effect (ATD: some data overlap, decreases over time)?	2		
4 Visual analysis suggests ≥ 3 effects, ≥1 weak effects, no non-effects (ATD: most data non-overlapping, size of difference variable from one dp to another)?	3		

5 Visual analysis suggests ≥ 3 demonstrations of effects, with no non- or weak effects (ATD: minimal/no overlap occurs, consistent change between conditions)?	4		
12) Are generalized effects evident and consistently replicated? (select item that best characterizes generalized effects).			
1 No measurement of generalization outcomes	0	* 3 if max score from S8 or S9 is 1 or 2. 4 if max score from S8 or S9 is 3 or 4	
2 Consistent non-effects or contratherapeutic effects.	1		
3 Inconsistent effects or weak positive effects	2		
4 Consistent positive effects shown via post-tests or pre-post tests	3		
5 Consistent positive effects shown within context of design.	4		
13) Are effects maintained over time? (select item that best characterizes maintenance of effects).			
1 Maintenance was not assessed	0		
2 Maintenance data were similar to pre-intervention/baseline data	1		
3 Maintenance data showed outcomes that were deteriorating or less optimal than intervention or criterion levels.	2		
4 Immediate maintenance data showed maintained outcomes similar to intervention or criterion levels	3		
5 Long-term maintenance data (i.e., 1 week or more) showed maintained outcomes similar to intervention or criterion levels.	4		

GROUP DESIGN QUALITY RATINGS			
Criteria	**Y**	**N**	**Definitions**
RIGOR			
1) Does evidence exist for reliability of dependent variables (DV)?			
1 Do authors report DV reliability data? If yes, go to next question. If no, finish section.	**1**	**0**	**Dependent Variable Reliability Data**: Data collected by an independent 2nd observer, usually referred to as interobserver agreement (IOA) or interrater reliability (IRR) data **OR** adequate reliability (e.g., interrater, test-retest, internal consistency of ≥0.8; ICC ≥ .75) reported for DV measures. **Commonly used measures**: measures frequently used in the research literature and/or gold-standard measures (e.g., any of the Wechsler IQ tests, Autism Diagnostic Observation Schedule (ADOS), Early Social Communication Scales (ESCS), Communication and Symbolic Behavior Scale (CSBS), MacArthur rating scales)
2 Do authors report collection of agreement data in both primary comparison conditions (e.g., pre and post-intervention) and for at least 20% of all assessments overall?	**1**	**0**	
3 If standardized/norm-referenced assessments were used as primary outcome measures, did authors report adequate reliability statistics for DV assessments or provide a citation for where to find psychometric properties (or were these commonly used [e.g., gold standard] instruments known to be reliable/valid) AND/OR are DV reliability data higher than 80% (or lower than 0.6 Kappa)?	**1**	**0**	
6 Was agreement data collected by observers blind to study conditions (or if only standardized/norm referenced assessments used, were these assessments administered by researchers other than those implementing the intervention)?	**1**	**0**	
2) Does evidence exist for reliability of independent variables (IV)? (FIDELITY)			
1 Do authors report any data related to fidelity of implementation? If yes go to next question. If no, finish section.	**0**	**0**	**Fidelity of Implementation Data**: Assessments of the degree to which researchers engage in behaviors consistent with planned procedures. (Also called procedural fidelity, treatment integrity, IV reliability)
2 Do authors report the use of self-report fidelity only? If yes, finish section. If no, go to next question.	**0**	**0**	
3 Do authors report fidelity data suggesting fidelity of more than 80% or other evidence supporting application of the IV*? If yes go to next question. If no, finish section.	**1**	**0**	

4 Do authors report fidelity data collection in at least 20% of sessions? If yes go to next question. If no, finish section.	**1**	**0**	*__Other evidence__: identification of intervention by independent raters naïve to study purposes, report of data associated with IV (e.g., # of successful teaching episodes/minute) .
5 Do authors report agreement data on fidelity assessments? (e.g., 2 observers assess fidelity and compare assessments to get a % of agreement). Go to next question.	**1**	**0**	
6 Are data collected by observers blind to study condition/purpose?	**1**	**0**	
3) Do sufficient data exist (is the study design sufficient to allow for unbiased/minimally biased results)?			
1 Is an experimental or quasi-experimental design used? If yes go to next question. If no, finish section.	**0**	**0**	**Experimental Design**: random assignment to treatment and comparison group **Quasi-experimental Design**: group comparison without random assignment **Sample size**: note the treatment and comparison group size on data sheet (>10 criteria based on NAC National Standards Report p. 18) **Evidence for group equivalence**: includes post hoc tests showing groups were not significantly different (regarding participant characteristics, attrition, etc)
2 Is the design experimental? Go to next question.	**2**	**1**	
3 Was the sample size sufficient for the statistic used (n>10 per group or sufficient power for lower # participants)? If no finish section. If yes, go to next question.	**0**	**0**	
4 Did authors report evidence for group equivalence between experimental and comparison group? If no finish section. If yes go to next question.	**0**	**0**	
5 Was group equivalence determined via random assignment? Go to next question.	**1**	**0**	
6 Did authors provide other information about group equivalence (e.g., post hoc tests, reported differential attrition rates)	**1**	**0**	
Criteria	**Y**	**N**	**Definitions/Notes**
QUALITY AND BREADTH OF MEASUREMENT			
4) Does evidence exist for ecological and social validity?			
1 Do authors report feasibility/acceptability ratings via interviews, questionnaires or surveys?	**1**	**0**	**Normative Comparisons**: The use of data from individuals who do not evidence the same target problem as the study participants (usually typically developing individuals), used to determine to what extent the participant's behaviors are similar (e.g., did improvements lead to normative levels of behavior)? **Typical Environments**: Settings in which the individual would be served if he/she weren't part of the research study. **Indigenous implementers/social partners**: Implementers of the intervention or individuals who are the recipient of target behaviors are those in the individual's usual environment (e.g., teachers, parents, peers, siblings).
2 Do authors report psychometric data for the interviews, questionnaires, or surveys; OR do they provide a citation to another source that shows acceptable psychometric data?	**1**	**0**	
3 Do authors report 1 or more of the following: (1) blind raters of importance of results, acceptability/feasibility of procedures, or acceptability of DVs, (2) normative comparisons?	**1**	**0**	
4 Do authors report use of typical environments and/or use of indigenous implementers or social partners?	**1**	**0**	
5) Are participant descriptions sufficient?			
1 Do authors report demographic information, including age and diagnosis, for all participants?	**1**	**0**	**Inclusion criteria**: characteristics that must be present in order for an individual to participate in a study. **Pre-intervention behaviors**: behaviors typically used by participant, related to current intervention (e.g., for a social skills intervention, authors may report typical social behaviors an individual engaged in during unstructured time with peers)
2 Do authors report formal test results (e.g., IQ, language, achievement)?	**1**	**0**	
3 Do authors report general information about sample (e.g., educational placement, problem behaviors, functional repertoire of behaviors, areas of strengths and weaknesses)?	**1**	**0**	
4 Do authors report inclusion criteria/pre-intervention behaviors for sample?	**1**	**0**	
6) Are comparison group descriptions sufficient?			

1 Are *procedures* for both primary comparison groups adequately described? (Business as usual or no-tx comparison insufficient without some information about services comparison group received)	**1**	**0**	**Dosage**: Information regarding how often sessions occurred and for how long they lasted (e.g., number of minutes, trials, or opportunities).
2 Is *dosage* adequately described?	**1**	**0**	
3 Is setting described for both primary groups (location, individuals in environment, physical characteristics)?	**1**	**0**	
4 Are implementers adequately described in terms of training and demographic characteristics? NOTE: only choose "yes" if readers can determine characteristics of implementers who are likely to be similarly successful with implementing the intervention. If researchers are named as implementers, choose "yes" (criterion is met).	**1**	**0**	
7) Are dependent variable (DV) descriptions sufficient?			
1 Do authors report use of at least 1 well-validated observational measure (e.g., ESCS, ADOS, CSBS)? If no, go to next question. If yes, go to question 5.	**3**	**0**	**Multi-method/source**: more than one measure (e.g., ESCS and investigator created rating scale) or source (e.g., clinician and parent ratings), with at least one of the methods classified as observational, used to assess primary outcome(s).
2 Do authors describe observable characteristics of DVs (e.g., operational definitions)?	**1**	**0**	
3 Do authors provide examples and/or nonexamples of target behaviors?	**1**	**0**	
4 Do authors adequately describe the measurement system (e.g., counts, duration, 5-s partial interval system, 15-s momentary time sampling)?	**1**	**0**	
5 Was measurement of the primary DV multi-method/source and/or collected by blind coders?	**1**	**0**	
8) Is there sufficient evidence to evaluate generalization across stimuli (*Stimulus Generalization*)			
1 Do authors report assessment of a target behavior performed (a) in a context (b) with materials (c) with social partner different than training? If the answer to any of these 3 questions is yes, go to next question. If the answer is no for all 3 questions, finish section.	**0**	**0**	**Stimulus generalization**: authors assess performance of a target skill in a non-instructional context w/ $\geq$ 1 change in stimuli (e.g., different implementer, social partner, materials, or setting). EX: authors teach a child to respond to a wave from a peer by waving during structured routines & during pre-post tests measure whether child responds to a wave when she enters classroom in the morning; authors teach child to read sight words on notecards & during pre-post tests measure whether child reads words in a book.
2 Do authors measure this generalization in post-tests only (no pre-test comparisons)? If yes, finish section. If no, go to next question.	**1**	**1**	
3 Do authors measure generalization in pre-post test? If yes, go to next question. If no, finish section.	**1**	**0**	
4 Do authors measure generalization for two stimulus dimensions (e.g., teach student to point to request during play in the classroom and measure pointing to request during a standardized assessment in the classroom)? If yes, finish section. If no, go to next question.	**1**	**0**	
5 Do authors measure generalization for three or more stimulus dimensions (e.g., teach student to point to request during play in the classroom and measure pointing to request during a standardized assessment in a clinic room)?	**1**	**0**	
Criteria	**Y**	**N**	**Definitions/Notes**
9) Is there sufficient evidence to evaluate generalized behavior change? (*Response Generalization*)			
1 Do authors (a) measure a behavior that is a *generalized tendency*, either in addition to the primary outcome of interest or as the primary outcome (b) teach 1 specific behavior/type of behavior but measure a different behavior as a measure of response generalization? If the answer for either question is yes, go to next question. If both questions are answered no, finish section.	**0**	**0**	**Response Generalization**: the authors measure change in behavior(s) that are related to but distinct from target behavior. EX: authors teach child to initiate to peers but also measure change in child's response to peers;

2 Do authors measure response generalization in post-tests only (no pre-test comparisons)? If yes, finish section. If no, go to next question.	**1**	**1**	teach child to read sight word but also measure if child can spell word; teach communicative skill but also measure if there is a change in problem behavior.
3 Do authors measure response generalization in pre-post tests? Go to next question	**1**	**0**	
4 Do authors measure more than one specific response that differs in response class or response type from those directly targeted using pre-post tests?	**1**	**0**	
5 Do authors use a broad measure related to the target behavior (a variety of response types [e.g., student is taught to imitate his peers and pre-post assessments of overall social functioning are conducted])?	**1**	**0**	
10) Is there sufficient evidence to evaluate maintenance of behavior change?			
1 Do authors report evidence of continued behavior change, during post-intervention sessions? If yes, go to next question. If no, finish section.	**1**	**0**	
2 Is this maintenance measured on more than one occasion? Go to next question.	**1**	**0**	
3 Are maintenance data collected with at least one week between completion of treatment and assessment of maintenance? If yes, go to next question. If no, finish section.	**1**	**0**	
4 Are maintenance data collected with at least one month between completion of treatment and assessment of maintenance?	**1**	**0**	
Evaluation of Effects			
11) Are effects evident and consistently replicated? (Select item that best characterizes effects)			
1 Did the study include a sufficient number of participants to appropriately analyze intervention effects (refer to Rigor #3)? If no, finish section. If yes, go to next question.	0	0	→For now, evaluate effects based on whether the study reported statistically significant effects in favor of the treatment group (NAC 2009) →If study reports Cohen's D or other effect size estimate, note on coding sheet (e.g., "Cohen's D = .02")* (generally D=.2 -small effect, D=.5 - medium effect, D=.8 – large effect (look up ES interpretations if authors report other statistics). →Evaluate effects separately for each **primary outcome variable**- observational measure of prelinguistic social communication skill (see p.1 inclusion criterion #2).
2 Do statistical analyses suggest possible/weak evidence for intervention effects (significant positive difference between at least one measure of primary outcome variable at pre- and post-testing or between intervention and comparison group but weak or no effect sizes reported)? If yes, finish section. If no, go to next question.	1	0	
3 Do statistical analyses suggest probable evidence for intervention effects (intervention group performs significantly better than comparison group or from pre- to post-intervention on at least one measure of primary outcome variable, with small effects)? If yes, finish section. If no, go to next question.	2	0	
4 Statistical analyses suggest evidence for moderate intervention effects (intervention group performs significantly better than comparison group or from pre- to post-intervention on at least one measure of primary outcome variable, with at least moderate effects)? If yes, finish section. If no, go to next question.	3	0	
5 Considerable evidence for consistent effects (intervention group performs significantly better than comparison group or from pre- to post-intervention on all measures of primary outcome variables, with moderate to large effect.	4	0	
12) Are generalized effects evident and consistently replicated? (Select item that best characterizes generalized effects)			

1 If scores from both sections 8 and 9 are 0, report 0 for section 12. If scores from either section are > 0, go to next question.		
2 Consistent non-effects or contra-therapeutic effects as demonstrated by statistical analyses (e.g., no significant difference in generalization measures between intervention and comparison group or a significant difference favoring the comparison group).	1	
3 Inconsistent effects or weak positive effects	2	
4 Consistent positive effects shown via post or pre-post tests for 1 stimulus / response dimension.	3	
5 Consistent positive effects shown via (1) group comparisons for ≥ 1 stimulus /response dimension; (2) post/pre-post tests for >1 stimulus/response dimension.	4	
13) Are effects maintained over time? (Select item that best characterizes maintenance of effects).		
1 Maintenance was not assessed.	0	
2 Maintenance data were similar to pre-intervention or comparison group data.	1	
3 Maintenance data showed outcomes that were deteriorating/less optimal than intervention/criterion levels but better than pre-intervention and/or comparison group levels.	2	
4 Immediate maintenance data showed maintained outcomes similar to intervention or criterion levels,.	3	
5 Long-term maintenance data (i.e., ≥1 week) showed maintained outcomes similar to intervention or criterion levels.	4	

APPENDIX B: Parent Demographic and Treatment Questionnaire

Child Information

Child's date of birth: _____/_____/_____
(month) (day) (year)

Child's gender (check one): _____ male _____ female

Child's race (check one):

_____African American _____White/Caucasian _____Native American
_____Latin American _____Asian American _____Other (please specify:_____)

Number of Siblings: _____

My child is served under the following special education eligibility (check all that apply):

_____Autism _____Significant Developmental Delay _____Speech-Language Impairment
_____Other (please specify:_____)

Mother's Information

Mother's marital status: _____married _____divorced _____separated _____single

Mother's race (check one)

_____African American _____White/Caucasian _____Native American
_____Latin American _____Asian American _____Other (please specify:_____)

Mother's education (check one)

_____some high school _____high school degree _____Associate's degree
_____Bachelor's degree _____Master's degree _____Doctoral degree

Mother's occupation: _____

Mother's yearly income (check one):

_____<$19,000 _____$20,000-$39,000 _____$40,000-$59,000 _____$60,000-$79,000
_____$80,000 +

Father's Information

Father's marital status: _____married _____divorced _____separated _____single

Father's race (check one)

_____African American _____White/Caucasian _____Native American
_____Latin American _____Asian American _____Other

(please
specify:_____)

Father's education (check one)
_____some high school _____high school degree _____Associate's degree
_____Bachelor's degree _____Master's degree _____Doctoral degree

Father's occupation: _____
Fathers yearly income (check one):
_____<$19,000 _____$20,000-$39,000 _____$40,000-$59,000 _____$60,000-$79,000
_____$80,000 +

Treatment Information

Please list any therapies or treatment that your child received **in the past** to treat his or her communication difficulties and associated problems, and the approximate dates for when your child began and ended each therapy or treatment. Examples include but are not limited to applied behavior analysis (ABA), speech therapy, and early intervention services.

Service/Intervention	Start Date	End Date

Please list any therapies or treatment that your child ***currently*** receives to treat communication difficulties and associated problems, when your child began receiving these services and how often he/she receives service (for example, 2 thirty minute sessions per week). Examples include but are not limited to applied behavior analysis (ABA), speech therapy, and early intervention services.

Service/Intervention	Start Date	How often?

APPENDIX C: Teacher Questionnaire

Part 1: Demographic Information and Experience

Teacher ID:_____	*Today's Date*:_____ _		*School*:_____ _	
Sex: Male Female	*Ethnicity*:	African American	Asian American	Caucasian/White
Age: _____		Hispanic/Latino	Native American	Other
Teacher Title:	General Education	Special Education	Specialist	
	Paraprofessional	Resource	Other	
Highest Degree Earned:	High School diploma	Associate's degree	Bachelor's degree	
	Master's degree	Specialist's degree	Doctorate degree	
Time in current position:	_____ years _____ months			

Please list any prior educator positions held and the length of time in that position:

Position	*Length of time in position*

Are you certified in Special Education? Yes No

If 'No', have you had training in Special Education? Yes No

If 'Yes', please briefly describe training:

_____

_____

_____

_____

Approximately how many students are in your classroom? _____ *How many teachers/paraprofessionals?* _____

How many students in your classroom have IEPs? _____

Under which IDEA categories are your Special Education students being served? Circle all that apply:

Autism	Intellectual Disability	Multiple Disabilities	Hearing Impairment
Deafness	Speech or Language Impairment	Visual Impairment, including blindness	Orthopedic Impairment
Deaf-Blindness	Specific Learning Disability		Other Health Impairment
Traumatic Brain Injury	Serious Emotional Disturbance		

Have you had specific training to educate students with Autism Spectrum Disorder (ASD)? Yes No

If 'Yes', please briefly describe training:

_____

_____

_____

_____

Have you had specific experience working with or educating students with ASD? Yes No

If 'Yes', please briefly describe training:

_____

_____

_____

_____

Have you had specific training to educate students with communication delays? Yes No

If 'Yes', please briefly describe training:

_____

_____

_____

_____

Have you had specific experience working with or educating students with communication delays? Yes No

If 'Yes', please briefly describe training:

_____

_____

_____

_____

Please rate your knowledge and use of the following strategies on a **1-5 scale**. **1** *indicates you are not familiar with or never use the strategy and* **5** *indicates that you are very knowledgeable about or always use the strategy.*

Instructional Strategy	**Knowledge of Strategy**	**Current use of Strategy**
Environmental arrangement to facilitate communication		
Putting child's presumed communicative intent into words		
Following the child's lead		
Embedding instruction in common routines		
Time Delay		

Please describe any strategies for communication instruction that you currently use in your classroom:

_____

_____

_____

_____

_____

_____

Part 2: Student Information

Student ID: _____ _	*Special Education Eligibility/Eligibilities*: _____ _____ ____
Student age: _____ _	

Please briefly describe the student's daily schedule. Be sure to indicate times where the student will not be in the classroom (for example, if he or she is at lunch or receiving pull-out services) as well as any other times throughout the day when they would not be able to participate in the study.

Time of Day	**Activity**

Does the student have IEP objectives related to communication skills? Yes No

If 'Yes", please list IEP objectives here:

_____

_____

_____

_____

_____

_____

Please estimate the number of spontaneous, communicative words the student uses consistently: _____

Please list some of the student's preferred items (toys, food, etc) and activities (e.g., playing with cars):

Preferred Items	Preferred Activities

APPENDIX D: Social Validity Questionnaire

Teacher ID:_____	Student ID: _____	Date:_____	School:_____

Please rate your knowledge and use of the following strategies on a **1-5 scale**. **1** *indicates you are not familiar with or never use the strategy and* **5** *indicates you are very knowledgeable about or always use the strategy.*

Instructional Strategy	**Knowledge of Strategy**	**Current use of Strategy**
Environmental arrangement to facilitate communication		
Putting child's presumed communicative intent into words		
Following the child's lead		
Embedding instruction in common routines		
Time Delay		

Although not a required part of the study, were you ever able to observe parts of PMT sessions? (circle one)

Yes No

Please indicate the extent to which you agree or disagree with the following statements:

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
I believe PMT has been effective in increasing student use of intentional communication to request and share attention.					
I believe PMT has been effective in improving the student's other social communicative behaviors (e.g., imitation, play, responding to other's attempts to share attention).					
I believe PMT has been effective in helping the student reach at least some of his or her IEP goals.					
PMT sessions in the classroom did not interfere with typical class activities/instruction of other students.					
PMT had an overall positive effect on the student's behavior in the classroom.					
I would be interested in using PMT in my classroom for students with communication delays in the future.					

I believe other teachers would benefit from using PMT with their students.					
Please respond to the following only if you were able to observe any PMT sessions (not required)					
PMT strategies appear easy to learn and implement.					
Overall, the student appeared to enjoy PMT sessions.					
Activities used in PMT were consistent with activities I use or would be interested in using in my classroom.					

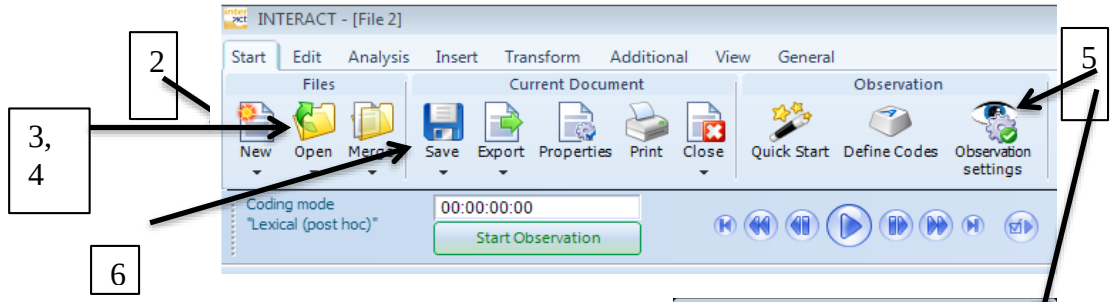
APPENDIX E: Child Behavior Data Collection

Instructions for Child Behavioral Data Collection

Child behaviors will be coded from the unstructured classroom play sample (~10 min), generalization probes (~10 min), and baseline and PMT sessions (~20 min) using INTERACT coding software. Code the entire videotaped session.

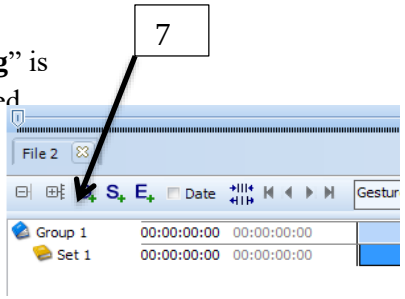
GENERAL INTERACT SET UP

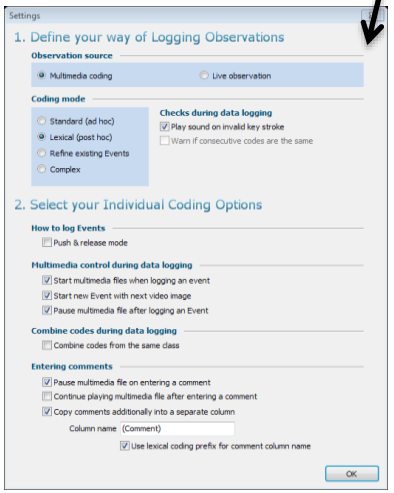
1. If computer is running on MAC OS, begin VM Fusion and start Windows OS.
2. Once Windows OS is running, insert flashdrive with videos and INTERACT license (flashdrive) and double click on the INTERACT14 icon on the desktop.



STARTING A NEW CODING SESSION

1. Close "Quick Start" menu.
2. Create a new file by clicking "New."
3. Click "Open" and select the code file (desktop > Dubin Codes > **Component1_2.11.15**).
    a. The code file pop-out will automatically minimize once the observation session is started (do not close pop-out).
4. Click "Open" to and select the video file for the session to be coded (from flashdrive "adub"
5. Click "Observation settings" and make sure "**Multimedia coding**" is selected for "Observation source" and "**Lexical Chain**" is selected for "Coding Mode."
6. Save file using the name of the video clip + coder initials in the appropriate folder (IOA code files or Primary code files in the "Dubin Codes" folder on the desktop).



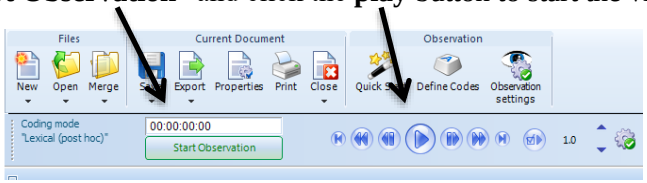


a. Video file: B4B1_AD_2.24.15 (1st B4 baseline) → coding file: B4B1_AD_2.24.15_AD (Ashley coded)

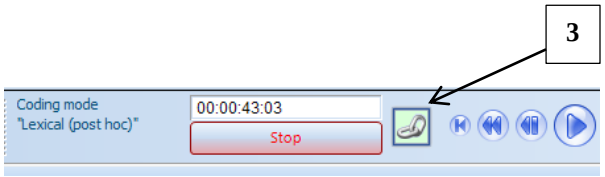
7. Add a new group and set (click "G_+" and "S_+")

LOGGING CODES

1. Click "**Start Observation**" and click the **play** button to start the video file.

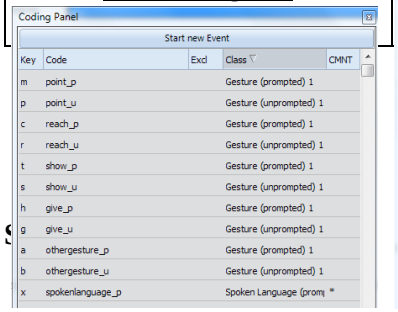


2. When you see a target behavior (defined on page 4), press the space bar to signify the start of the behavior and press the space bar again when the behavior ends - there will probably not be much time between both presses (e.g., for behaviors such as "eye contact" that may last less than 1 second, it will probably be necessary to press the space bar signifying the start of the behavior and immediately press the space bar a second time to indicate the end of the behavior).
    a. Although the primary variables of interest are discrete events, the coding scheme uses duration codes. Reliability will be calculated with respect to events, not duration.
3. Upon pressing the space bar the second time (to indicate the end of the behavior), the video will pause and you will be prompted to code the behavior. A **green box with a chain icon** will appear by the video control buttons, indicating the need to enter codes for the behavior observed.

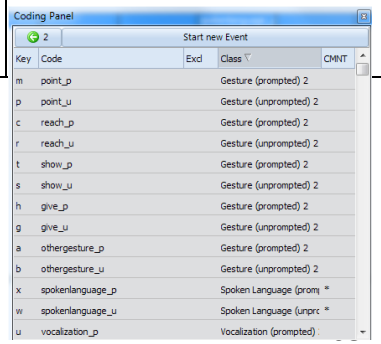


    a. If the green box does not appear, INTERACT will not allow a code to be entered. Check to make sure the space bar was pressed a 2nd time. If it was not, it is possible to rewind the video to the end of the behavior and then press the space bar.
4. All behaviors require 4 level of codes (for many behaviors, levels 2-4 will be coded NA [not applicable]):

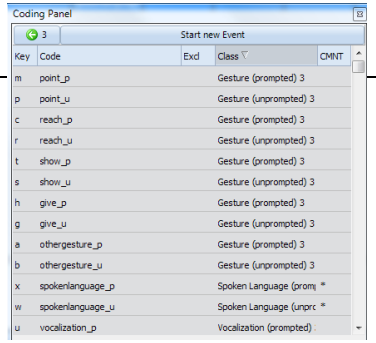
Level 1 – 1st IC component; collateral gains



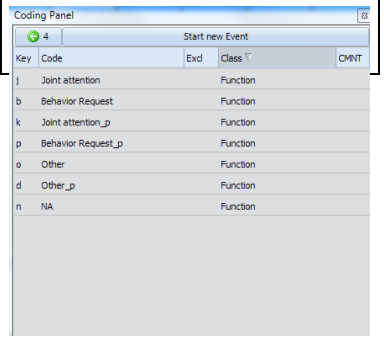
Level 2 – 2nd IC component



Level 3 – 3rd IC component



Level 4 - Function



- **RJA** - type "J" and then press play to go back to coding (and repeat step 2 when you see the next behavior of interest).
- **Object interest** – type "O" and you will be prompted to type a comment. Write the object the child was playing with and press enter. Continue coding by pressing the play button.

Intentional Communication codes (require going through lexical chain hierarchy):
Type the key that corresponds to the IC component observed (independent or prompted* eye contact/gaze shift, gesture, or vocalization/contextually relevant spoken language). If multiple IC components were observed simultaneously or within 3 seconds of each other, select one arbitrarily (order does not matter). Use the table below to determine if the behavior was independent or prompted:

Behavior	Prompts used
1) Gaze/Eye Contact	**Verbal**: adult says "look" or the child's name **Model**: adult intersects child's gaze or moves object toward her face
2) Gestures	**Verbal**: adult tells child to produce gesture **Model**: adult models gesture (or points to palm to prompt giving) **Physical**: adult physically guides child to produce gesture
3) Vocalizations	**Adult vocalization (AV)**: adult produces >1 syllables consisting of developmentally early/middle sounds or sounds the child has produced during the session that may or may not follow the child's vocalization then pauses expectantly for 3-5 seconds to allow the child an opportunity to vocalize
****Spoken Language**	**Adult vocalization/spoken language:** adult produces the first sound(s) in the word or the exact word and then pauses expectantly for 3-5 seconds. **Verbal**: adult tells child to show what they want or adult asks what the child wants.

**Although spoken language isn't directly targeted in PMT, sometimes children repeat adult words or respond to prompts meant for gestures with spoken language.

NOTE ABOUT PROMPTING DURING GENERALIZATION SESSIONS: Teachers may use prompts that are not aligned with the prompts described in the table above (e.g., longer time delay, verbal prompts that don't explicitly tell child what to do [e.g., "what about brown?"] telling them to label things [e.g., "where are his feet"]). Only code behavior as prompted if the teacher prompt meets the above criteria. Count questions as verbal prompts if they include the label for what the act the child is to perform (e.g., "can you ***show*** me his nose?"). Of note, even though in PMT we aren't prompting gesture use to label or for receptive identification, if the teacher prompts gesture use for this purpose (e.g., point to the number nine), the behavior would still be coded as prompted because a prompt consistent with that used in PMT is being used to prompt a topography that is targeted in PMT (just in a different context).

1. If only one behavior occurred (with the exception of contextually relevant spoken language, giving or showing), type "N" when prompted to code the 2nd and 3rd components and function. Press play to continue coding.

2. If two behaviors occur simultaneously or within 3 seconds of each other but this combination of behaviors does not meet the definition for intentional communication (below), code the 1st and 2nd components, type "N" when prompted to code the 3rd component, and code "pre" when prompted to code function.

- Includes (1) vocalization + eye contact; (2) vocalization + gesture that does not intrinsically show attention to person (i.e., not giving/showing)

3. If (1) eye contact/coordinated attention to object and person + gesture or (2) nonword vocalization + coordinated attention to object and person occur simultaneously or within 3 seconds of each other OR if the single behavior observed is contextually relevant spoken language, giving, or showing, determine the function:

- **Requesting (REQ)**: the child wanted something or wanted the adult to do something (e.g., pointing to a car that was being pushed back and forth during a routine because the child wanted a turn).
- **Initiating Joint Attention (IJA)**: the child wanted to direct the adult's attention toward something for social purposes. The child must have access to the item to count IJA (e.g., showing; vocalizing/gesturing toward something the adult is not withholding).
- **Other**: unclear if REQ or IJA; other function (e.g., shaking head no while vocalizing to protest; waving with coordinated EC and saying "bye")

4. Determine if the IC act was prompted (_p) or independent.

1. **Independent.** If the response meets the following criteria, select the function (not followed by _p to indicate independent intentional communication):
    a. Independent contextually relevant spoken word, give, or show.
    b. For responses requiring multiple components, at least 2 of the required components were independent (e.g., independent gaze shift and vocalization with prompted gesture).
2. **Prompted**. If the communicative partner prompted one or more of the component behaviors AND the IC act would not be considered an IC act without the prompted component, select the function followed by _p to indicate it was prompted intentional communication.
    - A behavior is considered prompted if child engages in behavior less than 3 seconds after an adult model or prompt. If a child engages in that behavior twice before 3 seconds have elapsed between prompt/model and child behavior, the second instance of the behavior is considered independent.
        - Example: Adult points to a picture. 1 second later the child points to a picture (prompted point). 1 second later (which would be 2 seconds after the adult point), child points to another picture (independent point).
        - The first behavior a child engages in within 3 seconds of an adult model/prompt is considered prompted. If a child engages in the same behavior again, it is independent (even if it has been less than 3 seconds since the adult prompt)

**If the child engages in one target behavior and the adult attempts to prompt another behavior, the prompted behavior will most likely occur >1 s after the independent behavior. If the child is still engaging in the target behavior when the second behavior is

prompted, code as simultaneous behaviors. If the child engages in one target behavior, stops engaging in the behavior, and then engages in the behavior again when the adult attempts to prompt a second behavior, code two separate behaviors (e.g., (1) press space bar twice to signify start and end of the independent behavior and code that behavior (2) go back to coding and press space bar again to code the simultaneous occurrence of the previously coded behavior and the second (prompted) behavior.

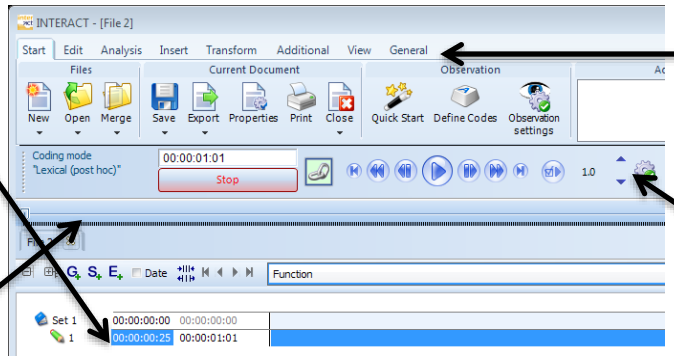
NOTE ABOUT SPOKEN LANGUAGE

- A comment box will appear when selecting spoken language. Write the word(s) spoken in the comment box.
    - **i.** Each word should count as one instance of spoken language, but the way the system is set up if a child speaks a multiword phrase, it will only be counted as one instance – type the whole phrase into the comment box so the SL total can be recalculated later
- Spoken language must be *contextually relevant* to count as IC. Words are considered contextually relevant if they clearly relate to objects or actions/events that can be observed during the interaction OR they are a repetition of something the adult said.
- Spoken language that is not contextually relevant (e.g., scripting, child says something that is not clearly related to the objects visible or ongoing interactions in the session, immediate repetitions of a word the child just spoke unless utterances are separated by an adult action [e.g., asking for clarification] or other child action [e.g., child says "ice cream" and then points and says "ice cream" seemingly to make sure the adult was paying attention as opposed to saying "ice cream…ice cream"]) is still coded; however, it does not count as IC.
    - **i.** When prompted to indicate function, select NA.

CODING TIPS

If you see a behavior but code it a few seconds after it happened, **double click on the time** to edit it manually (or delete and re-code).

If you coded something by accident, right click on the event to delete the accidental code. Rewind the video (using arrow buttons or **dragging button on timeline**) and re-code.

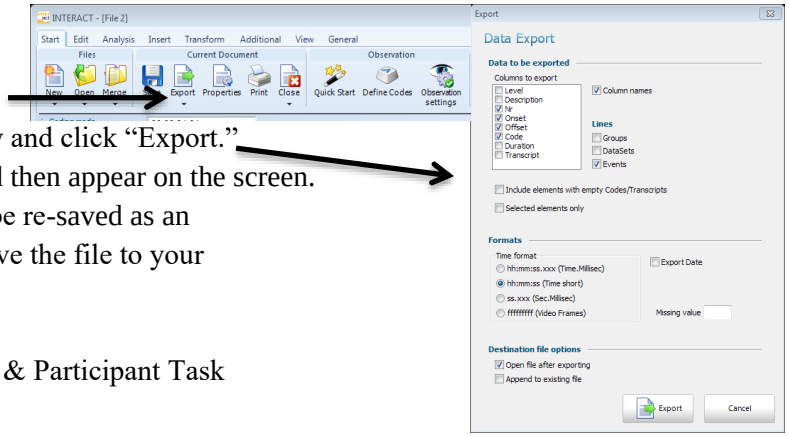


For questions that arise during coding, INTERACT help can be found under the "General" tab.

Use the up and down arrows to the right of the play button to change the speed of the video (slow down or speed up).

AFTER CODING: Save the file and follow the instructions below to export the file and record that IOA is complete for the session.

Exporting Files



1. Click "Export." A dropdown menu will appear; click "raw coding data."
   - Make sure the correct items are selected in the Data Export window and click "Export."
2. Save the exported file as the same name as the INTERACT file. It should then appear on the screen.
3. INTERACT automatically saves exported files as ".csv" and it needs to be re-saved as an Excel file. When the exported file appears on screen, click "save as" and save the file to your folder on the flashdrive as the same name but change the type to Excel.
4. Upload the Excel file to Dropbox (Coding & Reliability Data > Andrea).
5. Enter the date the session was coded in the Excel file "PMT Recruitment & Participant Task Lists," located in the Coding & Reliability Data folder.

IC COMPONENT 1: GESTURES			
Code	**Definition**	**Examples**	**Non-examples**
p: Point	Child aims *index finger* toward a person or object. Index finger must be clearly separated from other fingers. If a child repeatedly points and touches the same object, only count 1st occurrence as a point. To count as a second instance of pointing, (1) ≥1 seconds elapse between points; (2) the child points to something different; (3) child points w/ other hand. Using index finger to operate a toy does not count as pointing unless context/other child	*Child extends index finger toward an out of reach toy *Child touches a picture in a book with his index finger *Child extends index finger and moves hand toward something but then camera cuts off hand or hand was cut off by camera and when the hand returns to view the child's index finger is extended (code point even though you cannot tell where the child was pointing) *Child touches iPad with index finger and shifts gaze toward adult while vocalizing	*Child points to the same picture 4 times in a row (only count 1st point) *Child uses index finger to pop bubbles on an iPad game *Child touches a picture with thumb or several fingers at once *Child points to a picture in book 1 second after adult points (code as prompted point). *Child is spinning around with his index finger extended (likely stereotypy and not directed toward anything)

	behaviors suggest communicative intent (see last example).	(code point because other child behaviors suggest communicative intent as opposed to playing)	
m: Point_p (prompted)	Child points (meeting above definition) within 3 s of an adult prompt (models point, tells child to point or show what he/she wants, asks child what he/she wants).	*Child touches a book w/ index finger 2 seconds after the adult points at the book. *Child points to the door 1 second after adult points to the book. *Child points to the book 2 seconds after adult asks what he wants.	*Child extends index finger toward book 4 seconds after the adult points at the book (code at unprompted point). *Child extends index finger toward book 1 second after adult point (code as prompted) and then immediately points to another picture in book (code as unprompted even though only 2 s have elapsed since adult model because only 1st point after model counts as prompted.

IC COMPONENT 1: GESTURES (continued)			
Code	**Definition**	**Examples**	**Non-examples**
r: Reach	Child extends arm with an *open hand* toward an object that they cannot obtain without adult assistance (e.g., because the adult is holding the object still/blocking object or the object is on a high shelf/far away). *The child's hand must be open and not holding anything to code a reach*. Arm does not have to be fully extended to code a reach. If the child ends up grabbing the item, code based on whether the object was out of the child's reach during initial extension. If the object was withheld by the adult and within the child's reach BUT the child extends arm and brings it back without grabbing, code reach. If the object was outside of the child's reach but not restricted by the adult, only code reach if the child pulls back his/her arm without the item or only obtains the item with the adult's assistance. If the child reaches toward an object to touch it, code as a reach if the child does not grab and take the item - caveat: if the child continues to touch the object for more than 3 s, only consider the first 3 s the reach. If the child engages in a second or third communicative behavior during the first 3 s, code pre-IC or IC as appropriate. If the additional behaviors occur after the child has been touching the object for more than 3 s, code additional behavior(s) separately from the reach (3s is arbitrary amount of time chosen to indicate shift from reach to just touching/playing).	*Child extends an open hand toward a ball in the adult's hand (that the adult is holding still) and the adult hands the child the ball. *Child stretches an open hand toward spinning light held still by adult and adult moves the lights toward the child. *Child extends an open hand toward a book held still by the adult and when adult didn't give it immediately moves on to another toy (code as reach even though the child lost interest). *Child stretches an open hand toward the door. *Child reaches toward spinning lights and moves to touch them.	*Child uses open hand to grab ball from adult's hand (the adult doesn't need to provide assistance). *Child stretches open hand toward car AFTER adult had started moving car toward child (adult in process of giving). *Child reaches and obtains a book from the shelf or reaches up and pushes button on the wall (access not blocked). *Child extends open hand toward adult's hand and grabs the adult's hand to obtain access to the ball the adult was blocking. *Child has been touching the spinning lights for 4 seconds and then shifts her gaze to the adult while still touching them (you should have already coded the reach; code GS as a separate behavior)
NOTE ON REACHES AND POINTS: If child is reaching and then extends index finger (while arm is still extended and before child has engaged in another behavior to signify IC/pre-IC [e.g., GS, EC, voc]), code point rather than reach. If child is reaching, returns arm to side (or otherwise stops reaching or uses EC/GS/voc), and then points, code both behaviors (the reach and then the point). The same criteria applies when the child is pointing and the point turns into a reach.			
c: Reach_p (prompted)	Child reaches (meeting above definition) within 3 s of an adult prompt (models reach, tells child to show what he/she wants, asks child what he/she wants).	*Child extends open hand toward a ball in the adult's hand 1 second after the adult told him to show him what he wanted.	*Child extends open hand toward a ball in the adult's hand 4 seconds after the adult told him to show what he wanted (code as unprompted reach).

IC COMPONENT 1: GESTURES (continued)			
Code	**Definition**	**Examples**	**Non-examples**
s: Show	Child extends an object held in his / her hand toward someone. Does not required additional evidence of coordinated attention to the adult or object to receive credit as intentional communication (i.e., shows count as IC with or without simultaneous/sequential eye contact)	*Child extends his arm up toward the adult's face while holding a block in his hand. *Child extends his arm to his left side with a ball in it while the adult is sitting on his left looking at the ball (or the adult's face is low enough that it seems the child is moving the ball where the adult can see it)	*Child extends his arm toward the adult and places it in her hand *Child extends his arm in the air while holding a block (not toward adult). *Child holds a car up in the air and shakes it while looking at it
t: Show_p (prompted)	Child shows something (meeting above definition) within 3 s of an adult prompt.	*Child holds a ball up toward the adult's face 2 seconds after the adult shows the child a block.	*Child holds a car up toward the adult's face 4 s after the adult says show me what you want to play with (code unprompted).
g: Give	Child pushes or hands an object to the adult. The child must move the object toward the adult's hands (within a few inches of the adult's hand) but the object does not need to end up in the adult's hand to count as a give. Must be child initiated (in contrast to the adult taking the object). Does not require additional evidence of coordinated attention to the adult or object to receive credit as intentional communication (i.e., gives count as IC with or without simultaneous/ sequential eye contact).	*Child grasps a container of M&Ms and places it in the adult's hand. *Child pushes a book toward the adult's hand *Child attempts to place a ball in the adult's hand but the adult doesn't grab on to it and it falls (still count the attempt as a give as long as the child was moving the ball toward the adult's hand)	*Child pushes a container of M&Ms on the floor but they do not go near the adult (e.g., pushes the container a few inches and the adult is across the floor). *Child holds out a container of M&Ms and the adult takes it. *Child pushes a car or rolls a ball toward the tester (assume this is part of a play routine as opposed to a give for the purpose of behavioral requesting).
h: Give_p (prompted)	Child gives an object to the adult (meeting above definition) within 3 s of an adult prompt (telling the child to give something, pointing to open palm, asking the child what he/she wants)	*Adult says, "what do you want?" and within 1 second the child places the jar of M&Ms in the adult's hand. *Child places ball in adult's hand 1 second after adult points to palm.	*Child places a container of M&Ms in adult's open hand (just holding out open hand does not count as prompting, code unprompted).
h: Other gesture_p (prompted)	Child performs a gesture meeting the above criteria within 3 s of an adult prompt (likely a model prompt).	*Child waves to a stuffed animal 2 seconds after the adult waves to the child.	*Adult reads a sentence about sitting an the child sits (sitting is not a gesture).

IC COMPONENT 1: GESTURES (continued)			
Code	**Definition**	**Examples**	**Non-examples**
b: Other gesture	Gesture that is not defined above. May include wave (moving open hand at a person or object), using hands to show size, head nod/shake, shoulder shrug, "shh" gesture, clapping (*hands must touch at least twice to code*), other clearly descriptive/conversational gestures. **Clapping and waving will often be coded as "other" for function if they occur with other behaviors, unless there are context clues to suggest coding IJA or request for function (e.g., clapping while moving toward the adult and saying the name of an item the adult is withholding). Descriptive gestures may be coded as "other" function if the function is unclear; however, some descriptive gestures are clearly IJA (e.g., showing size) and clearly requesting (e.g., moving han from one side of a book to the other to signify "turn the page").	*Child waves (i.e., moves hand side to side) toward a picture in a book or a stuffed animal or the adult. *Adult reads a sentence about something going high or being tall and the child extends his/her hand up toward the ceiling. *Child claps hands together several times and looks at the adult. *Child moves hand from one side to another to gesture "turn the page" when adult is holding page in book.	*Child claps hands together once *Sign language *Child shakes his hand repeatedly to one side (may look like a wave but is not clearly directed at a person or object) *Child shakes head from side to side repeatedly (may look like a nod but the repetitive nature suggests stereotypy).
NOTE ABOUT PROMPTING: The adult saying the child's name or "Look" does not count as prompting for gestures (it is a prompt for eye contact or a gaze shift). Count gestures as unprompted if they occur following the adult saying his/her name or "Look."			
If a child begins to use one gesture and then changes forms (e.g., begins reaching or waving and then extends index finger to point) in one fluid motion, code the "higher level" gesture (point>reach>other).			
IC COMPONENT 2: ATTENTION TOWARD ADULT (EYE CONTACT) or ADULT & OBJECT (GAZE SHIFT)			
Code	**Definition**	**Examples**	**Non-examples**
NOTE ABOUT CODING ES/GS: If you cannot see at least part of the child's eye, you can only code EC if you can see the child's nose move toward the adult's eye region and/or the adult's reaction suggests the child made eye contact (e.g., the adult's eyes wide; adult smiles).			
e: EC (eye contact)	Child looks at the upper region of the adult's face. If the adult's face is off-screen, EC can only be coded if some portion of the adult's body is visible (such that the location of their face can be inferred).	*Child's eyes and nose are oriented toward the adult's eyes. *Child is looking upward past the adult's shoulder but the adult's head is not visible on screen (can infer location based on where shoulders are though).	*Child looks up where the adult had been but the adult is now completely off screen (cannot infer location of face). *Child looks at the adult's mouth. *Child looks from a book (or other object) to adult's eyes (this would be a gaze shift)
f: EC_p (prompted eye contact)	Child makes eye contact (meeting above definition) after adult prompt (saying the child's name or "look" or moving their face in between the child's face and object or moving the object toward her eyes).	*Child looks up toward the adult's eyes 1 second after the adult says the child's name.	*Child looks up from the book toward the adult's eyes 2 seconds after the adult says "look" (this would be a prompted gaze shift).

DISTINGUISHING BETWEEN EC/GS: If on the fence about coding EC or GS, consider the following:
Did another component behavior occur simultaneously or within 3s of the EC/GS?

- If not, do not spend too much time deciding on the code. If so, watch the act once more at regular speed to determine if situational clues provide evidence that the child looked at an object before or after looking at the adult ((e.g., the adult is in possession of an object that the child wants or was just engaged with and the child is looking in the general area of that object [even if the object has just gone off screen]; the child and adult are engaged in a routine with the same object and they have just been looking at it). Watch the act again at a slow speed to see if the child shifted gaze from the object to the adult or vice versa without turning his/her head (i.e., look for his/her eyes shifting).
    - Code GS if based on the additional viewings it is reasonable to assume the child looked at an object before or after looking at the adult
    - Code EC if after 2 additional viewings you are still unable to determine the child's focus of attention immediately before or after he/she looked at the adult.

IC COMPONENT 3: SPOKEN LANGUAGE & VOCALIZATIONS; OTHER COLLATERAL GAINS			
Code	**Definition**	**Examples**	**Non-examples**
w: spoken language	Child-initiated intelligible spoken word (or close word approximation) related to the current activity or materials present in the session. *Separate instances of spoken language must be separated by at least 1 second*.	*Child says, "ball" while playing with a ball *Child says, "car" 4 s after the adult says "car" *Child says "French fries" (counts as 1 instance of spoken language) *Child says a number while playing with the number puzzle.	*Child says "pizza" while playing with a ball (code as irrelevant word unless pizza is one of the materials present in the session) *Child says "car" 2 seconds after adult says "car" (code prompted) *Child says "ice cream" twice in a row (only count 1 instance of spoke language because <1s between words)
x: spoken language_ p (prompted)	Spoken language that meets the above definition within 3 seconds of an adult prompt (adult models the word [either alone or in a sentence], adult asks "what do you want" or tells the child to say what he wants).	*Child says "ball" 1 second after adult says "ball". *Child says, "apple" 2 seconds after the adult asks what he wants.	*Child says "apple" 6 seconds after the adult tells him to show what he wants (code as unprompted)
y: irrelevant word	Spoken language that is not contextually relevant [(1) unrelated to the current activity or materials present, (2) not a repetition of a word spoken by the adult within 3 seconds]. Collateral gain. Only count as IC if paired with coordinated attention to adult and object.	*Child says "pizza" while playing with the ball and there is no indication of pizza being involved in the session or prior mention of pizza.	*Child says "car" 2 seconds after the adult says "car." Even though there are no cars in the video, repetitions of adult spoken language are coded as prompted spoken language.

v: voc (vocalization)	Discrete phonation *lasting 2 seconds or less* produced by child OR jargon/babbling (producing vocalizations with >1 different sound lasting longer than 2 seconds but with intonation similar to producing words/phrases). Repeating the same sound for >2 s does not count as babbling (e.g., "ayayayayayaya"). Vocalizations must be separated by at least 1 second to count as discrete events. If there are other children in the classroom making noise and you cannot see the participant's mouth, do not code vocalization.	*Making "ah" sound for 2 seconds *Squealing ("ee!") that lasts 1 second	*Crying, whispering, sneezing, making "clicking" sound, sound made from sucking in air, yawning *Making "baaaah" sound without rising and falling intonation that makes it sound like phrase speech for 5 seconds *making "eeee" sound with rising and falling intonation that does not sound like phrase speech (sounds like stereotypy – the rise and fall have a repetitive pattern like "eeEEeeEEeeeeEEEE"). *Saying "ee" repeatedly with less than 1 s between utterances (only 1st counts as vocalization. 1 second must elapse [the child must not make a sound for 1 s] to code a new voc)
u: voc (prompted vocalization)	Discrete phonation meeting the above definition that occurs within 3 seconds of an adult model of the same sound.	*Adult says "ee" and child says "ee" 2s later. *Adult says "ba" and child says "ba" 2 s later in a higher pitch	*Adult says "ee" and child says "eeeeeeeeeeee" for >2 s immediately after (child utterance too long to be counted as vocalization) *Adult says "ee" and child says "uh" (different sound)
o: object interest	Collateral gain. Playing with an object in a manner that goes beyond object exploration; doing something with the object other than holding, inspecting, or mouthing. Only count independent play (i.e., does not occur within 5 s of an adult prompt).	Rolling a car, turning on the spinning light, stretching bouncy ball, taking items in and out of a dump truck, putting numbers in a puzzle or taking numbers out, reading a book	Mouthing letters, shaking a ball, touching blocks, holding a car, holding the spinning light but not turning it on or off, adult placing child on 'sit and spin' and spinning him/her around, child sitting while adult holds book and turns the pages
IC FUNCTIONS			
Code	**Definition**	**Examples**	**Non-examples**

n: NA	Not applicable. Use when the child uses only one behavior that alone doesn't count as IC.	*Child points but does not make EC or vocalize; child vocalizes without making gesture or EC; child makes EC but doesn't vocalize or gesture	*Show, give, spoken language (all count as IC even when used alone)
j: IJA	**<u>Initiating Joint Attention</u>**: IC act used containing necessary elements simultaneously or sequentially (within 3 seconds of each other) to share attention with communicative partner. Child must be in possession of the object or able to obtain the object without adult assistance for this code.	*Child holds a car up toward the adult's face (show) *Child points to a picture and looks at the adult	*Child points to the door and vocalizes (pre-IC) *Child points to the door with coordinated gaze to the adult (BR)
k: IJA_p (prompted)	Child IC act that meets above IJA definition but one or more of the components *necessary to for the behavior to count as IC* was prompted by the adult.	*Child points to a picture and looks at the adult 1 s after the adult says the child's name. *Child says "ba," looks at the adult (but not from the ball to the adult), and points to the ball after adult points to the ball (this would also count as Pre-IC because 2 of the components were unprompted)	*Child shows the adult the ball and shifts gaze from the ball to the adult after the adult says "look" (this would be unprompted because the show was independent and counts as IC alone) *Child says "ba," looks from the ball to the adult, and points to the ball after adult points to the ball (code independent because vocalization and GS were unprompted)
b: BR	Behavior Request: IC act containing necessary elements simultaneously or sequentially (within 3 seconds of each other) used to obtain something or some action from the communicative partner.	*Child reaches toward the car in the adults hand while looking at the adult's eyes *Child says "ba" while shifting his gaze from the ball to the adult's eyes *Child gives a container of M&Ms to the adult to be opened.	*Child points at a word in a book and looks at adult's eyes (although this may be a request for the adult to read it is difficult to reliably distinguish from IJA – code as IJA) *Child shifts his gaze from a ball in his lap to the adult's eyes while saying, "Ba" (code as IJA because child has access to the ball unless it is clear based on prior events in the video that the child wants the adult to do something with it).

IC FUNCTIONS (continued)			
Code	**Definition**	**Examples**	**Non-examples**
p: BR_p (prompted)	Child IC act that meets above BR definition but one or more of the components *necessary for the behavior to count as IC* was prompted by the adult.	*Child looks at the adult's eyes and points to the ball held by the adult 1 second after the adult says "show me what you want." *Child says, "ca" while reaching toward the car and shifting his gaze from the car to the adult 2 seconds after the adult says the child's name (this also counts as pre-intentional because 2 components were unprompted)	*Child looks at the adult 1 second after the adult says, "look" and gives her a container of M&Ms (even though the EC is prompted, the independent give counts as IC alone).
o: other	IC act containing necessary elements simultaneously or sequentially (within 3 seconds of each other) but act is not used for requesting or IJA or the intention is unclear.	*Child waves at the adult and looks from the adult to the door *Child shifts his gaze from the book to the adults eyes and claps	
d: other_p (prompted)	IC act that meets the above definition but one or more of the components *necessary for the behavior to count as IC* was prompted by the adult. **Also count repetitions of irrelevant words as other_p (only applicable for E2 – sometimes adult would repeat his irrelevant word and then he would repeat word)	*Child waves at the adult while looking at the adult's eyes 2 seconds after the adult waves to the child.	
2: pre – intentional	Use of 2 IC components simultaneously or sequentially (within 3 seconds of each other) that together do not meet the definition of IC.	Child says "ba" and looks at adult; child says, "ba" and points to book w/out coordinated attention to adult	Child says "Ah" and shifts her gaze from the ball to the adult (this would be IC)

Differentiating Types of Communicative Acts		
Intentional Communication (independent)	**Intentional Communication (prompted)**	**Pre-Intentional Communication**
1) Vocalization + Gaze Shift *GS is necessary to demonstrate coordinated attention to adult and object* **2) Point, reach, or any other gesture + Gaze Shift or Eye Contact** *GS is not necessary to demonstrate coordinated attention between adult and object (EC demonstrates attention to adult and gesture demonstrates attention to object)*** **3) Give, show, intelligible word** *Additional evidence of coordinated attention to adult (through EC/GS) not necessary.* **Any of the above 3 examples that occur with another prompted element (as long as the necessary components are independent)** *E.g., independent give + prompted EC; independent point and GS + prompted voc.*	**1) Vocalization + Gaze Shift** if either or both behaviors are prompted. **2) Point, reach, or any other gesture + Gaze Shift or Eye Contact** if either or both behaviors are prompted. **3) Prompted give, show, intelligible word** **4) 3 component acts if either:** • **2-3 of the component behaviors are prompted.** • **1 component is prompted but that component is necessary to code IC** (e.g., prompted GS + point + voc; prompted point + EC + voc)* **=also count as Pre-Intentional Communication*	**1) Vocalization + Eye Contact** *EC does not demonstrate coordinated attention to adult and object.* **2) Vocalization + Gesture** *Neither component demonstrates attention to the adult.* **3) 3 component acts in which 1 component that is required for the act to count as IC is prompted** * Prompted GS/EC + gesture + vocalization * Prompted gesture + EC + vocalization

Differentiating Functions of Communicative Acts - *Evidence to support different functions (not requirements for coding the different functions)*		
Initiating Joint Attention	**Behavior Regulation**	**Other**
1) The child is in possession of the object	**1) The child uses a "reach" or "give" gesture within the communicative act.**	**1) One component of the act was an "Other Gesture."**

→E.g., child shifts gaze from book to adult and vocalizes; child labels an item he is holding **2) The child uses the "show" gesture** **3) Often accompanied by positive affect** (but positive affect is not required to code IJA).	**2) The adult is withholding the item the child is gazing or gesturing toward or it is otherwise unobtainable to the child** *→E.g., pointing toward the door* **3) The child's affect may be neutral or negative but probably not positive until they obtain the requested object** (but neutral/negative affect not required to code BR)	*→E.g., GS + clapping; GS + waving at the adult* **2) It is not clear that the child wants something or wants to direct the adult's attention toward something** *→E.g., Vocalization + GS to a toy not withheld by the adult but also not in the child's immediate possession [book on the shelf] that the child is not attempting to obtain. May be IJA but not clear.* *→E.g., Vocalization + GS to a toy withheld by the adult while exhibiting positive affect (e.g., laughing) and not attempting to obtain the toy.* *→If the act includes a gesture (other than "Other gesture"), it should be possible to classify as IJA or IBR.*

ADDITIONAL OBJECT INTEREST EXAMPLES

- Putting things in/dumping things out of a dump truck
- Putting magnets on the board, taking magnets off the board
- Jumping on the trampoline
- Putting numbers in a puzzle, taking numbers out of the puzzle

ADDITIONAL EXAMPLES/INFORMATION ABOUT OTHER GESTURES

- Waving (must be toward someone or something. If the child is just waving their hands in the air and it is not clear what toward, do not code as waving – likely stereotypy)

ADDITIONAL NOTES ON VOCALIZATIONS

- If you are on the fence about whether something is vocalization or vocal stereotypy, if it lasts 2 seconds or less count as vocalization.

APPENDIX F: Teacher Behavior Data Collection

Instructions for Teacher Behavioral Data Collection

For the unstructured classroom play sample and 10-minute generalization probes, begin coding at the beginning of the video and continue coding for 10 minutes or when the video ends (whichever is first). Tally within minute intervals for all behaviors except following the child's lead.

Behavior	Definition	Examples
Linguistic Mapping (LM)	Adult uses developmentally appropriate language to put presumed meaning to child's communication w/in 5 s of communication. Each adult-labeled communicative act counts as 1 instance of LM, regardless of # of words used. →If it is not possible to clearly see child communication (e.g., child may have pointed but camera cut off their hand) or the child only produces GS (w/out other components), do not code LM →LM is different from narration. Narration occurs when the adult describes the child's actions, which may or may not be communicative. LM should not be coded when the adult is speaking about child actions that are not communicative (***exception*** – count LM when child grabs item from adult).	• Saying "ball" or "you want the ball" when the child points to the ball (both count as 1 instance of LM) • Saying, "Yes, I see the ball!" when the child shows the adult the ball. • Saying, "We can go outside later" when the child reaches toward the door. • **Non-examples**: (1) saying "duck" when child points to the word "duck" [natural consequence], (2) saying "spin" as child spins [narrating child's play], (3) saying "ball" after the child says "ball" o If the child is pointing to a book, assume the point is toward words and code natural consequence rather than linguistic mapping.
Natural Consequences	The adult responds to the child's communicative act by complying with the child's presumed communicative intent (e.g., providing the object the child requested) →If it is not possible to clearly see child communication, do not code natural consequence.	• Saying "duck" when child points to the word "duck" • Giving child the ball when the child points to the ball • Widening eyes and smiling while saying "I see the ball!" when the child shows the adult the ball (the animation is what makes it the natural consequence of IJA, "I see the ball" is LM)
Directing Child (DC)	The adult places a demand/instructs the child to do something unrelated to the object/activity in which he/she is currently engaged. This may include questions about	• Telling the child "roll the ball" while child plays with the car; holding a letter "h" and asking the child "is this the letter H" when the child is playing with stuffed animals; asking the child to identify letters or numbers in a book by asking, "where

	objects/activities related or unrelated to the child's attentional focus. →Directives that DO NOT count as DC: (1) redirecting child to play area; (2) prompting communication; (3) prompting play *when child unengaged*	is…?" instead of reading (thus directing the child to do things rather than playing with child) BUT if the teacher says "point" or "show" when asking to identify, count as a prompt for communication IF the target item is related to the child's focus. • ***Non-examples***: telling child, "come here" when they leave play area or "point to it" to prompt gesture; saying, "bounce ball" as the child bounces the ball (this would be narration since child is already performing action)
Behavior	**Definition**	**Examples**
Prompts	The teacher uses verbal, model, or physical guidance to prompt *child communication* using items/activities with which the child is currently engaged (or new items only if the child is not engaged with anything). If the prompt is unrelated to the object/activity with which the child is engaged OR prompting a behavior outside of communication (e.g., play), count as DC. ***NOTE***: *prompts do not have to align with PMT prompting methods to count.*	• Telling the child "show me what you want" or asking "which one?" while he is looking at books on a shelf. • Telling the child to ask for jumping on the trampoline as the child approaches the trampoline. • Telling child "point to the _____" or "show me the ___" • ***Non-examples***: Telling the child, "roll the ball" (prompting play not communication); telling the child to request trampoline when she is playing with a ball (directing child); asking child general question such as "what are you doing?" "where are you going?" (not intended to elicit IJA/BR, not directive, and likely unanswerable by the child [response requires more than yes/no] so not coded as a prompt), asking question such as "what about purple" where intended response is unclear (do not code).
Initiating a Routine	The adult attempts to establish an interactive / turn-taking activity with the child. The adult must clearly try to take a turn or insert an adult action using an activity or object with which the child is currently engaged or introduce new action/activity when child is unengaged. The child *DOES NOT* have to reciprocate for the behavior to count. Each time the adult attempts to initiate a routine counts as one instance (even if the same routine is attempted several times throughout a session). After coding one instance, child must discontinue engagement with routine/materials and become re-engaged before counting a second "initiating a routine"	• Adult counts and lines up cars as child plays with the cars • Adult places shape in shape sorter/dump truck as child plays with shape sorter/dump truck • Adult points to and labels picture/word in book child is reading. Child takes several turns pointing and then goes to play with cars. 1 minute later the child picks up the book and the adult starts labeling pictures. This sequence would include 2 routines (the first and second book routine because they were separated by the child playing with the cars). • ***Nonexamples***: adult labels child actions without also performing an action; child brings over a book and starts pointing at words (not initiated by adult)

Environmental Arrangement (EA)	The adult manipulates the environment in attempt to evoke child intentional communication. Time delay is used when child IC is not immediate. EA can also be coded when the physical environment is not manipulated (e.g., using time delay and pausing in routine); however, the pause must be followed by prompted or unprompted child communication (if only brief pause and then return to routine, do not code EA).	• Adult holds a preferred item where child can see but not reach it • Adult interrupts a routine (e.g., pauses before taking a turn or giving child the material to take a turn) • Adult pauses during a routine where the child is pointing to words and the adult is reading (i.e., does not read a word after the child point). • Adult holds down a book page to keep child from turning the page
Following Child's Lead (FCL)* *Code using 15s momentary time sampling*	The clinician uses a non-directive action (including narration) related to an activity/object with which the child is engaged. Child does not have to be actively engaged with adult to code FCL. Mark "n/a" if child/adult is off-screen when FCL is to be coded.	• Adult is labeling pictures in a book child is looking at • Adult and child are sitting next to each other, both playing with balls • Adult is shaking a ball while the child is shaking a block • Child is shaking a block and the adult says, "shake shake shake"

Child ID:	Teacher ID:	Data Collector:	Condition:
Date:	Session:	Start time:	End time:

Min	Following Lead				Linguistic Mapping	Natural Consequence	Directing Child	Initiating a Routine	Use of Prompts	Use of Time Delay	Environmental Arrangement
1											
2											
3											
4											
5											
6											

7											
8											
9											
10											
Total	%FL:										

APPENDIX G: PROCEDURAL FIDELITY DATA COLLECTION

INSTRUCTIONS FOR CODING FIDELITY OF TEACHING EPISODES

1) Pause video upon initiation of a **teaching episode** (i.e., any time the adult (1) prompts the child to communicate [pausing for at least 3 seconds within a routine; placing something out of the child's reach and pausing to encourage communication; asking the child what they want; telling the child to produce a communicative behavior; saying the child's name or "look"] or (2) produces a nonverbal vocalization).

- **NOTES ON WHEN *NOT* TO MARK INTERACTION AS TEACHING EPISODE**:
    - *Do not mark an interaction as a teaching episode if the clinician begins an interaction with the use of a specific technique (i.e., prompt to communicate) but is not able to complete the interaction by complying with the intent of the child's communicative act and linguistically mapping the referent because the child shifts attention away from the routine. The child's abandonment of the activity is neither a correct nor incorrect teaching episode.*
    - *Do not mark an interaction as a teaching episode if the clinician creates enabling context (e.g., takes a turn with the child's toy) and pauses but returns toy/continues activity without prompting communication or if the child grabs the toy back before the clinician is able to prompt communication. Instead, code as initiating a routine.*

2) Mark the time the teaching episode began under the "Time" column.

- **ADDITIONAL NOTES ON HOW TO DETERMINE THE BEGINNING OF A TEACHING EPISODE***:* Do not begin counting seconds of time delay until it is clear that an item is truly being withheld. If the clinician manipulates the environment (e.g., places hand over button to block the child from making balls bounce; puts the lid on the jar of m&ms) BUT the child is still accessing reinforcement (e.g., the balls are still bouncing from the last time the button was pushed; the child is still chewing m&ms), do not mark the start of the teaching episode until it becomes clear that the child is no longer accessing reinforcement (e.g., the balls stop bouncing; the child finishes chewing the child engages in a communicative behavior).

3) Circle the type of teaching episode in the "Type" column based on definitions in Procedural Fidelity Codes table on the following page. Extra teaching episode rows are included in case there are more than 20.

4) Record codes for correct and incorrect elements for each episode. If an episode contains all correct elements and no incorrect elements, mark "C" in Teaching Episode column. If any correct elements are missing and/or incorrect elements were observed, mark "IC."

- ***NOTE ABOUT PROMPTING HIERARCHY***: *mark correct if the adult uses **at least 1-2 prompts** in the hierarchy when child does not respond following time delay (e.g., after waiting 5 s, tells child to point to the object). Mark incorrect if the adult either does not provide any prompts or provides more than two prompts when the child does not respond following time delay.*

NOTE ABOUT CODING FROM VIDEO RECORDING: If adult or child behaviors are unclear due to the camera angle, err on the side of caution and do not code something that cannot be clearly seen.

Teaching Episode Procedural Fidelity Codes		
Goal Type	**Correct Procedural Elements**	**Incorrect Elements**
1) Gaze	**Suggested prompt hierarchy (PH)**: 1: Wait 3-5 seconds for child to shift gaze from object/event to adult* 2: If no response after 3-5s, adult says "look" or child's name (verbal prompt) 3: If no response after 3-5s, adult intersects child's gaze or moves object toward her face **Linguistic Mapping (LM)**: adult provides a grammatical word (e.g., "ball," "a ball," "laughing") to label the child's referent →*LM unnecessary when presumed child intention is to have adult continue singing song, read a word, or label a picture (only need to comply w/ request).* **Compliance (C)**: adult complies with child's intent, regardless of whether or not child demonstrated appropriate gaze shifting	**Persists with prompts (PP)**: adult provides ≥3 prompts. **Failure to prompt (FP)**: adult does not move through PH when early prompts are not effective. **Excessive Time Delay (ETD):** adult withholds item for greater than 10 seconds without prompting communication (and during the 10 s the child has not moved on to another object/activity). **Inappropriate LM (ILM)**: adult linguistically maps beyond child's topic or does not linguistically map. →***NOTE****: Adult is not required to use linguistic mapping when the child is requesting during recitation of a song or reading a familiar/highly repetitive book. In these instances, continuing the song/reading the book counts as providing the natural consequence and linguistic mapping is not necessary. The teaching episode should still be coded as correct.* **Failure to comply (FC)**: adult does not comply with child's intended communication.
2) Gestures	**PH**: for all gestures but give (see note) 1: Wait 3-5s for child to produce a gesture* 2: If no response after 3-5s, tell child to produce gesture (verbal prompt) 3: If no response after 3-5s, model gesture (model prompt if appropriate**) 4: If no response after 3-5s, physically guide child to produce gesture (if possible/appropriate) *NOTE*: to prompt child to give, replace 2 & 3 → (2) gesture to palm, (3) tell child to give. ***ok to skip model prompt if child doesn't imitate* **LM**, **C**	
3) Vocalizations	**Adult vocalization (AV)**: adult produces >1 syllables consisting of developmentally early/middle sounds or sounds the child has produced during the session that may or may not follow the child's vocalization then pauses expectantly for 3-5 seconds to allow the child an opportunity to take another turn AND	**Incorrect AV (ICAV)**: adult produces vocalizations immediately following child's request/IJA. **Persists with Models (PM)**: adult presents ≥3 vocal models *with no child response to the*

	Child communication (CC): child did not produce IC immediately prior to AV	*stimulus* (child and adult taking turns vocalizing doesn't = PM)
4) Combining Components	Adult uses correct procedural elements for prompting gaze, gestures, or vocalizations depending on the component that is missing from the child's IC act.	Same incorrect elements as those for teaching gaze, gestures, or vocalizations.

***NOTE ON TIME DELAY**: Count a teaching episode as correct if it contains all the appropriate elements except time delay is shorter/longer than the recommended length but no longer than 10 seconds.

****NOTE ON VOCALIZATIONS/WORDS**: If a child responds using a word/vocalization during a teaching episode, and the adult uses appropriate NC and LM, count the teaching episode as correct (even though the clinician was likely targeting another behavior, it is important to respond to vocs/words).

Example

Min	Following Lead				Directing Child	Initiating a Routine	Linguistic Mapping	Natural Consequence	Environment Arrangement	Teaching Episodes	Teaching Episode Details			
											Time	Type	Correct	Incorrect
1	+	+	+	+		I	I	I	I	IC	01:25	1 | 2 3 4	PH, C	ILM

Child ID:	Clinician Initials:	Data Collector:	
Date:	Session:	Start time:	End time:
Session Goals			
1		**2**	

Min	Following Lead				Directing Child	Initiating a Routine	Linguistic Mapping	Natural Consequence	Environment Arrangement	Teaching Episodes	Teaching Episode Details			
											Time	Type	Correct	Incorrect
1												1 2 3 4		
2												1 2 3 4		
3												1 2 3 4		
4												1 2 3 4		
5												1 2 3 4		
6												1 2 3 4		
7												1 2 3 4		
8												1 2 3 4		
9												1 2 3 4		
10												1 2 3 4		
11												1 2 3 4		
12												1 2 3 4		
13												1 2 3 4		
14												1 2 3 4		
15												1 2 3 4		
16												1 2 3 4		
17												1 2 3 4		
18												1 2 3 4		
19												1 2 3 4		
20												1 2 3 4		
Totals	% FL:											1 2 3 4		
NOTES:												1 2 3 4		
												1 2 3 4		
										% c:				