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Authors

Gulsrud, Amanda C
Hellemann, Gerhard
Shire, Stephanie
et al.

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Isolating active ingredients in a parent-mediated social communication intervention for toddlers with autism spectrum disorder

Amanda C. Gulsrud[1], **Gerhard Hellemann**[1], **Stephanie Shire**[1], **Connie Kasari**[1,2]

[1]UCLA Semel Institute for Neuroscience & Human Behavior, Los Angeles, CA, USA

[2]UCLA Graduate School of Education and Information Studies, Los Angeles, CA, USA

Abstract

Background: Behavioral interventions are commonplace in the treatment of autism spectrum disorders, yet relatively little is known about how and why these interventions work. This study tests the relationship between isolated core components of a packaged social communication intervention and the primary outcome, joint engagement, to better understand how the intervention is affecting change in individuals.

Methods: A total of 86 toddlers and their parents were enrolled in the study and randomized to one of two treatments, the joint attention, symbolic play, engagement, and regulation (JASPER) parent-mediated intervention or a psychoeducational intervention. Measures regarding the parent's use of intervention strategies were collected before and after the 10-week intervention. Additional measures of child and parent joint engagement were also collected.

Results: A significant effect of treatment was found for all four of the core strategies of the intervention, favoring a larger increase in the JASPER condition. A hierarchical linear regression revealed several individual predictors of joint engagement, including parent-rated buy-in, interventionist-rated parent involvement, and parental use of strategies. To complement the hierarchical analysis, we also tested the potential mediating effect the strategies may have on the relationship between treatment and joint engagement. Results showed that the strategy of mirrored pacing mediated the relationship between treatment and joint engagement in the positive direction.

Conclusions: These results strongly suggest that the mirrored pacing strategy is an active ingredient of the JASPER treatment.

Keywords

JASPER; parent-mediated intervention; social communication; active ingredients

Correspondence: Amanda C. Gulsrud, 760 Westwood Plaza, Rm 68-237C, Semel Institute, UCLA, Los Angeles, CA 90024, USA; Agulsrud@mednet.ucla.edu.

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Introduction

The emphasis on evidence-based treatments in the field of autism research has highlighted the need to better understand how, why, and for whom specific intervention approaches work. To date, several studies have demonstrated positive effects on child outcomes using a range of applied behavior analysis (ABA) methods. ABA methods aim to increase specific child skills in a range of domains and decrease interfering, or challenging behaviors. While many different ABA-based models have shown effects on a range of developmental outcomes, we know very little about how behavioral interventions work, in other words, the underlying mechanism contributing to outcomes.

There may be several different candidates contributing to positive outcomes. Researchers have tested the effects of dose, generally defined as hours per week or length of intervention and agent of intervention, such as parent or therapist (Virués-Ortega, 2010). Other studies have tested the effects of augmenting an intervention with specific active ingredients related to intervention content. Intervention content is particularly critical, when considering the core impairments in autism spectrum disorder (ASD). Most children function within the typical range of intelligence by age 8 years yet still have significant social communication impairment (CDC, 2012). Therefore, improving social and communicative development is a critical target for early interventions.

A few early intervention studies have examined outcomes on core social communication impairments. For example, Kasari, Freeman, and Paparella (2006) tested whether adding in systematic teaching of joint attention or play skills into a general ABA-based early intervention program resulted in gains on these social communication outcomes. Indeed, joint attention improved for children who received the augmented joint attention intervention and play improved for children who received the play intervention. Neither of these skill domains changed significantly for children receiving the ABA-based classroom alone. Landa, Holman, O'Neill, and Stuart (2010) similarly augmented a toddler classroom with specific content on 'interpersonal synchrony' (socially engaged imitation, joint attention, and affective sharing) and compared these outcomes to children who participated in a noninterpersonal synchrony control classroom. A significant treatment effect for one of the three treatment targets was noted; that of socially engaged imitation (defined as imitating an adult model with eye-contact) for the group of children randomized to the interpersonal synchrony classroom. Both of these studies find that augmenting the content of an early intervention results in some specific gains in these content areas.

The foregoing studies mediated interventions through expert therapists. However, there has been increasing attention to parent-implemented interventions for very young children with ASD. Given the importance of parents in children's lives, there is intuitive appeal for these types of interventions. Yet, current studies have yielded mixed results. Several have found no significant change in parents or children compared to treatment as usual (Carter et al., 2011; Rogers et al., 2012) while others have found only effects on parents but not children (Kasari et al., 2014; Siller, Hutman, & Sigman, 2012). This study examines the contribution of specific caregiver strategies on outcomes of joint engagement, a core developmental impairment, for toddlers with ASD. We focus on a recent comparative efficacy RCT (Kasari,

Gulsrud, Paparella, Hellemann, & Berry, 2015) of the parent-mediated joint attention, symbolic play, engagement, and regulation (JASPER) intervention over the course of a 20 session, 10-week intervention. Child outcomes included increased length of time children initiated jointly engaged interactions with parents and the diversity and sophistication of their play abilities. JASPER was compared to a parent intervention involving information sharing, but not hands-on coaching. The effects of the study were maintained at a 6-month follow-up and generalized to early intervention classroom teachers who were not trained in JASPER and who were blind to treatment allocation.

The aim of this study was to unpackage the core components of the parent-mediated JASPER intervention in relation to the primary outcome of joint engagement. The first goal was to determine whether we can reliably isolate and measure specific behavioral strategies and whether the use of strategies change over time and with treatment type. We hypothesized that parents who received the JASPER intervention would display a greater increase in strategy use during the treatment. Next, we explored the relationship between parent strategy use and the primary target of joint engagement. Our goal was to better understand how and if specific strategies influence and potentially cause the observed changes in joint engagement. We hypothesized that strategies related to maintaining the social interaction would most strongly influence joint engagement.

Methods

Participants

Toddlers 36 months or younger were enrolled if they signed the informed consent, had a clinical diagnosis of ASD confirmed by independent testers with the ADI-R (Lord, Storoschuk, Rutter, & Pickles, 1993) and the ADOS (Lord, Rutter, DiLavore, & Risi, 2001), had no significant physical disabilities, and parent and child were available for follow-up assessments (i.e., not international residents). A total of 86 parent–child dyads participated in the study with the average child's chronological age of 31.5 months and parent's age of 35.9 years. See Table 1 for participant characteristics.

Parent–child dyads were randomized to one of two treatment conditions – JASPER Parent-mediated (JASPER) or a psychoeducational intervention (PEI). Testing for the success of randomization showed that the two groups were matched on demographics (Table 1) except for chronological age at entry, where the JASPER group with an average age of 31 months, was significantly younger than the PEI group with an average age of 32 months.

Intervention procedures

Parent–child dyads were exposed to either an evidence-based and targeted program that increases child social communication by teaching parents specific strategies to increase joint engagement (JASPER), or a psychoeducational control condition aimed at increasing parent education and reducing stress (PEI). Dose was controlled with each family participating in a 30-hr per week early intervention classroom in addition to the 1-hr weekly in the experimental research protocol for the entire 10-week duration of the study. Further details of the intervention can be found in Kasari et al. (2015).

Measures

Parent–child interaction.—A 10-min videotaped interaction was collected for each parent–child dyad prior to the start of intervention and at the end of intervention (10 weeks later). Parents were asked to engage in free play with their child as they normally would at home using a standard set of toys (including dolls, dishes, puzzles, trucks, shape sorter, blocks). These materials were separate from the materials used in intervention sessions. The videotapes were coded by reviewers blind to group status for periods of joint engagement adapted from Adamson, Bakeman, and Deckner (2004) and included the time spent engaging in play routines, where parent and child were mutually attending to the play interaction reflecting the states of both supported joint engagement and coordinated joint engagement. Reliability was established between independent coders for total time jointly engaged on a random 25% of videotapes across time points, conditions, and participants (intraclass correlation: ICC = .95).

Parent interaction styles and strategy use were also rated in 2-min intervals across the 10-min interaction. The rating was developed to reflect the parents' fidelity to strategies taught in the JASPER training protocols. Four composite codes were included in the analyses: environmental arrangement, mirrored pacing, prompting, and communication. Each composite represented the average of the scores for several behaviors related to each interaction theme. Each of the behaviors was rated for presence or absence in each of the 2-min intervals yielding a percentage score between 0 and 1.

Environment arrangement was operationalized by scoring the parents on four behaviors conceptually clustered as part of this theme: minimizing distractions, maintaining appropriate play materials, selecting new toys when needed, and maintaining the interaction at the child's eye level. This can broadly be described as the ability of the parent to manage the physical aspects of the setting and toy environment during the interaction. An example of a parent who would rate highly on this measure would be one who set up the play environment with toys at the child's appropriate developmental play level, structured the interaction with toys in between themselves and the child, maintained the toys at mutual eye level, and helped the child move between toy sets easily by bringing toys close to the child.

Mirrored pacing was operationalized by scoring the parents on three conceptually linked behaviors: parent's imitation of appropriate and functional play acts, and the timing and positioning of these mirrored actions. Timing consisted of the contingency and rapidity of the imitative act and positioning included whether the adult displayed the act in the child's line of view. Parents in the JASPER intervention were taught to identify which acts should and should not be imitated and to use this strategy to naturally reinforce joint engagement. The parents were also taught to pace the act to maximize the child and parent's attention to a shared activity by either imitating right away while the child was still fixed on the object or pausing until the child refocused. For example, if the child put a figure down the slide, the parent would wait to imitate until the child was reaching to put her figure down the slide again and both parent and child were focused back at the top of the slide.

Prompting consisted of two parental behaviors conceptually clustered together. First, parents were positively rated if the type of prompt used (physical, verbal, or model) matched the

level of need for the child to be successful. For example, when a verbal or model prompt was used for children who needed less help and a partial or full physical prompt was used for children who needed more support to be successful. Second, parents were rated on their appropriate use of the prompting sequence from least to most help, for example, moving to a more directive partial physical prompt when a less directive model prompt was not effective.

Communication was operationalized as the scoring on four behaviors, we consider part of this theme: imitation and expansion upon the child's language, provision of contingent language models at the child's language level, and the directive (commands, question asking) or nondirective (commenting, labeling) nature of the language. Following the JASPER training protocol, directive language was rated less favorably than nondirective language. Parents were rated highly on this strategy composite if they immediately imitated the child's language and added one word, consistently modeled language at the child's expressive language level, and used the majority commenting language (e.g., 'It's a ball').

Reliability of these ratings was established between two independent coders on a random 20% of videotapes sampled across time points, conditions, and participants. The measures proved to be highly reliable, with a range of ICCs from .86 to −.97 (M = .92).

Cognitive assessment.—The Mullen Scales of Early Learning (MSEL; Mullen, 1989) was used to assess general cognitive ability at baseline. The Mullen yields age-equivalent scores for visual reception, gross motor, fine motor, receptive, and expressive language. The baseline early learning composite (ELC) score was used in this study.

Language assessment.—The Reynell Developmental Language Scales (Reynell & Curwen, 1977) was used to assess the receptive and expressive language abilities of children in the sample. The scales yield raw scores on Expressive Language and Verbal Comprehension; these scores were transformed into age equivalencies and baseline scores were used in this analysis.

Parenting stress.—The Parenting Stress Index (PSI; Loyd & Abidin, 1985) was used to obtain a measure of overall parent-reported stress. The PSI consists of two domains: one associated with parent characteristics and the other with child characteristics. The parent domain consists of items related to sources of stress related to parental functioning and the child domain consists of items reflecting perceptions of child characteristics that make it difficult for parents to fulfill their parenting role. Items are rated on a Likert-type scale and summed with higher scores reflecting greater dysfunction. The total of child and parent domain scores from baseline was used in the current analysis.

Caregiver involvement scale.—The Caregiver Involvement Scale (Kasari, Gulsrud, Wong, Kwon, & Locke, 2010) is a four-item interventionist report that measures how well the parents performed in terms of the strategies learned during the intervention session, and their enthusiasm, confidence and comfort in performing what they had learned. Each item is rated on a 1–5 scale, where scores of (1), (3), and (5) have specific anchors. For example, for caregiver comfort level, the interventionist would decide whether parents were (1) not comfortable at all (shifting around, looking at interventionist to check, nervous talking/

laughter, not touching child much, strained), (3) neutral (does things easily but not really relaxed, some affection with child but may be hesitant if interventionist is looking), (5) very comfortable (relaxed, easy movements, affectionate with child, talking freely and easily, smiling). A factor analysis revealed that all four items loaded onto one factor called Involvement. A mean score at exit from intervention was used in this study.

Caregiver diary.—This measure examines caregiver-rated buy-in to intervention and its use has been previously reported (Kasari et al., 2010). The eight items on the measure ask whether the parent: made time to carry out the learned strategies; found it complex to carry out the learned strategies; thought it natural to carry out the learned strategies; made an effort to carry out the learned strategies; was confident carrying out the learned strategies; was comfortable carrying out the learned strategies; felt other people noticed changes in his/her child; and noticed changes in his/her child's interaction with others. All items consist of a series of ratings on a five-point scale from not at all true (1) to very true (5). Parents completed a diary at the beginning of each week's intervention session but only the first parent buy-in rating was used in the current analysis to reflect the parent's earliest ratings of buy-in. A factor analysis of the subscale items revealed three factors: Adherence (questions 1 and 4), Competence (questions 2–3, 5–6), and Improvement (questions 7–8).

Results

Relationship between treatment and parental strategies

The treatment effect differed between the JASPER and the PEI group for each of the four parent strategies: Environment arrangement [$F(1,81) = 14.1$; $p < .01$]; mirrored pacing [$F(1,81) = 14.1$; $p < .01$]; prompting [$F(1,81) = 12.1$; $p < .01$]; and communication [F (1,81) = 15.5; p < .01]. In all cases, the JASPER group improved significantly more from pre- to post-treatment compared to the PEI group. Overall, the strategy most commonly used for both groups at baseline and exit was environmental arrangement, which was already being used about 70% of the time during baseline. The strategy used least frequently at baseline was mirrored pacing, JASPER (0.32) and PEI (0.31). The largest gains were made in mirrored pacing for both groups, JASPER (0.35) and PEI (0.09) (see Table 2).

Relationship between parental strategies and the primary outcome (joint engagement)

A hierarchical linear regression was utilized to better understand the relationship between the changes in the four parental strategies and the treatment effects on the primary outcome, joint engagement. This model was theory-driven and included variables hierarchically based upon our understanding of the underlying temporal and causal order of the effects of the different components. The individual predictors were conceptually grouped and added to the model sequentially. Predictors that were significant were each retained and the variables of the next level were added, stepwise building up the full model. In order of precedence, the groupings consist of: child and parent demographics, which include child chronological age, gender and ethnicity, and maternal age and education; child developmental characteristics and parent factors, which include child MSEL ELC and Reynell expressive and receptive language age equivalencies, and parent-reported stress and initial buy-in to intervention; treatment characteristics, including the number of days to complete treatment and therapist-

rated caregiver involvement at exit; parent strategies, including the four core strategies of environmental arrangement, mirrored pacing, prompting, and communication; and treatment group assignment of either JASPER or PEI.

The final model revealed that the individual predictors, initial parental buy-in (8%), ratings of caregiver involvement at exit to the study (5%), parental use of mirrored pacing and environmental arrangement (30%), and treatment (12%) all significantly predicted a combined total of 55% of the variance in joint engagement (see Table 3).

Parental strategies as mediators of treatment

To complement the hierarchical analysis, we were interested in measuring the extent to which parental strategy use may mediate the relationship between treatment and joint engagement. To test this, we ran separate mediation analyses on the two strategies, mirrored pacing and environmental arrangement, which were related to joint engagement in the regression model. Results showed that the strategy of mirrored pacing mediated the relationship between treatment and joint engagement in the positive direction, strongly suggesting that this strategy is an active ingredient of the treatment (see Table 4). Environmental arrangement, a strategy that was significant in the hierarchical model, did not show mediation. This suggests that while we have evidence that parents who improved in their use of environmental arrangement had improved child outcomes, we have to consider this effect to be independent of the changes in environmental arrangement due to the treatment program.

Discussion

This study explored the relationship between core behavioral components of a well-established parent-mediated social communication intervention (JASPER) and the primary child outcome, joint engagement. The main goal of the study was to isolate and test potential ‘active ingredients’ of JASPER and examine their relation to treatment targets. There were several important findings. First, we successfully isolated several core strategies of the JASPER intervention and demonstrated that parents were able to increase their implementation of these strategies over time. Second, both mirrored pacing and environmental arrangement were positively related to joint engagement. And finally, mirrored pacing mediated the relationship between treatment and joint engagement lending support for its role as an active ingredient.

The first goal of the study was to isolate specific components of the JASPER intervention and to apply a coding system sensitive enough to capture change in these components over the course of the intervention. The four main treatment components were environmental arrangement, mirrored pacing, prompting, and communication. Parents were taught the intervention techniques and their use of the four core components was rated at the beginning and end of treatment. Meaningful increases in the implementation of all four components were found for those parents who received the JASPER intervention compared to those who received the PEI condition. This detailed coding of parent fidelity to treatment protocol was able to capture the richness and variability in parent’s use of the JASPER strategies. Across both conditions, parents were most likely to implement environmental arrangement

strategies and least likely to implement mirrored pacing strategies. JASPER parents made the largest gain in their use of mirrored pacing across the course of the intervention.

The relation of each strategy to the primary outcome, joint engagement, was explored and potential predictors were conceptually grouped and entered into the regression analysis in four steps. The largest portion of variance explained in the hierarchical regression was from the change in the use of mirrored pacing and environmental arrangement and the baseline use of environmental arrangement, which in combination, explained just shy of 25% of the total variance in joint engagement. This result confirmed the relationship between two of the four parent strategies and the primary outcome. Both of these strategies appear to play significant roles in the ability for parents and children to maintain a state of shared attention. Environmental arrangement includes both the physical structure of the environment (toy choice and arrangement) and the dynamic ability to shift materials and structure with the child's needs (replacing toys as needed, bringing toys to the child). Mirrored pacing is the ability to follow in and meaningfully expand on the child's interests and play actions. It involves responding contingently to the child by selectively mirroring back the actions that promote the social interaction. Both of these strategies are core components of JASPER and the link with joint engagement helps us to understand how this intervention is affecting change in children.

Neither the communication nor prompting strategies significantly related to joint engagement. This suggests that some, but not all, JASPER strategies directly relate to joint engagement. We hypothesize that communication and prompting strategies play a larger role in increasing child responding to adult requests, and less of a role in facilitating joint engagement with this age group of children. Different behavioral outcomes will likely require different targeted strategies and future studies should examine the role that JASPER communication and prompting strategies play in language and play acquisition.

Other variables in the regression model were also related to joint engagement, including baseline caregiver buy-in (8%) and therapist-rated caregiver involvement at study exit (8%). Of the three caregiver buy-in factors (Adherence, Competence, Improvement), only the Improvement factor proved significant in the model, suggesting that children whose parent's rated them as already making noticeable improvements in interpersonal interactions at the start of the intervention made larger gains in joint engagement at study exit. One explanation for this is that these children entered into the study with greater sociability. Therefore, they were able to better uptake and benefit from the intervention. Interventionist ratings of caregiver involvement at exit were also closely related to treatment gains. Positive ratings of overall caregiver enthusiasm, confidence, and accuracy in implementing strategies related to increases in joint engagement. These findings are consistent with previous work showing that parental buy-in to and attitudes regarding the intervention are important to child progress (Kasari et al., 2010). In addition, treatment assignment entered as the final step into the model explained an additional 12% of the variance in joint engagement, suggesting that while the preselected predictors explain a large portion of the variance they did not explain all of it. Interestingly, neither child nor parent demographics predicted joint engagement in the model, suggesting children, regardless of their cognitive and language abilities, and parents, regardless of their age, education status, and level of stress, may equally benefit

from the approach. Future work should explore an even more exhaustive list of potential predictors to maximize our understanding of the factors that contribute to treatment outcomes.

The final goal of this study was to test mediation in an effort to isolate potential active ingredients of the parent-mediated JASPER intervention. The analysis established mirrored pacing as one of the active ingredients of JASPER. Mirrored pacing is a core component of the JASPER intervention and includes many levels of awareness on the adult's part. The adult must notice and respond contingently to the child's play acts by imitating. The adult must also know how to discriminate between those play acts that should be imitated and those that should not. This strategy is also child-driven and teaches the caregiver to follow the child's play interests and respond by mirroring back these playacts. These skills maintain the play routine for longer intervals of time by prioritizing child-led play and providing a structure for the adult and child to engage in turn-taking, which increases the length of overall joint engagement between adult and child. Joint engagement is important for child learning. When children and adults share a mutual focus of attention and engage in longer periods of play together, there are more natural opportunities for communicative interchanges and when the adult joins into the child's motivation by imitating it serves as a form of social reinforcement for the child's initiation of play. Environmental arrangement, while a strong predictor of joint engagement, only trended in the mediation analysis. Therefore, although we can show that an increase in environmental arrangement is linked with an increase in joint engagement, we do not have enough evidence to claim that this change is a direct effect of JASPER.

JASPER strategies are based within models of typical development. Contingent responding, imitating, modeling, and expanding child actions are all firmly situated in typical parent–child interactions (Snow, 1977). The difference between dyads of parents with typically developing youngsters and children with ASD is that many of the behaviors naturally shared between child and parent may be disrupted for dyads containing a child with ASD (e.g., Kasari & Sigman, 1997). Teasing apart the specific behaviors parents' use to successfully engage their children can be helpful to identify what to teach when there are impairments in joint engagement. The results of this study suggest that several strategies support joint engagement in children with ASD, but mirrored pacing appears to be an underlying mechanism of change.

As JASPER is based on a typical developmental model, involving both developmental and behavioral strategies to effect change in children, it falls within a category of behavioral interventions, now labeled Naturalistic, Developmental, Behavioral Interventions (NDBI; Schreibman et al., 2015). Undoubtedly, several other NDBI models involve similar strategies to JASPER, but one difference is the consistency in which JASPER studies have yielded significant effects on core impairments, whether mediated by therapists, parents or teachers (Kasari, Gulsrud, Freeman, Paparella, & Hellemann, 2012; Kasari, Paparella, Freeman, & Jahromi, 2008; Kasari et al., 2006, 2014, 2015). Future studies testing active ingredients of these various models will be important to determine if mirrored pacing, in particular, is an active ingredient across multiple models of early intervention.

Testing mediation in a rigorously conducted treatment trial seems a plausible way to better understand the current treatments available to young children with ASD and their families and assist in the development of future empirically informed treatments. To our knowledge, only one other study has formally tested mediation in a treatment trial for young children with ASD. This study found that parental synchronized communicative acts mediated the relationship between treatment and the primary target of autism symptomatology as rated on the Autism Diagnostic Observation Schedule (ADOS; Aldred, Green, Emsley, & McConachie, 2012). Parental synchronicity of language has been found to play a role in young children's language development and draws the most parallel to the communication strategy in the JASPER intervention. Future work should explore how specific parental strategies within JASPER may target different areas of child development (e.g., language, cognition, play).

This study is one of the first to formally test potential active ingredients of a well-defined and empirically supported treatment for young children with autism spectrum disorder. Mirrored Pacing proved to be an active ingredient in the maintenance of joint engagement, a primary outcome of the JASPER intervention. Future studies should explore a wider range of treatment targets and outcomes to better tailor treatments and provide the most potent combination of ingredients for optimal gain in children with ASD.

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Key points

- Intervention can be isolated and measured.
- All parents increased in their use of intervention techniques, but the active treatment group increased to a significantly greater degree.
- Parent strategies were related to the primary outcome of joint engagement.
- One of the parent strategies, Mirrored Pacing, mediated the relationship between treatment, and the primary outcome suggesting its role as an active ingredient of treatment.

Table 1

Participant characteristics

Child and parent characteristics: *N* (%)	**JASPER (*N* = 43)**	**PEI (*N* = 43)**	**Total**	**Test**	***p***
Chronological age (months): mean (*SD*)	30.7 (3.5)	32.3 (2.7)	31.5 (3.2)	$F(1,84) = 6.3$	<.01
Gender					
Female (%)	8 (19)	8 (19)	16 (19)	$\chi^2(1) = 0.0$	1.00
Race/ethnicity					
African American (%)	0 (0)	2 (5)	2 (2)	$\chi^2(4) = 4.5$	.34
Caucasian (%)	27 (63)	26 (60)	53 (61)		
Hispanic (%)	3 (7)	4 (9)	7 (8)		
Asian/PI (%)	4 (9)	6 (14)	10 (12)		
Other (%)	9 (21)	5 (12)	14 (17)		
Mullen early learning composite: mean (*SD*)	68.0 (20.3)	68.1 (20.6)	68.0 (20.3)	$F(1,84) = 0.0$	.98
Age of parent	36.9 (4.4)	34.9 (4.7)	35.9 (4.6)	$F(1,83) = 3.9$	.05
Parental education (years): mean (*SD*)	17.2 (2.3)	16.4 (2.6)	16.8 (2.4)	$F(1,84) = 2.6$	.11
PSI child	85.3 (20.5)	87.2 (19.7)[a]	86.2 (20.0)	$F(1,83) = 0.2$	.66
PSI parent	53.4 (30.2)	52.6 (33.6)[a]	53.0 (31.7)	$F(1,83) = 0.1$	.91

PEI, psychoeducational intervention; JASPER, joint attention, symbolic play, engagement, and regulation; PSI, Parental Stress Index.

[a]one of the participants has no PSI, $N = 42$.

Table 2

Changes in strategy use

	PEI Entry	JASPER Entry	PEI Exit	JASPER Exit	PEI Change	JASPER Change	
Environmental arrangement	0.70 (.13)	0.70 (.14)	0.73 (.12)	0.89 (.10)	0.02 (.19)	0.18 (.18)	$F(1,81) = 14.1$ $p < .01$
Mirrored pacing	0.31 (.28)	0.32 (.22)	0.39 (.30)	0.67 (.25)	0.09 (.32)	0.35 (.32)	$F(1,81) = 14.1$ $p < .01$
Prompting	0.47 (.13).	0.47 (.14)	0.50 (.17)	0.68 (.24)	0.03 (.21)	0.21 (.26)	$F(1,81) = 12.1$ $p < .01$
Communication	0.47 (.14)	0.49 (.17)	0.51 (.16)	0.72 (.24)	0.04 (.19)	0.23 (.25)	$F(1,81) = 15.5$ $p < .01$

PEI, psychoeducational intervention; JASPER, joint attention, symbolic play, engagement, and regulation.

Table 3

Hierarchical regression table

	Variables in equation	Potential predictors	Significant predictors	R^2	R^2 change	
Baseline variables	-	MSEL ELC	Entry caregiver buy-in	.083	.083	$F(1,74) = 6.74$ $p = .01$
		Reynell Rec Lang				
		Reynell Exp Lang				
		PSI-child				
		PSI-parent				
		Entry caregiver buy-in				
Study engagement	Entry caregiver buy-in	Days to completion	Exit caregiver involvement	.162	.082	$F(1,73) = 7.13$ $p < .01$
		Exit caregiver involvement				
Strategy use	Entry caregiver buy-in	Entry EA	Entry EA	.409	.244	$F(3,70) = 9.66$ $p < .01$
	Exit caregiver involvement	Entry MP	Change EA			
		Entry Prompt	Change MP			
		Entry Comm				
		Change EA				
		Change MP				
		Change Prompt				
		Change Comm				
Other treatment effects	Entry caregiver buy-in	Treatment	Treatment	.549	.140	$F(1,69) = 21.29$ $p < .01$
	Exit caregiver involvement					
	Entry EA					
	Change EA					
	Change MP					

MSEL, The Mullen Scales of Early Learning; ELC, early learning composite; PSI, Parental Stress Index; EA, environmental arrangement; MP, mirrored pacing; Prompt, prompting; Comm, communication.

Table 4

Mediation table

	A	b	c	C'	z	p
Tx-EA-joint engagement	0.384	0.105	0.68	0.638	1.13477595	.26
Tx-MP-joint engagement	0.389	0.262	0.68	0.577	2.366277878	.02