HHS Public Access

Author manuscript

Autism. Author manuscript; available in PMC 2024 February 01.

Published in final edited form as:

Autism. 2023 February ; 27(2): 443–455. doi:10.1177/13623613221102736.

One Size Does Not Fit All for Parent-Mediated Autism Interventions: A Randomized Clinical Trial

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Abstract

Coaching parents to use language facilitation strategies improves long-term language outcomes for autistic children. To optimize parent-mediated interventions, more studies need to explore factors that influence parents' learning. The current study involved 119 autistic children (18–48 months) and their biological mothers enrolled in a single-site, factorial randomized clinical trial. Mothers were taught to use one of two types of language facilitation strategies (responsive or directive) during eight weekly, hour-long instructional sessions. We explored the impact of (a) type of language facilitation strategy, (b) maternal Broad Autism Phenotype (BAP; subclinical traits of ASD), and (c) pre-intervention strategy use on mothers' outcomes measured immediately and 3-months after intervention sessions. At post-intervention, mothers who learned responsive strategies demonstrated significantly greater use of taught strategies than mothers who learned directive strategies (d=0.90, 95% CI=[0.47, 1.32]). Mothers' use of taught strategies did not differ by BAP status. However, a significant two-way interaction was found between pre-intervention strategy use and BAP status on taught strategy use (F(1,107)=6.04, p=0.016, ΔR^2=0.053). Findings suggest that strategy type, maternal BAP status, and pre-intervention strategy use may be important factors to consider in order to individualize parent-mediated interventions.

Introduction

Social communication, a core deficit of autism spectrum disorder (ASD), is frequently targeted by teaching caregivers to use Naturalistic Developmental Behavioral Intervention (NDBI) (Schreibman et al., 2015) strategies (Sandbank et al., 2020). NDBIs integrate intervention approaches based on both behavioral learning and developmental theories which aim to improve autistic children's social communication and language development in naturalistic contexts (Schreibman et al., 2015). Language facilitation strategies within

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NDBIs correspond to two broad classes: (a) *responsiveness*/synchrony of parent talk to child interests that are informed by developmental theory (McDuffie & Yoder, 2010; Siller & Sigman, 2002), and (b) parent *directives*/prompts for language that are informed by behavioral learning theory (Haebig et al., 2013; Walton & Ingersoll, 2014). Recent meta-analyses of NDBIs found considerable variability in child outcomes across studies (g=−0.18 to g=1.22) (Fuller & Kaiser, 2020; Tiede & Walton, 2019), which may be partly due to variability in parents' use of language facilitation strategies.

One way to understand variability in parent use of language facilitation strategies is to consider the skills necessary for parents to learn and use the different types of NDBIs language facilitation strategies. Responsive language facilitation strategies involve parents learning to: (a) identify the presence of a child communicative act, (b) interpret the function of the child's communicative act, and (c) generate a response that is appropriate to the context and the child's developmental level. Directive language facilitation strategies involve parents learning to: (a) follow a specific sequence of prompting steps, (b) identify the accuracy of the child's response to the directive, and (c) reinforce child target responses and communicative attempts. To date, no parent-mediated language intervention study has examined whether the type of intervention strategy taught to the parent influences their use of language facilitation strategies. This informed the first factor we considered in the study, namely the impact of strategy type on mothers' use of language facilitation strategies.

Other factors to consider are parental characteristics that impact parent-child interactions. Given the dyadic nature of learning during parent-child interactions, it is well established that parent characteristics impact parent-child interactions (Tomasello, 2010; Siller & Sigman, 2002). How and to what extent parent characteristics impact parents' use of language facilitation strategies is less known (Trembath et al., 2019). In fact, a Special Interest Group on Implementing and Evaluating Community-Based Early Intervention of the International Society for Autism Research identified a critical need for evaluation of moderators of parent-mediated interventions (Vivanti et al., 2018). Understanding how parent characteristics impact parents' use of strategies is fundamental to individualizing interventions to meet the needs of parents' learning styles. Two parental characteristics may be particularly relevant to parents' learning to use different language facilitation strategies: the Broad Autism Phenotype (BAP) and parents' natural interaction styles prior to learning language facilitation strategies.

The BAP is a constellation of subclinical language and personality traits which are similar to the core features of ASD and present at elevated rates in first degree relatives of autistic individuals (Losh et al., 2008; Piven et al., 1997; Sasson et al., 2013). The BAP is associated with three primary dimensions that may impact parents' use of language facilitation strategies: aloofness (i.e., reduced interest in social interactions), pragmatic language difficulties (i.e., difficulties with the social use of language) and rigidity (i.e., difficulty responding to change) (Hurley et al., 2007). For example, aloofness and pragmatic language difficulties may influence a parent's communicative insightfulness and thus, make it difficult for a parent to notice and respond to child communicative attempts. In fact, aloofness was associated with lower rates of responsiveness in mothers of children with ASD and maternal pragmatic language difficulties were negatively associated with mothers'

use of linguistic expansions (i.e., expanding a child's communicative utterance to include more complex language) (Flippin & Watson, 2018). In contrast, rigidity may facilitate learning directive prompting strategies which follow a prescriptive and consistent sequence. To date, only one study has considered BAP traits in relation to strategy use within the context of an intervention study (Parr et al., 2015). Findings from this study suggest that the presence of more BAP traits in parents is associated with lower use of responsive strategies following parent instruction. The authors noted several study limitations including the small sample size (n=18) and the time between the assessment of BAP and parent strategy use (8 years). Additionally, the study only included responsive strategies but did not consider the impact of the BAP on parents' learning of directive strategies. Thus, the extent to which BAP is differentially associated with parents' use of specific language facilitation strategies remains unknown.

Another parental characteristic to consider is parents' natural tendency to use specific language facilitation strategies prior to receiving instruction – herein referred to as pre-intervention strategy use. It is possible that parents at various levels of pre-intervention strategy use differentially benefit from instruction (e.g., parents who were already naturally using some strategies with their child before intervention may make more gains than parents who do not naturally use language facilitation strategies). Across parent-mediated intervention studies, pre-intervention strategy use varies considerably, even for the same type of language facilitation strategies. For example, the standard deviations of pre-intervention strategy use range from 14% (Green et al., 2010) to 50% (Aldred et al., 2004). This pre-intervention variability appears to impact parents' post-intervention use of language facilitation strategies, such that smaller variability in parents' pre-intervention strategy use (14%) yields smaller changes in parents' post-intervention use of language facilitation strategies (8%) (Green et al. 2010). In contrast, in a study with larger variability in parents' pre-intervention strategy use (50%), the change in parent use of language facilitation strategies was 20% (Aldred et al., 2004). Although this comparison across studies highlights the potential impact of pre-intervention strategy use on post-intervention strategy use, to date, no study has empirically tested the extent to which pre-intervention levels of parent strategy use moderate strategy use.

Taken together, these findings highlight the importance of considering intervention factors and parent characteristics that contribute to parents' use of language facilitation strategies. Specifically, there is a critical need to: (a) compare parents' immediate and maintained use of different types of language facilitation strategies and (b) examine parent characteristics that moderate immediate and maintained use of language facilitation strategies. The present study is the first factorial randomized clinical trial design to systematically examine: (a) type of language facilitation strategy (i.e., responsive vs. directive strategies), (b) BAP traits, (c) pre-intervention levels of strategy use, and (d) planned interactions between factors that impact parent use of language facilitation strategies (primary outcome) as well as maternal satisfaction, confidence, and feasibility (secondary outcomes). This study considered primary and secondary outcomes at two timepoints – immediately after intervention sessions (referred to as post-intervention) and at a follow-up visit 3 months after intervention sessions (referred to as follow-up). Mothers' immediate use of language facilitation strategies was

measured at post-intervention. Mothers' maintained use of language facilitation strategies was measured at follow-up. The study explored the following research questions:

1. To what extent does mothers' immediate and maintained use of taught language facilitation strategies differ between intervention strategy type (i.e., responsive or directive condition)? We predicted that immediate and maintained use of taught strategies would be greater for mothers in the responsive condition than mothers in the directive condition.
2. To what extent does mothers' immediate and maintained use of taught language facilitation strategies differ between BAP status (i.e., BAP[+] or BAP[−])? We predicted that immediate and maintained use of taught strategies would be greater for BAP[−] than BAP[+] mothers.
3. To what extent does BAP status moderate the effect of type of intervention strategy type on mothers' immediate and maintained use of taught language facilitation strategies? We predicted that (a) immediate and maintained use of strategies would be greater for BAP[−] mothers who learned responsive strategies than BAP[−] mothers who learned directive strategies and (b) immediate and maintained use of strategies would be greater for BAP[+] mothers who learned directive strategies than BAP[+] mothers who learned responsive strategies.
4. Exploratory: To what extent does pre-intervention strategy use moderate the effect of strategy type on mothers' immediate and maintained use of taught language facilitation strategies? To what extent does pre-intervention strategy use differentially affect the moderation of BAP and type of intervention on mothers' use of taught language facilitation strategies?

Methods

Trial Design

This was a single-site factorial randomized clinical trial design (2×2; strategy type, maternal BAP status) of 119 children with ASD and their biological mothers (NCT02632773, clinicaltrials.gov). Study recruitment occurred from January 6, 2016 to March 5, 2020. Enrollment and randomization to experimental condition (responsive, directive) were completed by the project manager. Mother-child dyads were randomly assigned to responsive strategy or directive strategy experimental conditions using block randomization with random block sizes and a 1:1 allocation ratio. Randomization was stratified by child verbal status (control variable) and maternal BAP status. The randomization allocation was computer-generated by the project statistician and could not be accessed by the research team.

Study data were collected and managed using Research Electronic Data Capture (REDCap) databases (Harris et al., 2009). Protocol deviations (PDs) and adverse events (AEs) were documented. No AEs occurred. A summary of PDs is presented in Table S1. The study was approved by Northwestern University Institutional Review Board. All mothers signed a written informed consent. All assessors, interventionists, and coders were trained to

administration fidelity and scoring reliability, such that 80% or above was achieved for three consecutive administrations/ratings during training. Manualized standard operating procedures are available upon request here. Trial child outcomes will be presented in a separate manuscript.

Sample Size

Pretrial power analysis estimated a sample size of n=108 with 80% power to detect an effect size of d=0.54 in strategy use between the responsive and directive condition, respectively. Actual participants included 119 children with ASD and their biological mothers; 111 of whom were randomized, 96 of whom completed assessments immediately after intervention, and 84 of whom completed follow-up assessments three months after intervention (see Figure 1).

Participants

Mother-child dyads were recruited through early intervention providers, ASD diagnostic clinics, and pediatricians. Children were eligible to participate if they had: (a) a diagnosis of ASD based on the Autism Diagnostic Observation Schedule (ADOS-2; Lord et al., 2012), (b) no additional diagnosis that could impact language development, (c) a chronological age between 18–48 months, and (d) no flexible phrase speech as defined by the ADOS-2. Biological mothers were eligible to participate if they (a) used English with their child at least 50% of the time, (b) learned to speak English before 12 years old, and (c) had no additional diagnoses that affected cognition or personality. Inclusion was restricted to these criteria to ensure the validity of the BAP measures. Only mothers were included because: (a) differences in interaction styles exist between mothers and fathers (Flippin & Watson, 2011) and (b) mothers are typically the parent who elects to participate in parent-mediated interventions (Kaiser & Roberts, 2013). Table 1 displays child and mother demographic information.

Strategy Types

Mothers were taught to use responsive or directive strategies during weekly, hour-long, in-home intervention sessions for eight weeks. Both strategy types were taught in the same manner. The first session consisted of a workshop to introduce the specific language facilitation strategies, and each of the seven subsequent weeks followed the standardized Teach-Model-Coach-Review instructional format (Roberts et al., 2014).

Mothers in the responsive condition were taught responsive language strategies that are based on a developmental and transactional model in which language is learned through reciprocal exchanges between adults and children. Mothers in the directive condition were taught directive language strategies based on a behavioral learning theory in which language skills are taught through systematic direct instruction. See Table S2 for strategy definitions.

Intervention Fidelity

The intervention was implemented by a bachelor's or master's-level interventionist. Intervention fidelity assessed the degree to which the interventionist implemented the intervention according to protocol. Ongoing intervention fidelity was monitored for

two randomly selected intervention sessions for each participant throughout the trial. Interventionists were unaware of which intervention sessions would be monitored for fidelity. Interventionist fidelity exceeded 80% for both conditions (Responsive: *M*=96.51%, *SD*=4.08%; Directive: *M*=93.08%, *SD*=5.23%).

The Broad Autism Phenotype

Maternal BAP status (absent [−]; present [+]) was determined at pre-intervention using two measures: (1) the Modified Personality Assessment Schedule-Revised (MPAS-R) (Tyrer, 1988) and (2) the Pragmatic Rating Scale (PRS) (Landa et al., 1992). The PRS and MPAS-R were scored from a videorecording by two raters. Discrepancies between raters were discussed and resolved.

Social (aloof and/or untactful) and rigid personality traits of the BAP were measured using the MPAS-R (Tyrer, 1988). Traits were rated based on concrete behavioral examples along a three-point scale (0, not present; 1, questionably present; 2, definitely present) for each trait. BAP[+] was assigned to participants scoring a 2 on social or rigid traits.

The PRS includes 26 items tapping different pragmatic language skills rated from a 15-minute, semi-structured, conversational interview focused on participants' life experiences. Each item was scored on a three-point rating scale (0, not present; 1, mildly present; 2, definitely present) and tallied. Participants scoring 13 or greater (based on 1 SD from an independent control sample) (Lee et al., 2018) were assigned BAP[+] status.

Outcomes

Mothers' Use of Taught Strategies.—The primary outcome was the mothers' use of taught strategies. For mothers in the directive group, use of taught strategy refers to the mother's use of directive strategies. For mothers in the responsive group, use of taught strategy refers to the mother's use of responsive strategies. Mothers' use of taught strategies was assessed at three timepoints: pre-intervention (i.e., prior to allocation of group assignment and intervention onset), post-intervention (i.e., within 30 days following intervention completion), and at follow-up (i.e., 3-months after the end of intervention). At each timepoint, mothers were instructed to play with their child as they normally would during a 10-minute mother-child interaction using a standard set of toys. Interactions were video recorded in a research lab (72.4%) or in the participant's home (27.6%) to ensure that participation was not limited to only those families who had transportation to and from Evanston.

Mother-child interactions were transcribed and micro-coded using procedures and definitions that were systematically developed by researchers and clinicians with extensive experience and expertise implementing NDBIs. First, each maternal communicative turn was assigned behavioral codes, which reflected the mothers' use of responsive or directive strategies. Then, line-by-line behavioral codes were summarized to reflect four responsive components and four directive components. Each of the four components were equally weighted and averaged to create an overall composite score. Responsive composite scores include the following four components: temporal contingency (i.e., the mother's timely

response to the child's communicative bid), topic contingency (i.e., the mother's language that refers to the child's focus of attention), appropriate language (i.e., the mother's language that is appropriate for the child's developmental level), and mirroring and mapping (i.e., the mother's imitation of the child's play action and subsequent addition of meaningful language that describes the child's actions). Directive composite scores include the following four components: prompt naturalness (i.e., the initiation of the prompt that refers to the child's focus of attention), prompt sequence (i.e., the mother's appropriate implementation of the prompting hierarchy), prompt target (i.e., the mother's selection of a developmentally appropriate prompt target), and prompt frequency (i.e., the mother's appropriate pacing of the initiation of prompts throughout the interaction).

Responsive and directive composites were developed to reflect the appropriate quantity and quality of the respective strategy implementation. As language facilitation strategies are designed to be implemented at varying frequencies, criterion for each component reflected the appropriate pacing of the respective strategy. Given the varying rate of strategy use, we decided to quantify each component as a proportion of the observed frequency/number of opportunities ranging from 0 to 1. The number of opportunities reflect the determined frequency of appropriate strategy implementation. For example, the code criteria for prompt frequency specified that the mother uses a prompt at least 1x/minute whereas the code criteria for mirroring and mapping specified that a mother uses mirroring and mapping at least 1x/15 seconds of silence. Therefore, varying opportunities for strategy implementation capture the appropriate frequency and pacing of the respective strategy. In addition, descriptive criteria were set to measure the mother's quality of strategy implementation. See Table S2 in the Supplement for an in-depth description of the behavioral codes. The full coding manual is available by request here. Coders were naïve to both (a) experimental condition and (b) BAP status. Ongoing reliability was monitored by a master coder such that 20% of all coded data were coded twice, balanced across timepoints (ICC=0.96).

Confidence, Feasibility, and Satisfaction.—Mothers' confidence using, the feasibility of, and their satisfaction with the language facilitation strategies (secondary outcomes) were collected using a 20-item self-report survey at post-intervention. Mothers rated each item using a 5-point Likert scale, ranging from "disagree strongly" to "agree strongly." Items were classified into the following domains: (1) mothers' confidence using the language facilitation strategies (α=0.83), (2) feasibility of the intervention (α=0.53), and (3) satisfaction with the intervention (α=0.80).

Statistical Methods

First, pre-intervention data were compared for differences between experimental conditions. There were no differences in demographic and other pre-intervention characteristics (See Table 1). As stated above, responsive and directive composite scores were both quantified on 0 to 1 scales and accounted for appropriate frequency and pacing of the respective strategy. Nevertheless, differences in strategy use at pre-intervention were apparent. Specifically, at pre-intervention, unadjusted strategy use was significantly lower and more variable in the directive condition than the responsive condition (Directive: M=0.26, SD=0.13; Responsive: M=0.30, SD=0.07, p=0.046). In other words, at pre-intervention, mothers in the directive

group used directive strategies at a lower proportion (i.e., frequency/opportunities) than mothers in the responsive group used responsive strategies. To maintain comparable scaling, taught strategy use in both groups and at all time points was standardized based on pre-intervention strategy use. Furthermore, we standardized the post-intervention strategy use onto the pre-intervention scale. Thus, the post-intervention and follow-up values are in pre-intervention standard deviation units.

We used prespecified sequential linear regression models to test our hypotheses where predictor variables are entered in "blocks." Each additional block is added to the earlier models, allowing for testing the statistical significance of the entire block of predictors. For primary hypotheses (i.e., main effect of strategy type and main effect of maternal BAP status), we tested whether strategy type (entered in block 2) explained more variance than pre-intervention strategy use alone (block 1). For the planned moderation analyses (i.e., BAP status moderating the effect of strategy type), we tested whether the interaction term explained additional variance beyond the two main effects alone (entered in block 3), also covarying pre-intervention strategy use and child verbal status. For the exploratory pre-intervention targeted moderation, the interaction term between either strategy type or BAP status and pre-intervention strategy use was added (block 4), with nonsignificant exploratory interactions dropped from the final model. Exploratory pre-intervention targeted moderation was then analyzed by adding the three-way interaction and lower-order two-way interactions. Nonsignificant exploratory interactions were dropped from the final model, but the pre-specified two-way interaction was included regardless as it was of primary interest to the trial.

Community Involvement

There was no community involvement in the reported study.

Results

Taught Strategy Use Descriptive Statistics

Given that taught strategy use at post-intervention and follow-up was standardized based on pre-intervention taught strategy use, at pre-intervention both groups had a mean taught strategy use of 0 and a SD of 1 (Directive: M=0, SD=1; Responsive: M=0, SD=1). Taught strategy use at post-intervention (Directive: M=1.17, SD=1.41; Responsive: M=2.65, SD=1.73) and follow-up (Directive: M=0.65, SD=1.47; Responsive: M=1.6, SD=1.63) are in pre-intervention standard deviation units. See Table S3 for descriptive data of raw and standardized taught strategy use at each time point.

Missing Data

As shown in Figure 1, 111 participants were randomized with available data at pre-intervention (n=55 responsive; n=56 directive), 15 of which were missing at follow-up immediately following intervention, and 25 were missing at the 3-month follow-up post intervention. Dropped participants did not differ from enrolled participants on any pre-intervention measures. Ultimately, no meaningful patterns for predicting missingness were identified. We used an intent-to-treat analysis with all 111 randomized participants, with

missing data imputed using multiple imputation by chained equations in the MICE R package (van Buuren & Groothuis-Oudshoorn, 2011). Model output was consistent when analyzed with and without imputed data. See Table 2 for taught strategy use outcomes and Tables 3 for confidence, feasibility, and satisfaction outcomes.

Strategy Type Main Effect

As hypothesized, mothers who learned responsive strategies demonstrated significantly greater gains in responsive strategy use at post-intervention than mothers who learned directive strategies demonstrated in directive strategy use (d=0.90, 95% CI=[0.47, 1.32]), controlling for pre-intervention strategy use. There was no significant difference in maintenance of strategy use by strategy type (d=0.23, 95% CI=[−0.25, 0.71]), meaning mothers in both the responsive and directive conditions maintained their use of taught strategies at the same level, controlling for post-intervention strategy use. Confidence, feasibility, and satisfaction did not differ by strategy type at post-intervention or follow-up.

BAP Status Main Effect and Moderation

Maternal use of language facilitation strategies did not differ by BAP status at post-intervention or follow-up. Further, confidence, feasibility, and satisfaction did not differ by BAP status at post-intervention or follow-up. Although it was hypothesized that BAP status would moderate the effect of strategy type, it was nonsignificant in this sample at post-intervention and follow-up. When including all hypothesized variables in the model, there continued to be a main effect of strategy type, but there was no main effect for BAP status and no significant hypothesized interaction (strategy type X BAP status). Further, BAP status did not moderate the effect of strategy type on confidence, feasibility, and satisfaction at post-intervention or follow-up.

Pre-intervention Strategy Use Moderation

The two-way interaction of BAP status X pre-intervention strategy use explained significantly more variance than BAP status alone, supporting pre-intervention targeted moderation (F(1,107)=6.04, p=0.016, ΔR^2=0.053, Cohen's f^2=0.065). We probed this interaction using simple slopes to identify the region of significance. For mothers with below-average pre-intervention strategy use, BAP[−] mothers made greater gains in strategy use than BAP[+] mothers; for mothers with above-average pre-intervention strategy use, BAP[+] mothers made greater gains in strategy use than BAP[−] mothers. For mothers in the average range at pre-intervention, BAP status did not have a significant effect (Table 2, Figure 2). The two-way interaction of BAP status X pre-intervention strategy use did not explain significant variance in confidence, feasibility, and satisfaction at post-intervention or follow-up.

Discussion

This study explored factors that impact mothers' use of language facilitation strategies in the context of a randomized clinical trial. Mothers taught to use responsive strategies resulted in greater improvement in use of taught language facilitation strategies than mothers taught to use directive strategies. BAP status alone was not a significant predictor of mothers' use

of taught strategies. Further exploration revealed that BAP status differentially impacted mothers' use of taught strategies depending on the mothers' pre-intervention strategy use. For mothers with fewer skills at pre-intervention (i.e., below average pre-intervention strategy use), BAP[−] mothers performed better at post-intervention than BAP[+] mothers. For mothers with more skills at pre-intervention (i.e., above average pre-intervention strategy use), BAP[+] mothers performed better at post-intervention than BAP[−] mothers. However, for mothers with average pre-intervention levels, BAP status was not associated with differences in mothers' use of taught strategies at post-intervention. Maintenance of strategy use did not significantly differ across strategy type nor BAP status. Additionally, maintenance of strategy use was not moderated by BAP status nor pre-intervention strategy use.

One potential explanation for the current finding may be due to different reasons for low strategy use at pre-intervention for BAP[+] and BAP[−] mothers. Both responsive and directive strategies involve some degree of maternal communicative insightfulness, such that the parent interprets the child's communicative act and responds contingently with a comment (responsive) or a prompt for more complex communication (directive). In fact, maternal insightfulness at pre-intervention has been found to moderate parent-mediated intervention outcomes, such that only mothers with higher pre-intervention levels of insightfulness made gains in intervention strategy use (Siller et al., 2013). Thus, low levels of strategy use at pre-intervention for BAP[+] mothers may reflect underlying differences in foundational skills (e.g., insightfulness specifically regarding child communication) needed to learn language facilitation strategies, irrespective of the specific strategy type (i.e., responsive, directive). However, BAP[+] mothers, who have higher levels of strategy use at pre-intervention (indicating more robust prerequisite skills) may outperform BAP[−] mothers because they are better at following specific intervention rules. In contrast, BAP[−] mothers may have more prerequisite skills at pre-intervention but not yet use the strategies at a high rate for reasons other than reduced insightfulness (e.g., self-efficacy, stress). Thus, when BAP[−] mothers with low levels of pre-intervention strategy use are taught to use specific language facilitation strategies, they are better able to build on their foundational skills and implement the strategies. Taken together, findings suggest that when choosing language facilitation strategies, clinicians should consider the unique learning styles and pre-intervention skills of caregivers, in conjunction with maternal BAP status. BAP[+] mothers with low levels of pre-intervention strategy use and BAP[−] mothers with high levels of pre-intervention strategy use may require additional coaching to learn language facilitation strategies.

Furthermore, we explored whether intervention factors and maternal characteristics impacted mothers' maintenance of taught strategies during the 3-month period when instruction was not regularly provided. Results suggest that mothers' use of language facilitation strategies at follow-up was predominately explained by their use of taught language facilitation strategies at post-intervention. Additionally, strategy type and maternal BAP status did not explain variance in mothers' use of language facilitation strategies at follow-up, above and beyond strategy use at post-intervention. As the goal of parent-mediated intervention is continued use of strategies after receiving instruction from clinicians, these findings emphasize the importance of continually monitoring parents'

use of intervention strategies. For example, it may be important to continue to provide instruction until parents can achieve a certain level of strategy use which will ensure parents will maintain some level of strategy use with their child.

These results and clinical implications should be considered in relation to the study's strengths and limitations. Strengths of this study include: (a) a large sample of mother-child dyads from diverse socio-economic backgrounds, (b) stratified random assignment to strategy types (responsive, directive) based on BAP status, (c) use of a direct assessment of BAP status that occurred prior to randomization, (d) *a priori* BAP classification decisions, and (e) fine-grained coding of mother use of language facilitation strategies. However, there are several limitations that impact the generalizability of study findings. First, the inclusion criteria for the participating parent were very narrow (i.e., biological mother, native English speaker, no other conditions). Although these inclusion criteria were necessary to ensure the validity of the MPAS and PRS, they nevertheless restrict generalizability. Second, mothers were classified as BAP[+] or BAP[−] on any single facet of the BAP. Given the sample size of BAP[+] mothers (n=43), it was not possible to analyze BAP subtypes. It is possible that different BAP subtypes vary in the degree to which they: (a) use different language facilitation strategies at pre-intervention and (b) implement different language facilitation strategies during and after direct instruction. Furthermore, BAP traits (aloof, rigid, pragmatic) should be analyzed continuously, to examine whether variability across BAP traits, rather than the presence or absence of any single trait, influences caregiver intervention strategy use. Although child factors may influence a parent's use of language facilitation strategies, the purpose of the current study was to assess maternal characteristics that may influence their use of language facilitation strategies. It is important for future studies to consider additional parent (e.g., maternal insightfulness, self-efficacy, stress) and child (e.g., age, gender) factors that may differentially impact parents' use of taught strategies.

Additionally, it is noteworthy to address components of the intervention and outcome measures that may impact the findings of the current study. One potential limitation of the current study is the length of the intervention. The rationale for the decision was twofold. First, manualized interventions, such as Project ImPACT, suggest that parents learn to implement both responsive and directive intervention strategies in approximately 12 weeks (Ingersoll & Dvortcsak, 2019). The decision to decrease the duration of the intervention was informed by the fact that parents were learning to implement one set of intervention strategies rather than all strategies included in an NDBI. Second, whereas it is important to include longer intervention durations in order to monitor child progress, the goal of the current study was to examine differences in mothers' use of taught strategies, rather than assess child outcomes. Although beyond the scope of the current paper, our future analyses will focus on understanding the extent to which child social communication and language outcomes differ based on the strategy type.

Outcomes of the current study focused on mothers' use of taught strategies. As such, quantification of taught strategy use was a main consideration. Researchers and clinicians with extensive expertise in NDBIs determined the appropriate frequency and pacing of the respective strategy based on clinical judgement. Nevertheless, there is a lack of consensus

across manualized NDBIs regarding the optimal frequency and pacing of strategies, and thus, is an area of future research. Additionally, despite efforts to maintain comparable quantification of directive and responsive strategy, differences in strategy use of responsive and directive strategies were present at pre-intervention. Therefore, we standardized scores at each time point based on the mothers' pre-intervention taught strategy use (a statistical approach akin to comparing effect sizes in a meta-analysis). It is critical to consider these conceptual and analytical decisions when interpreting the findings of the current study.

Future research should include a larger sample that represents all types of caregivers from diverse racial and ethnic groups to allow for more nuanced subgroup analyses. Mixed methods research involving qualitative approaches would also allow for a more comprehensive understanding of mothers' experiences learning different strategies. In conclusion, results of this study should guide clinical trials that test the efficacy of individualizing interventions based on parent pre-intervention characteristics. Individualization of parent-mediated interventions based on parent characteristics, such as learning style, personality preferences, and pre-intervention strategy use, holds potential for increasing parent strategy use, thereby supporting child language learning during the critical early period of a child's first years.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

All authors have indicated they have no potential conflicts of interest to disclose. This study was funded by National Institute on Deafness and Other Communication Disorders grant R01DC014709 (PI: Megan Y. Roberts).

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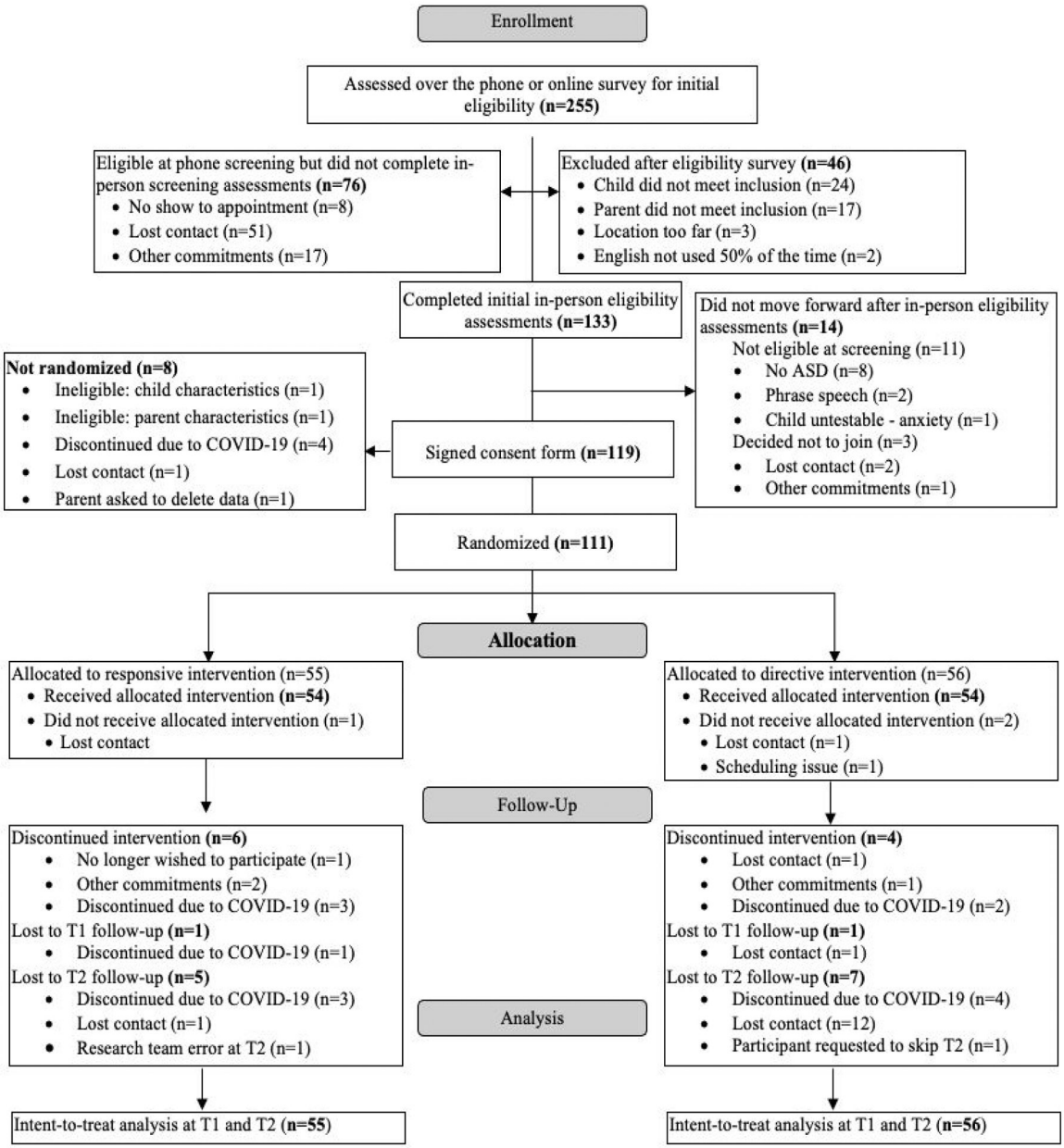

Figure 1.
CONSORT Chart.

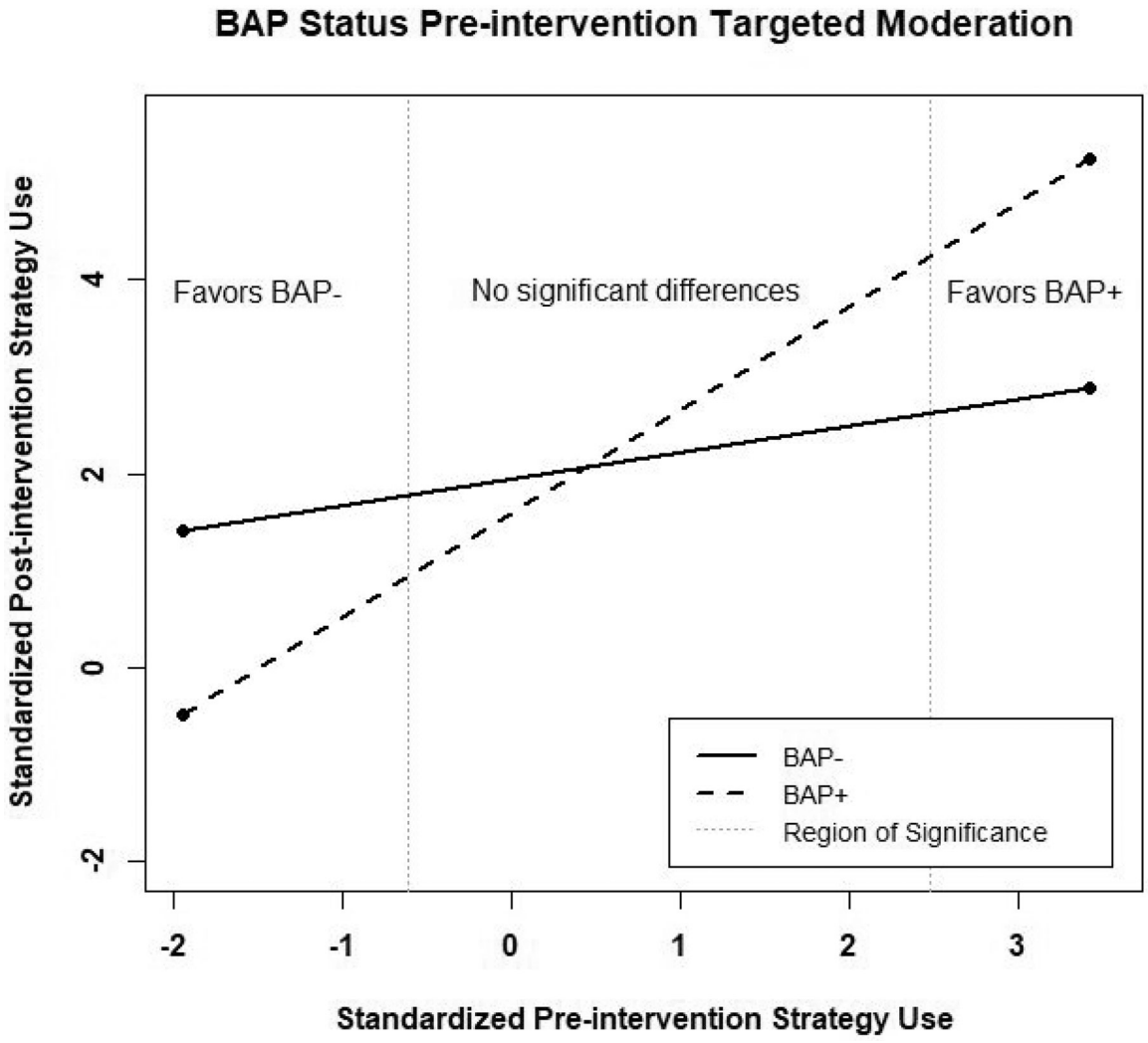

Figure 2.
BAP Status Pre-Intervention Targeted Moderation.

Table 1.

Child And Mother Pre-Intervention Characteristics by Strategy Type.

Child Characteristics				
Construct	**Metric**	**Responsive n=55**	**Directive n=56**	**Effect Size**
Age	Months	32.49 (6.20)	33.05 (6.13)	$d = -0.09$
Biological sex	Male	38 (69%)	46 (82%)	RR = 0.84
Race	Native American or Alaska Native	0 (0%)	1 (2%)	$V = 0.13$
	Asian	2 (4%)	1 (2%)	
	Black	6 (11%)	6 (11%)	
	Native Hawaiian or Other Pacific	0 (0%)	0 (0%)	
	Islander	26 (48%)	32 (58%)	
	White	14 (26%)	13 (24%)	
	More than one	6 (11%)	2 (4%)	
	No response			
Ethnicity	Hispanic	18 (33%)	21 (38%)	RR = 0.91
	Non-Hispanic	33 (61%)	33 (60%)	
	No response	3 (6%)	1 (2%)	
Age of diagnosis	Months	27.85 (6.29)	29.05 (5.04)	$d = -0.21$
Time since diagnosis	Months	3.97 (5.34)	3.32 (4.19)	$d = 0.14$
Autism severity	ADOS-2 Comparison Score	8.24 (1.69)	8.36 (1.49)	$d = -0.08$
Repetitive behaviors	RBS-R Overall Score	17.46 (12.54)	16.63 (12.37)	$d = 0.07$
Social communication	Communicative acts from language sample	15.22 (10.86)	14.27 (13.29)	$d = 0.08$
Social communication	CSBS-DP Total Weighted Raw Score	55.57 (34.19)	58.39 (34.58)	$d = -0.08$
Verbal status	ADOS-2 score of 3–4 (preverbal) on A1	31 (56%)	31 (55%)	RR = 1.02
Expressive vocabulary	MCDI Total Words Said	70.11 (95.88)	76.52 (99.84)	$d = -0.07$
Expressive language	PLS-AC Raw Score	20.16 (4.63)	20.89 (5.75)	$d = -0.14$
Receptive language	PLS-EC Raw Score	23.65 (4.90)	24.00 (5.22)	$d = -0.07$
Nonverbal IQ	MSEL T Score	28.02 (10.04)	29.16 (11.80)	$d = -0.10$
Community therapy	Hours per week	3.17 (4.72)	4.63 (8.68)	$d = -0.21$
Mother Characteristics				
Construct	**Metric**			
Age	Years	34.78 (5.19)	35.96 (5.19)	$d = -0.23$
Race	Native American or Alaska Native	0 (0%)	2 (4%)	$V = 0.19$
	Asian	3 (6%)	3 (6%)	
	Black	7 (13%)	8 (15%)	
	Native Hawaiian or Other Pacific	1 (2%)	0 (0%)	
	Islander	33 (61%)	33 (61%)	
	White	5 (9%)	3 (6%)	
	More than one	5 (9%)	5 (9%)	
	No response			
Ethnicity	Hispanic	16 (30%)	14 (26%)	RR = 1.16
	Non-Hispanic	36 (67%)	39 (72%)	

	No response	2 (4%)	1 (2%)	
BAP status	BAP[+]	21 (38%)	22 (39%)	RR = 0.97
	BAP[−]	34 (62%)	34 (61%)	
Use of responsive strategies	Responsive Strategies Composite Score	0.30 (0.07)	0.29 (0.06)	$d = 0.06$
Use of directive strategies	Directive Strategies Composite Score	0.25 (0.13)	0.26 (0.13)	$d = -0.06$
IQ	WASI Full IQ Standard Score	100.95 (14.03)	102.73 (12.41)	$d = -0.14$
Education	Less than HS	1 (2%)	1 (2%)	$V = 0.15$
	HS graduate	3 (6%)	5 (9%)	
	Special training	5 (9%)	2 (4%)	
	Some college	12 (22%)	16 (29%)	
	College graduate	17 (31%)	17 (31%)	
	Graduate degree	16 (30%)	14 (25%)	
Employment status	Not employed	3 (6%)	0 (0%)	$V = 0.19$
	Stay-at-home parent	17 (31%)	21 (38%)	
	Part-time	13 (24%)	13 (24%)	
	Full-time	19 (35%)	20 (36%)	
	Second job	2 (4%)	1 (2%)	
Income	<$30,000	6 (11%)	5 (9%)	$V = 0.17$
	$30,000 – $49,999	5 (9%)	6 (11%)	
	$50,000 – $100,000	8 (15%)	15 (27%)	
	>$100,000	26 (48%)	21 (38%)	
	No response	9 (17%)	8 (15%)	
Government assistance	Receiving assistance	12 (22%)	9 (16%)	RR = 1.36
	Not receiving assistance	42 (78%)	46 (84%)	

Abbreviations: Autism Diagnostic Observation Schedule – 2nd Edition (Lord et al., 2012); Repetitive Behavior Scale – Revised (Lam & Aman, 2007); Communication and Symbolic Behavior Scales – Developmental Profile (Wetherby & Prizant, 2002); MacArthur-Bates Communicative and Developmental Inventory Words and Gestures (Fenson et al., 2007); Preschool Language Scales – 5th Edition Auditory Comprehension Subscale, Preschool Language Scales – 5th Edition Expressive Communication Subscale (Zimmerman, Steiner & Pond, 2011); Mullen Scales of Early Learning Visual Reception Scale (Mullen, 1995); Wechsler Abbreviated Scale of Intelligence – 2nd Edition (Wechsler, 2011); d = Cohen's d; Relative Risk = Relative Risk; V = Cramer's V

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Table 2.

Primary Study Outcomes at Post-Intervention and Follow-Up.

	Post-Intervention Taught Strategy Use	**Follow-Up Taught Strategy Use**
Strategy Type	B (SE)	B (SE)
Intercept	1.19 (0.22)***	0.29 (0.27)
Previous Timepoint Strategy Use[a]	0.62 (0.16)***	0.35 (0.10)**
Strategy Type (1=Responsive)	1.34 (0.31)***	0.33 (0.35)
Strategy Type X Previous Timepoint Strategy Use[a]	†	†
	R^2=0.28***	R^2=0.19***
BAP Status	B (SE)	B (SE)
Intercept	1.96 (0.21)***	0.37 (0.27)
Previous Timepoint Strategy Use[a]	0.28 (0.22)	0.39 (0.10)***
BAP Status (1=BAP[+])	−0.29 (0.33)	0.02 (0.31)
BAP Status X Previous Timepoint Strategy Use[a]	0.80 (0.33)*	†
	R^2=0.19***	R^2=0.18***
BAP Moderation of Strategy Type	B (SE)	B (SE)
Intercept	1.27 (0.33)***	0.19 (0.35)
Previous Timepoint Strategy Use[a]	0.63 (0.17)***	0.35 (0.10)**
Strategy Type (1=Responsive)	1.13 (0.40)**	0.33 (0.40)
BAP Status (1=BAP[+])	−0.55 (0.43)	0.01 (0.45)
Verbal Status (1=Preverbal)	0.24 (0.32)	0.16 (0.31)
BAP Status X Strategy Type	0.52 (0.63)	−0.03 (0.62)
BAP Status X Previous Timepoint Strategy Use[a]	†	†
Strategy Type X Previous Timepoint Strategy Use[a]	†	†
BAP Status X Previous Timepoint Strategy Use[a] X Strategy Type	†	†
	R^2=0.30***	R^2=0.19**

*p<0.05,

** $p<0.01$,

*** $p<0.001$

† Tested for baseline targeted moderation, but nonsignificant and thus excluded from this model.

[a] For post-intervention models, previous timepoint strategy use refers to strategy use at pre-intervention. For follow-up models, previous timepoint strategy use refers to strategy use at post-intervention.

Table 3.

Secondary Study Outcomes at Post-Intervention and Follow-Up.

	Post-Intervention			Follow-Up		
	Confidence	**Feasibility**	**Satisfaction**	**Confidence**	**Feasibility**	**Satisfaction**
Strategy Type	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Intercept	34.58 (0.61)**	16.25 (0.34)**	36.08 (0.56)**	33.50 (0.70)***	18.83 (0.46)***	35.16 (0.66)***
Strategy Type (1=Responsive)	0.53 (0.89)	0.05 (0.50)	0.69 (0.82)	1.00 (1.01)	0.77 (0.65)	1.63 (0.92)
	R^2=0.004	R^2=0.000	R^2=0.008	R^2=0.012	R^2=0.017	R^2=0.035
BAP Status	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Intercept	34.00 (0.80)**	16.24 (0.45)**	35.48 (0.73)**	32.96 (0.90)***	18.89 (0.58)***	35.04 (0.83)***
Strategy Type (1=Responsive)	1.58 (1.16)	0.14 (0.65)	1.79 (1.06)	1.88 (1.28)	0.96 (0.83)	2.00 (1.21)
BAP Status (1=BAP[+])	1.40 (1.24)	0.01 (0.70)	1.47 (1.14)	1.54 (1.45)	−0.14 (0.95)	0.34 (1.38)
BAP Status X Strategy Type	−2.53 (1.80)	−0.23 (1.02)	−2.68 (1.66)	−2.31 (2.08)	−0.505 (1.36)	−1.07 (2.04)
	R^2=0.026	R^2=0.001	R^2=0.037	R^2=0.030	R^2=0.023	R^2=0.038

** p<0.01,

*** p<0.001