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Parents' Adoption of Social Communication Intervention Strategies: Families Including Children with Autism Spectrum Disorder Who are Minimally Verbal

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Abstract

Notably absent from the intervention literature are parent training programs targeting school-aged children with autism who have limited communication skills (Tager-Flusberg and Kasari in Autism Res 6:468–478, 2013). Sixty-one children with autism age 5–8 with minimal spontaneous communication received a 6-month social communication intervention including parent training. Parent–child play interactions were coded for parents' strategy implementation and children's time jointly engaged (Adamson et al. in J Autism Dev Disord 39:84–96, 2009). Parents mastered an average of 70 % of the strategies. Further analyses indicated some gains in implementation occurred from mere observation of sessions, while the greatest gains occurred in the first month of active coaching and workshops. Children's joint engagement was associated with parents' implementation success across time demonstrating parents' implementation was relevant to children's social engagement.

Keywords

Parent training; Autism; Minimally verbal; Intervention; Coaching

Introduction

Children have numerous interaction partners including parents, teachers, and peers who are fundamental to the provision of daily, high-quality learning opportunities. Whereas teachers and peers may come and go, parents have the unique ability to influence a child over the course of many decades. In recognition of this pivotal role, parent- mediated intervention and training programs have been developed (Roberts and Kaiser 2011). Specifically for children with autism, a body of literature has examined a variety of tools and programs that parents can implement to support their child's development (e.g., Kasari et al. 2010). Yet, few of these studies systematically explore what parents learn within these programs and how parents' learning can then influence their children's outcomes (Patterson et al. 2012). Further, very few studies explicitly target the population of children with ASD who demonstrate some of the most severe delays in communication, those who are minimally verbal (i.e., use less than twenty spontaneous functional words: Tager-Flusberg and Kasari 2013).

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Importance of Parent–Child Interaction: Implications for Development

A social pragmatic view of development emphasizes the significance of social exchanges between the child and caregiver as the central context for learning (Tomasello 2001). For example, how parents engage their children in daily social interactions can influence communicative development for both typically (e.g., Brady et al. 2004) and atypically developing children (e.g., Mahoney and Perales 2003). Yet children with autism demonstrate a constellation of factors that may make entering into and maintaining a high quality interaction difficult for a parent, influencing both the amount and quality of children's learning opportunities (Luyster and Lord 2009). For example, it is well established that children with autism demonstrate early deficits in joint attention and other social communication skills that impact the child's awareness of others and their ability to coordinate attention between a partner and a shared referent (Mundy et al. 1990). Compared to matched samples of typical and atypically developing children, young children with ASD have been found to spend 20–30 % less time jointly engaged with caregivers (Adamson et al. 2009). Joint engagement provides a unique context for learning whereby a parent may scaffold a child's emerging skills within a shared attentional focus (Kasari et al. 2008). Yet, children with autism spend limited time jointly engaged. Related to these delays are the tendencies for children with ASD to make fewer social initiations (Mundy et al. 1990) and to reject more of their parents' bids for interaction (Adamson et al. 2001) than typically developing children. The cumulative effects of this impoverished social learning environment on the development of a child who is experiencing significant communication challenges are not well understood. Thus, it is necessary to explore how parents learn to facilitate shared interactions with their children with ASD who have limited spoken language.

Children with Autism Who are Minimally Verbal

It is estimated that 25–30 % of children with ASD are minimally verbal (i.e., <20 functional spoken or augmented words: Tager-Flusberg and Kasari 2013) at school entry (Anderson et al. 2007). Describing children with few spontaneous functional words as minimally verbal acknowledges that many children may produce some words, however, these words may be rote, routinized, or restricted to certain contexts limiting their communicative function. Very little is known about the communicative or more global development of children with autism who are school-age but have minimal expressive language due to the limited literature examining this specific subgroup. In a review of studies including children with autism who are minimally verbal, authors Pickett et al. (2009) identified 167 participants who acquired speech skills at age five through age thirteen. This finding demonstrates that children who are minimally verbal are acquiring important core skills in their school years, but it is still unclear what factors may influence these gains. Within the past year, two randomized controlled trials have been published examining the influence of targeted language interventions for children with autism who are minimally verbal (Kasari et al. 2014; Paul et al. 2013). With a small sample, Paul et al. (2013) compared two language interventions, finding gains for both groups in parent-reported communication. Kasari et al. (2014) documented gains in socially communicative utterances for school-age children with autism who are minimally verbal and superior gains for those who were randomized to have access to a speech-generating device. Together, these studies provide evidence that children with

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ASD who are minimally verbal can make gains in spoken language through targeted interventions.

Parent Training Programs and Fidelity of Strategy Implementation

Training parents to use intervention strategies is an essential component of intervention programming for children with ASD in order to provide children with consistent, daily support (National Research Council 2001). Recent reviews suggest parents of children with ASD can become effective language facilitators through parent training (e.g., Patterson et al. 2012). In addition, this learning can positively impact parents' behaviour (e.g., reduce depression, enhance communication style, knowledge of ASD) as well as children's development (e.g., increased spoken vocabulary, augmented communication) (McConachie and Diggle 2007; Thurnberg et al. 2009). Specifically, programs targeting parents' ability to foster a state of joint engagement have demonstrated positive effects on children's early social communication skills (e.g., Kasari et al. 2010), language development (e.g., Kaiser and Hancock 2003), and augmented communication (Adamson et al. 2011). However, less is known about the degree to which parents accurately deliver these interventions during training and over time, specifically with school age-children with ASD who are minimally verbal. Further, the addition of augmentative and alternative communication (AAC) adds another dimension to the interaction. It may be challenging for parents who are not yet fluid AAC users to integrate AAC while providing the same frequency and quality of learning opportunities (Brady et al. 2010). The degree to which the parent adheres to the intervention protocol is an important implementation outcome (Proctor et al. 2011). Although implementation science is in its infancy across the mental health sector, fidelity of intervention implementation is a necessary variable to distinguish implementation effectiveness versus treatment effectiveness as well as evaluate desired clinical service outcomes (Proctor et al. 2011). Documenting implementation fidelity is a necessary, but under-reported component of methodological quality (Lord et al. 2005). Fidelity measures provide information regarding implementation accuracy and protocol adherence (Smith et al. 2007). Meta- analysis of mental health service programming indicates that implementation impacts program outcomes (Durlack and DuPre 2008). However, only a handful of studies have evaluated parents' mastery of the skills presented in parent-training programs for families of children with ASD (e.g., Coolican et al. 2010; Rogers et al. 2012); these studies report mixed outcomes across a range of intervention practices (Patterson et al. 2012). Therefore, detailed examination of parents' accurate adoption of intervention strategies in randomized intervention trials is necessary.

The Current Study

Overall, the existing body of literature on parent training programs includes limited detailed examination of parents' strategy adoption, their ability to accurately and flexibly deliver high quality intervention over time, and the relationship between parents' increasing skills and children's outcomes. In addition, the literature examining parent training and the literature examining joint engagement both largely focus on toddlers and preschool age children, leaving the needs of school-age children who remain minimally verbal largely unexamined. Children with ASD who are minimally verbal are underrepresented in both the parent-training literature and larger intervention literature. Therefore, the primary aim of the current

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study was to examine the degree to which parents of school-age children who are minimally verbal adopt and successfully implement a targeted social communication intervention (Kasari et al. 2010; Kaiser and Hancock 2003). Data for the current study come from a randomized trial evaluating a social communication intervention versus the same intervention plus a speech-generating device (primary language outcomes data presented elsewhere (Kasari et al. 2014). Parents were able to observe the intervention for the first 3 months (stage 1) and then received 3 months of coaching (stage 2). We hypothesized that parents may demonstrate a small increase in accurate strategy implementation in stage 1 where they only observe the clinician work with their child. We then expected greater gains in parents' implementation during stage 2 as they received coaching. We also anticipated that parents of children in the intervention condition including AAC who needed to learn how to navigate the speech-generating device (SGD) in addition to the intervention may demonstrate less successful implementation than those in the spoken language only condition who only learned the intervention strategies. In addition, a secondary aim of this study was to examine the association between parents' intervention implementation success and children's joint engagement over the course of the intervention. We hypothesized that parents' increasing implementation success over time would be associated with children's total time jointly engaged.

Methods

Participants

Children—This study includes 61 children who were enrolled in a larger, multisite intervention study where each site complied with standards set by the university's Institutional Review Board (IRB). Families were screened by phone and those who appeared to meet inclusion criteria via parent report were invited to the clinic for assessment where the consent process was conducted with the parent by the study coordinator. Included children were: (a) 5–8 years of age; (b) diagnosed with an autism spectrum disorder by an outside party (confirmed by the study team using the Autism Diagnostic Observation Schedule: ADOS; Lord et al. 1999); (c) not diagnosed with any other sensory or genetic disorder (e.g., seizure disorder); (d) minimally verbal (less than 20 functional spoken expressive words); (e) received early intervention, and (f) able to demonstrate a nonverbal developmental age of at least 24 months on 2 of 3 standardized language and cognitive measures. On average, children were 6.31 years of age (*SD* = 1.16) with a mean nonverbal age equivalent score of 4.00 years (*SD* = 1.12) on the Leiter International Performance Scale Revised (Leiter-R: Roid and Miller 1997). The Leiter-R is a standardized test of nonverbal intelligence consisting of a visualization and reasoning battery, as well as an attention and memory battery. The assessment does not rely on spoken language making it particularly suitable for children with minimal spoken language. In addition, children's language skills were measured using the Test of Early Language Development-3 (TELD-3: Hresko et al. 1981) and the Peabody Picture Vocabulary Test-4 (PPVT-4: Dunn and Dunn 1997). The TELD-3 is a standardized assessment of expressive and receptive language capturing children's skills from age 2.0 through 7.11 years. The assessment includes an array of objects and pictures delivered with verbal instructions. The PPVT-4 consists of an array of pictures where children are asked to identify items within the picture array by pointing in

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order to evaluate children's receptive language skills. Overall, children's language skills were limited with an age equivalent expressive language mean of 1.73 years (*SD* = 0.39) as measured by the TELD-3. In addition, children obtained age equivalent receptive vocabulary scores of 2.64 years (*SD* = 0.67) on the PPVT-4 and receptive language scores of 2.03 years (*SD* = 0.62) on the TELD-3. Children demonstrated an average of 17.23 (*SD* = 16.44) different words at entry during a natural language sample (NLS) where the child engaged in play with five standard sets of objects (e.g., playdough, blocks, and cars) with an unfamiliar and blinded assessor. Five children demonstrated slightly more than 20 words; they were included due to low intelligibility and predominance of scripted language. Parents identified their children as Caucasian (*n* = 29), Asian American (*n* = 12), African American (*n* = 14), Hispanic (*n* = 3), and multiracial (*n* = 3). Parents reported that children had received 2–3 years of intervention typically including speech therapy and interventions based in applied behaviour analysis. Six families failed to complete intervention and dropped out after three of the 6 months of intervention due to undesired randomization (*n* = 2) and scheduling issues (*n* = 4). Consistent with Intent to Treat Analyses, data from these participants were included and families were asked to return at study exit and follow up for assessments (*n* = 2 returned). Fifty-two children completed the 6-month intervention and 45 completed a parent–child interaction at follow up. Attrition was not significantly different by treatment arm.

Parents—Families were asked to select one caregiver who would participate in the coaching. Additional caregivers were welcomed to observe sessions and workshops, but they did not receive coaching to ensure that all target caregivers received the same amount of coaching. Target caregivers (*n* = 61) included 51 mothers and 10 fathers for which demographic data was available for 59 caregivers. Target parents ranged in age from 28 to 46 years (*M* = 38.72 years, *SD* = 4.91 years). The majority of parents (*n* = 22) had completed some college, 20 completed a college degree or special post secondary training, 15 obtained graduate/professional degrees, 1 obtained a high school diploma, and 1 completed junior high school.

Procedures

Intervention—As part of a larger intervention study, families participated in a 6-month novel intervention combining two evidence- based approaches: Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER: Kasari et al. 2010) and Enhanced Milieu Teaching (EMT: Kaiser and Hancock 2003). The unique combination of these two interventions will be referred to as JASP + EMT. The JASP + EMT includes JASPER as an intact, targeted social communication intervention aimed at improving joint engagement, early social communication, and language in the context of developmentally appropriate play. In addition, language facilitation strategies including time delay procedures and milieu episodes (see Hancock and Kaiser 2006) were added from EMT. The interventions work well together as both are naturalistic interventions that incorporate modeling, expansions, and environmental supports to support communicative development. The intervention was provided in university clinic settings. Each child was assigned an interventionist (speech clinician, special educator, or child psychologist). Interventionists' were trained to fidelity prior to beginning sessions with participants. Their ongoing fidelity was monitored by senior

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clinicians at each site and scored by independent raters. Fidelity ratings included core components of JASPER, EMT, and the use of AAC strategies where applicable. Each item was rated on a scale from 1 to 4 (where 1 = strategy not present or inaccurate through 4 = developmentally appropriate strategy that was accurately applied). Interventionists' fidelity of implementation was scored for a random 20 % of sessions across sites, participants, and time points (M = 93.80 %).

Design—The larger study used a Sequential Multiple Assignment Randomized Trial design (SMART: Murphy 2005), which included two stages of treatment. SMART designs are used to develop adaptive treatment protocols where the sequence of treatment is adapted based on each individual's response to treatment where participants may be randomized at multiple points throughout the study (Murphy 2005). First, participants were randomized to one of two conditions that differed by the mode of communicative output targeted: either (a) JASP + EMT or (b) JASP + EMT plus augmented communication via a speech generating device which was either a Dynavox or iPad with speech generating application (JASP + EMT + SGD). Stage 1 consisted of 3 months of clinician-child intervention after which children's communicative development was assessed (see Kasari et al. 2014, for procedures). Stage 2 provided adapted treatment based on the child's growth in socially communicative utterances during stage 1 (primary study outcome reported elsewhere: Kasari et al. 2014). Three adaptive protocols were applied including increased intensity of therapist-child intervention for (a) JASP + EMT or (b) JASP + EMT + SGD and the addition of the SGD if the child did not receive one in stage 1. The parent training protocol remained the same across all treatment pathways.

Parent Coaching—Parent coaching interventions were the same across both JASP + EMT and JASP + EMT + SGD arms with the addition of communication modeling and responding via the SGD for those in the later arm. During the first 3 months of intervention (stage 1), the parent observed sessions where the clinician worked directly with their child. All sessions were provided in the clinic where the parent could observe through a one-way mirror. Sessions were 60 min in length and occurred twice a week. Parent coaching began at stage 2, 3 months into intervention. Parent education included: (a) six one-on-one, 1-h content workshops, (b) passive parent coaching, and (c) active parent coaching. All parent-training components were delivered during their child's two weekly sessions; specifically, workshops were delivered every fourth session and all other intervention sessions were dedicated to coaching. Workshops were delivered one-on-one by a trained study interventionist and designed to introduce concepts and strategies that would then be targeted during coaching sessions (see Table 1 for workshop components). This sequence of information was designed to provide basic skills and understanding upon which more complex strategies could be layered. However, interventionists had the flexibility to individualize the content. For example, an interventionist could elect to highlight strategies from later workshops if they were pertinent to the dyad's interaction early on (e.g., modeling and responding to children's joint attention skills) or focus to topics that were more difficult for that dyad to master. Parents were first introduced to the key concepts of JASP + EMT such as understanding the hierarchy of children's engagement (see Adamson et al. 2009), developmental levels of play (see Lifter et al. 1993), and environmental arrangement

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(organization of the materials for play). Parents were taught to identify their child's play level in order to select developmentally appropriate activities and asked to focus on facilitating their child's initiations of communication and play by following the child's lead, arranging materials in the environment, and imitating their child's play and language. Parents were then asked to modify their language to match their child's developmental level by matching the length of their child's utterance. Parents were also asked to comment on their child's play, thereby modeling language that is related to the child's attentional focus rather than ask questions or direct the child's attention. For those in the JASP + EMT + SGD condition, parents were asked to model language as well as respond to the child's language using both spoken and augmented communication. In addition, parents were introduced to strategies to establish repeatable play routines followed by more complex strategies in order to expand play and communication including strategies that make the expectation to communicate more clear (e.g., milieu episode for spoken language or time delay strategies for nonverbal or verbal communication). Parents then practiced these strategies with in vivo support from the interventionist during coaching. Passive parent coaching occurred for two-thirds of each session where the interventionist would deliver the intervention to the child and verbally highlight information for the parent. The final third of the session was comprised of active parent coaching whereby the parent would apply the strategies with their child with support from the interventionist as necessary. Interventionists' coaching fidelity was rated on 20 % of all sessions across all participants (M = 86.22 %, SD = 12.86 %).

Measure—Families completed a 10-min videotaped caregiver-child interaction (CCX) with a standard set of toys (including a ball, blocks, vehicles, dinosaurs, dishes with food, dolls and furniture, drum, puzzle, and shape sorter). Parents were instructed to play with their child as they usually would. This measure was conducted at the four main time points (entry, stage 1, exit, and follow up—see Fig. 1). However, at site 1, caregiver-child interactions were collected at an additional four time points such that data was collected at monthly intervals from entry to exit, as well as 3 month follow up for a total of eight observations.

Caregiver Strategy Adoption and Implementation—The videotaped CCX was taken monthly from entry through follow up (eight videos total) and coded for parents' adoption and execution of the intervention strategies. The implementation protocol includes seven sections, one for each of the six workshops as well as SGD use (if in JASP + EMT + SGD). The scale was composed of 53 items that represent the key components of the intervention across the six workshops (see Table 1 for key topics by workshop and for example items). The six workshops cover the intervention content into a sequence of steps beginning with basic strategies including environmental arrangement and following the child's lead (workshop 1), followed by imitation and modeling strategies (workshop 2). Parents were then introduced to the concept of establishing play routines and talking at the child's target level (workshop 3). Strategies to expand play and language (workshop 4) were followed by methods to facilitate joint attention skills and communication (workshops 5 and 6). Altogether, the implementation scale mirrored the interventionists' clinical fidelity rating scale but included items to add more detail about specific strategies (e.g., one item for

implementation of each of the four time delay strategies rather than one item to represent all of these strategies). Each item was rated using a five point Likert scale where a 1 represented inaccurate or lack of use of that strategy. A mid range score of 3 indicates that parents' were frequently trying the strategy but with the following concerns: (a) they may have failed to use a strategy when necessary and/or (b) they implemented the strategy incorrectly at times. Parents receiving scores of 4 on an item, indicates developmentally appropriate and accurate implementation 60–80 % of the time while high quality, accurate, and appropriate implementation was required over 80 % of the time for a score of 5. Furthermore, a score of 5 is equal to the standard which clinicians were required to meet in order to deliver the intervention.

A parent's total implementation score was obtained through summation of the 0–5 scores from the 53 items. The percentage score was obtained by dividing the total number of points obtained across the items by the total possible score. Two trained, independent raters blind to study time point scored the videos. Raters were trained interventionists and graduate students in human development. Coding discrepancies were resolved through consensus discussion between coders and the principal investigator. Twenty percent of the videos were selected at random across all dyads and time points to be coded for inter-rater reliability. Interclass correlations (ICC) were calculated for each of six workshop sub scores (range = 0.95–1.0).

Child Engagement—The CCX was also coded for children's engagement. An engagement state was defined as three or more consecutive seconds and characterized as one of seven mutually exclusive states reflecting a hierarchy of attention to objects and the parent (Adamson et al. 2009) from unengaged through joint engagement. The study analyses incorporated a composite variable “joint engagement” (JE) including the four joint states: supported joint (SJ), symbol infused supported joint (SJS), coordinated joint (CJ), and symbol-infused coordinated joint (CJS). Supported joint engagement captures periods where the child demonstrates s/he notices both the parent and the shared activity while coordinated joint attention requires that the child use eye contact, gestures, or language to direct the interaction (see further state descriptions and examples in Table 2). In addition, time spent unengaged (UN: no attention to objects or people) and object engaged (OB: focus solely on an object) will be reported. Reliability was established across independent raters where Intra-Class Correlations (ICCs) ranged from 0.84 to 0.99 per state.

Statistical Analyses

To address the primary aim of the study, mixed effects linear models were applied to the four major time points (entry, stage 1, exit, follow up) to explore changes in the parents' total intervention implementation score over the course of intervention and the follow up period between intervention conditions (JASP + EMT and JASP + EMT + SGD) or among the three sites. Time was split into three segments that were selected to coincide with changes in study stage. In addition, children's time jointly engaged was included as a time varying covariate to examine the secondary aim of the association between parents' level of adoption and accurate execution of intervention strategies and the time children spent jointly engaged with their parent. Further, a second piecewise linear mixed model was applied to

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the data from site 1 to provide a more detailed examination of the progression of parents' adoption of the strategies over time including this site's additional four time points.

All randomized dyads are included in the primary analysis, in accordance with the intention-to-treat principle. We reported the effect size (ω^2) at week 24 (end of intervention) where effect sizes of 0.01, 0.059, and 0.138 are generally regarded as small, moderate, and large respectively (Kirk 1996).

Results

Parents' Intervention Implementation Success

At study entry, parents used a range of strategies to engage their children in play (see Table 3 for entry means). Parents primarily used verbal prompts and questions to recruit their child's attention to an activity where they then modeled actions on those objects as evidenced by low scores for appropriate prompting in workshop 5 (entry M = 24.30 %). Parents rarely imitated their children's actions and inconsistently responded to their children's communication and play, leaving many of the children's bids to request or to share unanswered. Instead, parents elected to redirect the child to an activity or action chosen by the parent (entry fidelity M = 45.59 %). On average by study exit, parents' strategies had shifted in line with information presented in JASP + EMT. Overall, mean values at entry and exit demonstrate an increase in parents' total implementation (M = 69.75 %, SD = 11.93 %). These scores indicate that most parents made gains in their appropriate implementation of the JASP + EMT strategies achieving an average of 70 % mastery which is 10 % under the standard required of study clinicians. At 3-month follow up, parents' overall implementation success dropped by roughly 10 % (M = 61.38 %, SD = 11.05 %). The criteria used to assess parents' implementation in this study were stringent. Parents were held to the same standard as the trained interventionists who delivered the intervention within the study.

Parents' Implementation Success by Workshop

Parents' total implementation score is comprised of 53 items subdivided into six topical workshops. See Table 3 for mean workshop scores over time. Mean scores indicate that by study exit, parents had achieved greater mastery of the material presented in some workshops than others. Highest mean scores were achieved for workshops 1, 2, 3, and 6, while the lowest mean scores were found for workshops 4 and 5. At follow up, mean scores indicate relatively evenly distributed decreases across workshops with more variability found in scores for workshops 3 and 5. Parents demonstrated variability in skills related to workshop 3 content including establishing routines and matching children's rate and length of talk, as well as workshop 5 content including strategies to elicit language and play acts (e.g., time delay strategies).

SGD

For families enrolled in JASP + EMT + SGD (n = 31), parents' accurate use of the SGD as per the study protocol was measured in addition to their understanding of the base JASP + EMT strategies (see Table 3). To achieve an implementation score of over 80 %, parents were required to keep the SGD in reach and use the SGD when: modeling language (at least

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25 % of the time); expanding children's language (at least 50 % of the time); (c) responding to their child's augmented communication (at least 80 % of the time). This type of responding was designed to supplement spoken language by providing augmented input through language models and expansions without demanding output from the child (Romski et al. 2011). Mean scores at exit indicate that parents made limited use of the SGD (*M* = 15.77 %, *SD* = 17.90 %).

Children's Joint Engagement

Children's mean time jointly engaged increased from study entry through exit. In addition, mean values for both unengaged and object focused states decreased over time. Joint engagement decreased somewhat at follow up with increases in time unengaged and time focused on objects. See Table 4 for mean values for children's engagement at study entry, exit, and follow up.

Treatment Group

The data were also examined for differences in parents' implementation success between intervention conditions (JASP + EMT vs. JASP + EMT + SGD). Although it was hypothesized there would be group differences in parents' implementation, mixed ANOVA models demonstrated that there was no significant interaction between time and treatment condition for parents' implementation scores (p = .82). As such, treatment condition was not included as a parameter in the models to follow.

Linear Models: Parents' Implementation Success Over Time and Across Sites

Descriptive statistics were conducted to ensure that statistical assumptions were met for linear mixed models. A longitudinal mixed model including all 61 dyads was conducted to examine the association between parents' successful implementation of the strategies and the total amount of time children spent in a joint engaged state (JE). A model was constructed with parents' total implementation score (percentage) as the outcome:

$$\begin{aligned}\text{Implementation success}_{ij} = {} & \alpha_0 + \alpha_1 \text{time}_{ij} + \alpha_2 (\text{time}_{ij} - 4)_+ \\ & + \alpha_3 (\text{time}_{ij} - 7)_+ \\ & + \alpha_4 \text{site} + \alpha_5 \text{site} * \text{time}_{ij} \\ & + \alpha_6 \text{site} * (\text{time}_{ij} - 4)_+ \\ & + \alpha_7 \text{site} * (\text{time}_{ij} - 7)_+ \\ & + \alpha_8 \text{JE}_{ij} + \beta_i + \varepsilon_{ij}\end{aligned}$$

Within this repeated measures model, the four major time points were separated into three separate segments [time 1 (entry) to time 4, time 4- time 7 (exit) and time 7 to time 10 (follow up)]. Significant interactions were found between site and time during the intervention period including time 1–4 which represents the first half of treatment where parents only observed a clinician ($F(1,89) = 5.67$, $p < .01$) and time 4–7 which represents the 3 months of parent training ($F(1,89) = 13.18$, $p < .01$). No significant interaction was found during the follow up period from time 7–10 (p = .82) (Fig. 2).

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Post hoc comparisons were conducted to further explore site by time interactions. Comparisons indicate dyads from site 1 made significant change from time 1–4 ($F(1,89) = 5.23$, $p < .01$) while increases made by dyads at the other two sites were not significant. However, once parent training commenced, parents at all three sites made significant increases in their accurate adoption of the strategies (site 1: $F(1,89) = 5.53$, $p < .01$; site 2: $F(1,89) = 8.48$, $p < .01$, site 3: $F(1,89) = 10.35$, $p < .01$). Further exploration of site differences from time 4–7 indicate that parents' rate of change during parent training was significantly greater for dyads at site 2 ($F(1,89) = 3.72$, $p < .01$) and site 3 ($F(1,89) = 4.58$ $p < .01$) than site 1. Together, these findings indicate that parents at site 1 made significant gains in their adoption and accurate implementation of intervention strategies through observation. In addition, on average, parents across all sites made gains once coaching commenced. A separate analysis revealed no significant differences in implementation amongst the sites at the end of the intervention ($F(2,50) = 1.13$, $p = 0.33$; effect size: $\omega^2 = 0.005$).

Exploring Site Differences: Child and Parent Characteristics—To explore the "site" variable, differences amongst sites in mean values for parent education level, children's non-verbal IQ (NVIQ: Leiter age equivalent score), and children's receptive language (TELD receptive age equivalent score were examined. A one-way ANOVA was applied to children's NVIQ and receptive language scores. No significant difference was found for NVIQ ($p = .40$); however, a significant difference was found for receptive language ($F(2,58) = 5.72$, $p < .01$). Post-hoc contrasts with a Bonferroni correction applied for multiple comparisons indicated significant differences between sites 1 and 2 only ($p < .01$) where children at site 1 had a higher mean receptive language score. Further, a Kruskal–Wallis test was applied to parents' level of education (ordinal data). No significant difference amongst sites was found at entry ($p = .17$).

Joint Engagement—In addition, children's total time jointly engaged was included as a time varying predictor to examine the association of children's changing joint engagement with parents' changing success in strategy implementation over time. The model demonstrated that the duration of children's JE ($F(1,89) = 42.97$, $p < 0.01$) was significantly associated with parents' total implementation success at all time points.

Exploring Differences in Parents' Implementation: Children's Response to Intervention

Based on change in children's frequency of social communicative utterances, children were considered responders ($n = 41$) or slow responders ($n = 11$) to treatment by stage 1, prior to the introduction of parent training (see Kasari et al. 2014, for procedures and treatment outcomes). Descriptive statistics for parents' total implementation score for responders ($M = 69.75$ %, $SD = 11.93$ %) as compared to slow responders ($M = 68.75$ %, $SD = 7.36$ %) at study exit indicate nearly no difference between the groups on average.

Secondary Linear Model: Further Exploration of Change over Time

To further explore parent's accurate adoption of the strategies over the course of the intervention, a secondary analysis was constructed using the monthly time points for the 24 dyads enrolled through site 1 for a total of eight observations. The model includes eight time

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points including seven monthly interactions and one interaction at the 3 month follow up. Time was separated into the same three segments as the main model and an additional segment to represent the first month of parent training (time 4–5). Altogether, four distinct trends in parents' learning were found. Parents demonstrated a significant increase in their understanding and application of the strategies through observation from time 1–4 ($F(1,132) = 4.60$, $p < .01$). Second, the steepest increase in parents' learning occurred in the first month of coaching from time 4–5 ($F(1,132) = 4.10$, $p < .01$) while implementation scores then remained relatively stable and on average did not change significantly from time 5–7 ($p = .88$). Last, successful strategy implementation decreased slightly, but significantly, from treatment exit to follow up ($F(1,132) = -4.04$, $p < .01$). Overall, this model demonstrates that the rate at which parents learned to accurately and appropriately implement the strategies varied based on the type of training (observation vs. coaching). Parents did learn from observation alone, but the greatest gains occurred in the first month of coaching with increases tapering off over the last 2 months.

Discussion

Using a novel study design and including multiple methods to support caregivers' learning, this study yielded three main findings. First, parents who delivered more of the treatment strategies with fidelity were more successful in jointly engaging their children in interactions. Particularly for children with this profile (fewer than 20 functional words and over 70 % of time unengaged or object focused at baseline), the improvements in engagement were both statistically and clinically significant. While there was great variability in improvements in joint engagement, on average, dyads increased by half a standard deviation. Increasing the amount of time children spend jointly engaged in an interaction is critical to create a context for parents to help increase their children's social communication skills.

Second, this approach to parent training yielded information about the timing of parents' gains in knowledge of the intervention strategies that resulted in improved adoption and implementation of the intervention. In this three-site study, a phased approach was implemented to involve parents in the treatment. During stage 1, the therapist worked directly with the child. The parent was encouraged to watch sessions through a one-way mirror. During stage 2, parents received a combination of parent education (via workshops that covered treatment strategies) and hands-on coaching. Parents' mastery of the JASP + EMT strategies increased the most during the second stage of parent training in which both parent education and parent hands-on coaching took place.

In order to better understand the timing of parents' accurate adoption of the intervention strategies, a closer examination of parent interactions with their child was implemented at one site that collected monthly interaction sessions over the 6-month intervention and 3-month follow up. These data yielded further information on the timing of parent understanding of the intervention. Results at this site indicated that parents actually learned some of the intervention strategies from observing the sessions with therapist and child, prior to educational workshops or hands-on coaching. These data are interesting because they indicate that access to just observing their child in intervention can help parents to see

what is and is not working in their child's therapy. The result was increased adherence to the treatment approach before any structured teaching took place. While the direction of effects is unclear (i.e., the child is improving allowing parents to naturally engage more, or observing the therapist provides keys to strategy use) future studies may consider deliberately examining this process of strategy adoption via observation.

Although gains were made through observation, the greatest increase in adherence to the treatment occurred in the first month of study stage 2. Stage 2 began with the introduction of parent workshops 1 and 2 along with passive and active in vivo parent coaching with an interventionist. This combination of explanation of the strategy by the clinician (i.e., why use the strategy and when to use the strategy appropriately, etc.,) and the opportunity for parents to engage in guided practice using the strategy with their own child with immediate feedback led to rapid growth in treatment adoption and implementation.

Growth in treatment implementation slowed after the first month in stage 2. At this point, parents were introduced to more complex strategies including expanding children's play routines. In particular, parents struggled to apply the content from workshop 4 which focused on appropriate expansion of children's play. Although some parents demonstrated appropriate and flexible implementation of this complex strategy and obtained a score of 4 on items captured in this workshop (n = 11), many struggled to obtain an average of approximately 17 % mastery (SD = 32.14 %) at study exit. A play expansion provides the child with an additional play act that the child may incorporate into the existing play routine. In addition to maintaining engagement, expansions are designed to increase play diversity and flexibility, as well as provide opportunities for the parent to model new vocabulary. For example, if the child makes the bed and then puts the doll to sleep, an expansion of this routine could include waking the doll up. Timing of the application of a play expansion is critical. If an expansion occurs too early in the interaction, the act can disrupt the play routine and break the state of joint engagement. Expansions are a necessary clinical strategy used in order to increase the duration of time the child is jointly engaged in the play interaction as well as support the elaboration of children's play repertoires. However, due to the dynamic nature of play and engagement, expansions that are appropriate and well-timed such that they facilitate, rather than hinder engagement and play, can be challenging to introduce. In order to increase parents' success with this complex strategy, parents may benefit from increased practice time with immediate live feedback from a clinician in order to develop a flexible understanding of the strategy.

This notion of equipping caregivers, such that they can deliver flexible and dynamic support as the needs of their children change day to day and over time applies to not only expansions and other complex strategies, but also to the package of strategies as a whole. Parents who exited the study with an average total intervention implementation score of 70 % were obtaining an average score of 4 of 5 on individual items. In order to increase the consistency and density of learning opportunities provided by the parent, many caregivers could continue to benefit from support to identify moments where they can incorporate complex strategies such as play expansions. An increase in time spent in active rather than passive coaching would allow more time during months two and three to practice using complex strategies to support parents' ongoing success with the JASP + EMT strategies across

activities. In addition, brief booster sessions provided on a consultative basis and fading over time may also help some parents to navigate the transition of strategies to home, troubleshoot new challenges, and advance skill targets that arise once formal coaching supports have ended. As in vivo coaching requires clinical resources, future studies may want to explore alternative methods for delivering booster sessions or as needed consultations. Some potential solutions may be through the use of message boards, web-based consultations, or smart phone delivery of support.

Two other points about this study are in order. First, there were no differences in JASP + EMT implementation with or without the addition of the SGD. Four specific items in the parent fidelity measure examined use of the SGD. On average, these scores indicate that parents within the JASP + EMT + SGD group did not learn to proficiently use the SGD. Rather, parents tended to model and expand their children's language using purely spoken responses rather than respond with both spoken and augmented communication. In addition, parents tended to respond to their children's augmented communication with spoken language only. This lack of use of the device when modeling language and responding to children's spoken and augmented language led to low strategy use scores on the SGD items. Only three caregivers communicated frequently using the SGD during the play interaction. It is notable that the three caregivers with the highest implementation scores for SGD use (at 40, 50 and 75 % respectively) had children who frequently used the SGD functionally to communicate within the interaction (approximately one-third to one half of their utterances were delivered via the SGD while others did not use the SGD or used it with limited frequency) while caregivers within the remaining dyads demonstrated very low use of the SGD (M = 11.3 %). This preliminary descriptive data suggest that children who use the SGD for much of their communication were part of dyads with caregivers who made the most frequent use of the SGD. The direction of this effect requires further exploration.

A second point concerns the interactive profile of children who are school-aged and minimally verbal. Comparison of the duration of time spent engaged in shared attention by this population to a sample of younger, typically developing children exemplifies the severity of the challenges experienced by these children. Typically developing children of similar language abilities to the current sample have been found to spend an average of 75 % of 30 min long interactions jointly engaged (e.g., Adamson et al. 2009). However in this sample at baseline, children were mostly unengaged with their parents. The children spent more than 70 % of the interaction unengaged or engaged only with an object. In addition, children changed engagement states up to 86 times during the 10-min interaction. The lack of stability in the children's engagement and large amount of time spent either unengaged or stuck on objects creates a difficult situation for the social partner to navigate. However, with intervention, parents were better able to engage their children in interactions and made gains in the amount of time children shared their attention in a state of joint engagement. Study findings including joint engagement as a time varying covariate demonstrate the link between parents' greater strategy use and higher engagement.

Conclusion

Overall, parents were able to successfully apply JASP + EMT intervention strategies to support their school- age children with autism who are minimally verbal. Findings suggest that some parents began to adopt and apply the JASP + EMT strategies after only observation of their child with his/her interventionist while on average, parents made their greatest gains through direct coaching. Close examination of the process of parent training in this population indicated that parents' greatest gains in strategy use occurred during the first month of coaching. Altogether, these data suggest that while hands on training may be most effective, parents appeared to benefit from a variety of approaches including observational learning, didactic workshops, as well as both passive and active coaching. Future studies may further examine the active ingredients of parent training to determine the best combination of approaches for individual families, and to successfully personalize the intervention process for families of children with ASD who are minimally verbal.

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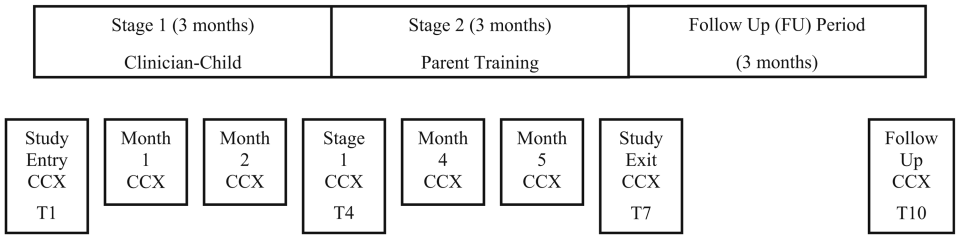

Fig. 1. Parent training sequence and CCX measures

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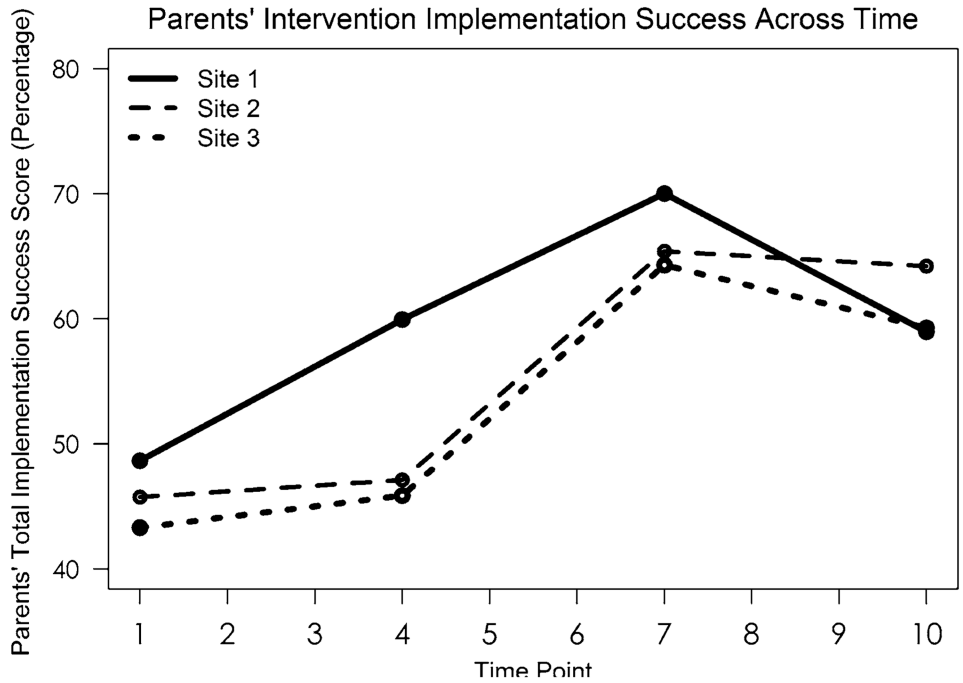

Fig. 2. Parents' successful strategy implementation across time by site

Table 1

Parent workshop content

Workshop	Description
1: Introduction to the intervention	Information regarding purpose and key components of the intervention
	Introduction to children's engagement states
	Basic strategies: environmental arrangement, following child's lead and responding to children's behaviour
	Example item: Parent notices child's toy choice and joins in
2: Mirroring and mapping	Focus on imitation and modeling language
	Focus on imitation and modeling appropriate play actions
	Example items: Plays with toys in the same way as the child (imitates); timing of play models is appropriate
3: Establishing play routines and target language	Introduction to play routines and strategies to develop play routines
	Child's language targets and appropriate language for play routines
	Example items: Parent models language relevant to child's attentional focus; play routines have consistent steps
4: Expanding language and play routines	Define appropriate play and language expansions for the child's play and language level and strategies for expanding play routines
	Example item: Additional toys are moved into the child's attentional focus to support the child's initiation of play expansions
5: Joint attention and time delay strategies	Focus on joint attention gestures-modeling and strategies to facilitate children's use of joint attention gestures
	Introduction to time delay strategies including waiting within routines, assistance, providing choices and inadequate portions
	Example item: Parent notices and responses to child initiations of joint attention and requests
6: Milieu Episodes	Focus on milieu episode prompting hierarchy for child communication
	Determining appropriate opportunities to use milieu episodes
	Example item: Prompt occurs only in response to a child's request or embedded in a routine

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Table 2
Engagement state descriptions: adapted from Adamson et al. (2009)

Engagement state	Definition
Supported joint (SJ)	Child and parent are actively engaged in a shared referent. The child is aware of the parent's participation (e.g., notices parent's actions on object and child joins in the play; child and parent are actively taking turns on an object) but does repeatedly and overtly acknowledge the parents' participation via eye contact
Supported joint with symbols (SJS)	Child and parent are actively engaged in a shared referent and the child demonstrates an awareness of the parent's participation. Additionally, the child acknowledges the parent's use of symbols (e.g., child follows parent suggestion about how to act on an object) or the child uses symbols in reference to the shared activity (e.g., child and parent are rolling a ball back and forth and the child talks about the activity (e.g., “roll ball”) without making eye contact with the parent)
Coordinated joint (CJ)	Child actively and repeatedly acknowledges both the shared activity and the interaction partner through eye contact and gestures (e.g., pointing, showing or giving objects)
Coordinated joint with symbols (CJS)	Child actively and repeatedly acknowledges both the shared activity and the interaction partner through eye contact and gestures (e.g. pointing, showing or giving objects). Additionally, the child responds to or uses language in reference to the shared activity

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Table 3

Mean and standard deviation for parent implementation success by workshop (percent)

	Entry (*n* = 61) *M* % (*SD*)	**Stage 1 (*n* = 55) *M* % (*SD*)**	**Exit (*n* = 52) *M* % (*SD*)**	**Follow up (*n* = 45) *M* % (*SD*)**
Total fidelity	45.59 (7.42)	50.97 (10.79)	69.75 (11.93)	61.38 (11.05)
Workshop 1	59.00 (8.70)	61.74 (12.09)	75.30 (11.79)	71.65 (9.87)
Workshop 2	55.79 (17.48)	63.03 (15.20)	76.08 (13.59)	70.83 (14.92)
Workshop 3	37.13 (12.69)	45.45 (17.54)	67.26 (18.35)	59.23 (15.97)
Workshop 4	5.36 (15.82)	10.68 (26.76)	17.04 (32.14)	20.45 (33.11)
Workshop 5	24.30 (10.16)	30.71 (15.01)	54.86 (19.35)	41.58 (18.73)
Workshop 6	80.64 (21.34)	80.93 (23.89)	86.70 (17.37)	88.15 (17.72)
	n = 29	*n* = 29	*n* = 31	*n* = 28
SGD use	6.55 (12.73)	18.69 (20.47)	15.77 (17.90)	14.44 (15.44)

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Table 4
Mean values and standard deviation for children's engagement in seconds

Engagement	Entry (*n* = 61) *M* (*SD*)	Stage 1 (*n* = 55) *M* (*SD*)	Exit (*n* = 52) *M* (*SD*)	Follow up (*n* = 45) *M* (*SD*)
Duration UN	118.28 s (68.09)	124.24 s (73.49)	130.98 s (95.46)	105.75 s (85.80)
Duration OB	309.86 s (116.45)	305.44 s (110.34)	297.70 s (103.06)	307.57 s (106.02)
Duration JE	118.28 s (68.47)	124.24 s (73.49)	155.52 s (106.62)	131.93 s (87.53)