Journal of Early Intervention
2016, Vol. 38(1) 3–23

DOI: 10.1177/1053815116630327
jei.sagepub.com
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Internet-Based Parent-Implemented Intervention for Young Children With Autism: A Pilot Study

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Abstract

Both naturalistic communication and parent-implemented interventions are evidence-based practices for young children with disabilities, but demonstrations of effective methods for teaching parents to implement naturalistic interventions successfully with their children are still warranted. The purpose of this study was to examine the effects of a training and coaching program on parent implementation of naturalistic teaching strategies and on concomitant child communication skills using a telepractice service-delivery model (i.e., Internet-Based Parent-Implemented Communication Strategies [i-PiCS]). We found that parents learned to implement the targeted naturalistic teaching strategies with fidelity when, and only when, they were provided with training and coaching over the Internet. The parents' implementation of these strategies also corresponded with positive changes in their children's communication skills. The limitations and implications of this investigation are discussed.

Keywords

parent-implemented intervention, training and coaching, social-communication skills, naturalistic intervention, telepractice

Introduction

The Centers for Disease Control and Prevention (CDC) recently released data indicating that one in 68 children is diagnosed with autism spectrum disorder (ASD) in the United States; for boys, the prevalence is one in 42 (CDC, 2014). ASD refers to a wide spectrum of individuals with different abilities and support needs, but all individuals with ASD experience deficits in social communication and social interaction (*Diagnostic and Statistical Manual of Mental Disorders* [5th ed.; *DSM-5*]; American Psychiatric Association, 2013). With the rise in prevalence in the last 10 years, parents of young children with ASD and professionals who support these children and

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their families (e.g., early interventionists, teachers, researchers) face increased challenges in meeting the demands for services essential to these individuals and their families (Bruder, 2010).

Naturalistic Teaching Strategies

Social-communication skills are critical to academic achievement, social success, and long-term quality of life outcomes, such as social inclusion, interpersonal relationships, and self-determination (Schalock, Keith, Verdugo, & Gomez, 2011). Thus, interventions that support the development of social-communication skills are essential services for young children with ASD. Milieu language interventions and naturalistic strategies are proven strategies for promoting the social-communication skills of young children with ASD (Hancock & Kaiser, 2002; Kaiser, Hancock, & Nietfeld, 2000).

Naturalistic strategies are particularly useful when teaching social-communication skills to young children with ASD and other developmental disabilities because these strategies can be integrated within everyday routines at home and in the community. Communication partners can embed the strategies within many learning opportunities throughout the day within and across environment, allowing for repeated practice that leads to skill acquisition and generalization.

Parent-Implemented Intervention

With the increased number of children identified with autism (CDC, 2014), there is a need to both develop effective interventions for this population and ensure that families have access to these interventions (Boyd, Odom, Humphreys, & Sam, 2010). Exploring new models of intervention delivery is an important avenue for continued research, especially for families with limited access to effective early intervention (EI) services (Meadan, Meyer, Snodgrass, & Halle, 2013). As young children spend many of their waking hours with parents or caregivers, parent- or caregiver-implemented interventions are logical means of ensuring that instruction is occurring frequently and throughout daily routines. Researchers have demonstrated that parents can acquire and apply evidence-based strategies for teaching their children (Roberts & Kaiser, 2011). In fact, parent-implemented interventions are evidence-based practices (Wong et al., 2013), provided they are acquired through high-quality training and coaching and implemented consistently with fidelity.

Addressing Barriers to EI Services

A primary challenge for traditional EI service delivery is the growing shortage of EI service providers. This shortage is especially evident in rural areas where delivering services in children's homes or communities requires extensive travel time (Cason, Behl, & Ringwalt, 2012; Hebbeler, Spiker, & Kahn, 2012; Kasprzak et al., 2012; Olsen, Fiechtl, & Rule, 2012) and for families living in poverty who are more likely to experience unstable housing, are often perceived as difficult to serve by EI service providers, and are therefore most likely to underutilize EI services (Guralnick, 1998; Peterson, Mayer, Summers, & Luze, 2010; Sontag & Schact, 1993; Staerkel & Spieker, 2006). Children living in rural areas and/or in poverty may receive interventions of less intensity (i.e., shorter duration and fewer sessions) due to barriers resulting from personnel shortages, travel time, and cost (Hallam, Rous, Grove, & LoBianco, 2009; Sontag & Schact, 1993; Staerkel & Spieker, 2006). These are just a few of the challenges associated with traditional EI service delivery that could be ameliorated through technology.

The infrastructure for and access to high-speed Internet is increasing across the United States (U.S. Department of Commerce, 2013). This improved infrastructure and access could empower service providers to deliver EI services and supports in children's homes without families or

professionals having to travel. This accessibility to and ease of service delivery could enable professionals to interact with more children and families each day, thus mitigating the negative impact of the current EI personnel shortage. In addition, by eliminating the extra time and costs associated with travel, providers could deliver services and supports for families and children at recommended dosages, strengthening the likelihood that interventions will yield positive results. To date, there is limited research about the effectiveness of Internet-based service delivery, often referred to as telepractice, in EI for parents of young children with ASD (Meadan et al., 2013; Vismara, Young, Stahmer, Griffith, & Rogers, 2009). A review of the literature on Internet-based parent-training interventions for parents of children with ASD resulted in only six published journal articles (Meadan & Daczewitz, 2015). The identified studies used different methodologies and included limited information on key components such as fidelity of implementation, length of the intervention, and technologies used. There is a clear need to conduct more rigorous research in this area that includes detailed information related to technologies and procedures used (Meadan & Daczewitz, 2015; Meadan et al., 2013).

Parent-implemented naturalistic interventions are evidence-based practices for young children with ASD (Odom, Collet-Klingenberg, Rogers, & Hatton, 2010), but demonstrations of effective methods for teaching parents to implement naturalistic interventions successfully with their children are still needed. The purpose of this study was to examine the effects of a training and coaching program on parent implementation of naturalistic teaching strategies and concomitant child communication skills using a telepractice service-delivery model. We modified and adapted the materials and procedures from the *Parent-Implemented Communication Strategies* (PiCS) program, a face-to-face, in-person program designed to teach and coach parents how to use naturalistic teaching strategies to promote their young children's social-communication skills (Meadan, Angell, Stoner, & Daczewitz, 2014; Stoner, Meadan, Angell, & Daczewitz, 2012). However, in this iteration of the program (i.e., the Internet-Based Parent-Implemented Communication Strategies [i-PiCS]), we taught and coached parents from a distance. The research questions that guided this study were as follows:

Research Question 1: Is there a functional relation between a program that delivers parent training and coaching from a distance to teach naturalistic teaching strategies via the Internet and parents' fidelity of implementation and rate of the newly acquired strategies?
Research Question 2: Is there a functional relation between parents' implementation of the newly acquired naturalistic teaching strategies and their children's social-communication skills?
Research Question 3: How do parents rate the social validity of the goals, procedures, and outcomes of an intervention program (i-PiCS) that is delivered from a distance via Internet technologies?

Method

Participants

Three mother–child dyads participated in this study. Madiha was a married mother with three sons. She and her husband, both of Middle Eastern descent, lived in a small town near a university and earned between US$25,000 and US$45,000 annually. Madiha had a bachelor's degree and worked a few hours a day outside her home. Her second child, Ali, was diagnosed with autism by a local developmental pediatrician and was almost 3 years old at the beginning of the study. His total language standard score on the Preschool Language Scale, Fifth edition (PLS-5; Zimmerman, Steiner, & Pond, 2012) was 75 (5th percentile), and his score on the Ages and Stages Questionnaire–Social Emotional (ASQ:SE; Squires et al., 2002) was 180 (cutoff score = 59). He

received speech and occupational therapies for a total of 4 hr per week. At the beginning of this study, Ali communicated primarily by pointing to objects he wanted or saying *no* when he did not want something. He used some gestures and sounds to communicate and produced approximately eight words functionally.

Karen was a married mother with one son. She and her husband, both of Caucasian descent, lived in a small urban town near a university and earned between US$65,000 and US$85,000 annually. Karen was working toward a master's degree and worked full-time as a special education teacher during this study. Her son, George, was diagnosed with autism by a local developmental pediatrician and was about 2 years old at the beginning of this study. His total language standard score on the PLS-5 was 53 (1st percentile), and his score on the ASQ:SE was 150 (cutoff score = 50). He received speech, occupational, and developmental therapies for a total of 3 hr per week. At the beginning of this study, George primarily used gestures to communicate. He would reach for or touch objects he wanted and would walk away to indicate that he did not want something.

Melissa was a married mother with two children. She and her husband, both of Caucasian descent, lived in a rural area approximately 10 min from the nearest town and earned between US$10,000 and US$25,000 annually. She had an associate's degree and worked full-time as a teacher at a preschool center during the school year. Her daughter, Wendy, was diagnosed with autism by a local developmental pediatrician and turned 4 years old during this study. Her total language standard score on the PLS-5 was 58 (1st percentile), and her ASQ:SE score was 220 (cutoff score = 70). She received speech, occupational, applied behavior analysis, and music therapies for a total of 8 hr per week. At the beginning of this study, Wendy communicated primarily through gestures, such as holding an adult's hand and leading him or her toward what she wanted. She would push away items or a partner's hand to reject items and occasionally said *no*.

Settings

All sessions were conducted in the families' homes or other locations of their choice (e.g., family member's homes), but the interventionists were never physically present. Instead, all sessions were conducted over the Internet using Skype, an online videoconferencing service.

Research Design

We used a multiple-baseline design across strategies within each family to examine the effects of the intervention on the mother's application of the teaching strategies and, in turn, her child's expressive communication. In this design, each family served as its own control. In keeping with the quality indicators of an experimental design that meets standards (see Horner et al., 2005; Kratochwill et al., 2010), this design permitted three demonstrations of a basic effect within each family (i.e., across the three teaching strategies taught in the intervention) and replication across the three families. The design was used to examine the effect of the i-PiCS intervention on changes in (a) parent strategy use that coincided with the introduction of training and coaching and (b) their children's communication skills coinciding with changes in their parents' strategy use.

Independent Variable

The independent variable in this study was a two-phased intervention (first training, then coaching), designed to teach parents to use targeted naturalistic teaching strategies. The training and coaching procedures replicated those used by Meadan, Angell, et al. (2014) but were delivered to parents from a distance using online videoconferencing instead of in person.

Internet technologies. To implement the intervention, multiple Internet technologies were used. First, during the study, the researchers provided an iPad to the family. One family owned an iPad and used it instead of borrowing one from the project. The iPad allowed the parents to videotape themselves interacting with their child and to videoconference via Skype with the researchers. Electronic materials, such as copies of training documents and videos of parent–child interactions, were shared between the family and the researchers using a secure online file sharing service, Box. The training and coaching sessions were recorded using screen-capture software, Camtasia. This software allowed us to record all audio and video of the Skype sessions with the family and to edit and annotate video clips of parent–child interactions to provide video feedback by sharing the coach's screen with the parent during the coaching phase. For more information about the technologies used, see Meadan et al. (2013).

Parent training. Two doctoral students in special education served as trainers and coaches (referred to as coaches in the rest of the article). Both coaches had experience working with children with disabilities and their families. The first phase of the intervention was a parent-training session delivered from a distance. In a 45-min Skype session, i-PiCS coaches taught the parent to implement three naturalistic teaching strategies: (a) modeling, (b) mand-model, and (c) time delay. Modeling is a strategy in which parents provide a model by producing a word, sign, or gesture and expect their children to imitate the production. Mand-model is a strategy in which parents ask their children a question (e.g., *What do you want?*), give their children a choice (e.g., *Do you want more or are you all done?*), or use a mand (e.g., *Tell me "more."*) to evoke a response. Time delay is a strategy in which parents wait expectantly (e.g., 5-15 s) within a familiar routine (e.g., when the swing stops, the parent pauses and looks expectantly at the child waiting for the child to sign *go*) to give their children an opportunity to initiate communication. The successful acquisition of the three naturalistic teaching strategies is closely linked to children's interest in and motivation to communicate. Thus, parents were also taught to use environmental arrangement (EA) in combination with each of the other three strategies. EA is a strategy in which parents modify the setting to increase the likelihood that children will communicate, such as putting a favorite toy where their child can see it but cannot reach it, enticing the child to ask for it (Ostrosky & Kaiser, 1991).

The training had five components. First, the i-PiCS coaches gave an overview of the social-communication intervention to each parent. Second, the parent and the coach reviewed handouts and flowcharts of each of the teaching strategies. Third, for each teaching strategy, the coach used Skype to share her computer screen with the parent so that they could watch a video clip example together of another parent using the strategy with a young child with a disability. Fourth, after training on all four strategies, the parent and the coach collaborated to create an action plan detailing how the parent would use each strategy in her everyday routines with her child. Fifth, the coach addressed the parent's questions and/or concerns.

Fidelity of implementation of training. We assessed fidelity of implementation for the training sessions on two levels. First, coaches completed a fidelity checklist containing 16 key elements during the training sessions. Second, another team member watched all training session videos and completed the same fidelity checklist (i.e., a reliability check). Fidelity of implementation for the training sessions was 100% for both levels for Karen and Melissa, and 100% for Level 1 and 94% for Level 2 (the reliability check) for Mediha.

Parent coaching. The second phase of the intervention was ongoing coaching provided to parents on their use of the EA strategy in combination with each of the other three naturalistic teaching strategies. Coaching sessions were conducted over Skype and had three components: (a) a pre-observation conference in which the parent and the coach discussed the targeted teaching

strategy and developed a plan for how to implement the strategy during the observation, (b) observation of parent–child interaction for about 5 to 7 min, and (c) the post-observation conference in which the parent and the coach discussed the observation and the coach provided feedback about the mother's implementation of the targeted teaching strategy. Parents also received video feedback once every four coaching sessions. The i-PiCS coaches would edit and annotate a video clip of the parent interacting with her child to highlight what the parent was doing well and what she might want to change next time, to share the clip with the parent during the pre-observation conference, and to provide feedback about the parent's performance related to the targeted teaching strategy. Parents participated in approximately two 30-min coaching sessions per week and completed all phases of the intervention in about 3.5 months. Parents were also asked to complete self-report forms to reflect on their levels of confidence with implementing the strategies outside of the coaching sessions.

Parents were coached in three phases: (a) EA + modeling, (b) EA + mand-model, and (c) EA + time delay. Each phase continued until parents used the strategy at an established performance criterion level (i.e., high quality on 80% of opportunities for two consecutive sessions and reported on a self-report form that they were confident implementing the strategy). This performance criterion was not explicitly communicated to the parents. After the performance criterion was reached with the modeling strategy, coaching on the mand-model strategy commenced. Likewise, after parents met the performance criterion for the mand-model strategy, coaching on time delay began.

Fidelity of implementation of coaching. We assessed fidelity of implementation for the coaching sessions on two levels. First, the coach completed a fidelity checklist containing 10 steps (16 steps for video feedback sessions) during every session. Then, another team member watched and recorded the same 10 or 16 steps for at least 30% of the coaching sessions in each of the three coaching phases for each family. Fidelity of implementation for the coaching sessions was 100% for both levels of measurement across all coaching phases and families.

Dependent Variables

To address the first two research questions, we monitored two dependent variables. The primary dependent variable was the quality and rate with which parents implemented the naturalistic teaching strategies. The secondary dependent variable was the children's social-communication initiations and responses.

To quantify these variables, 5 to 7 min of parent–child interactions were video recorded during baseline sessions, after the training sessions, and during each coaching session. Parent–child interactions were also video recorded throughout the coaching phases on random days when coaching was not provided to probe for generalized implementation in the absence of the coach. After parents had met the performance criterion in all three coaching phases, parent–child interactions were recorded to assess parents' maintenance of strategy use. Coaching sessions were recorded using Camtasia when the coach was observing the parent–child interaction via Skype. For the baseline, generalization, and maintenance measures, parents self-recorded videos and uploaded them to Box to share with the research team.

For each recorded session, we coded five random consecutive minutes using a coding manual that detailed the parent and child behaviors to be coded (available from the first author upon request). This manual included operational definitions for (a) the naturalistic teaching strategies, (b) rating the quality or how well the parent implemented the teaching strategies (from 1 = *low* to 4 = *high*), and (c) the child's communicative behavior (i.e., initiating and responding).

Parent quality and rate of strategy use. The fidelity with which parents implemented the teaching strategy was defined as the quality and rate with which the targeted evidence-based teaching strategy (i.e., modeling, mand model, and time delay) was implemented. Two calculations were made to document fidelity across all naturalistic teaching strategies. First, the percent of high-quality strategy use was calculated for each session by dividing occasions of high-quality strategy use by the total frequency of strategy use. Second, the rate of strategy use per minute, at any quality level, was calculated for each session.

Child communication skills. Child communication behaviors were defined as (a) initiating a communication exchange (i.e., initiated a communicative act 3 s or more after the last communication exchange) or (b) responding to a parent's communication act (e.g., imitated parent's model, responded to parent's mand). The communication topographies were operationally defined individually for each child and included vocalizing, verbalizing, gesturing, and signing. Any of these topographies occurring within 3 s of the parent's use of a teaching strategy constituted a response. If the parent used the time delay strategy and the child responded during the delay, this was coded as an initiation as well as a response to the parent's use of a strategy.

Interobserver agreement (IOA). One of two research team members was assigned to observe and code the data for each participating family. The primary observers were the coaches. Two special education graduate students and one Speech and Hearing Science undergraduate student were the secondary observers. The secondary observers were blind to the intervention procedures and schedule and coded the assigned sessions in random order. Before assessing IOA, the secondary observers were trained on the coding procedures and coded a small subset of the sessions, compared their results with the primary coders' results, and discussed disagreements. This process was repeated until the primary and secondary observers reached at least 80% reliability for each coding category. The categories included (a) time of event (i.e., parent strategy use or child communication), (b) type of strategy (i.e., modeling, mand-model, or time delay), (c) quality of strategy (range = 1-4), and (d) child behavior (i.e., responding or initiating). An agreement was defined as both observers coding each of the four categories in the same way; for time of event, a window of 2 s was permitted. IOA was calculated as agreements divided by agreements plus disagreements, multiplied by 100. The primary observer coded all sessions and the secondary observer independently coded at least 30% (range = 30%-100%) of the sessions, selected at random, in each phase of the study. The overall agreement across all participants and categories was 88.5%. The sessions that were used for IOA training purposes were excluded from the calculations. Table 1 contains IOA data, averages, and ranges by family for each phase.

Social Validity

To examine the third research question related to social validity, we used the subjective evaluation method (Kazdin, 1979) by administering in-depth post-intervention interviews. The social validity interview posed questions to parents about their opinions regarding the goals, procedures, and outcomes of the i-PiCS program (e.g., importance of communication skills, usefulness of program procedures, strategy knowledge, perceived effectiveness of the strategies). To reduce potential response bias, the in-depth interview was conducted with a research team member who had not had prior contact with the parents. The interviews were conducted via Skype at a time that was convenient for each mother. Each interview lasted approximately 30 min, and parents were asked their opinions about their child's communication skills pre- and post-intervention; their satisfaction with the i-PiCS goals, procedures, and outcomes; and their suggestions for improving the program. Each interview was transcribed and analyzed, line by line, by two

Table 1. Interobserver Agreement (IOA) by Family and Phase.

Family	Phase (*n*, % of sessions coded)	Average IOA of coded categories (range)				
		Time (%)	Strategy (%)	Quality (%)	Child's behavior (%)	Overall (%)
Mediha and Ali	Baseline	96	95	84	86	90
	(2, 67)	(95-96)	(94-95)	(79-89)	(82-89)	
	Post-training	100	97	83	97	94
	(1, 33)	—	—	—	—	
	Coaching: Modeling	91	92	84	93	90
	(3, 50)	(86-96)	(85-97)	(68-93)	(89-100)	
	Coaching: Mand model	91	95	83	87	89
	(4, 80)	(78-100)	(88-100)	(82-83)	(77-97)	
	Coaching: Time delay	99	90	94	92	94
	(2, 40)	(97-100)	(88-92)	(91-96)		
Karen and George	Baseline	81	100	83	83	78
	(3, 75)	(67-100)	—	(50-100)	(50-100)	
	Post-training	78	97	75	100	89
	(3, 75)	(60-89)	(91-100)	(67-86)	—	
	Coaching: Modeling	84	92	80	97	88
	(5, 44)	(70-95)	(83-100)	(27-100)	(87-100)	
	Coaching: Mand model	93	98	82	85	90
	(3, 75)	(79-100)	(95-100)	(75-91)	(70-95)	
	Coaching: Time delay	82	94	81	94	88
	(3, 60)	(60-100)	(83-100)	(60-100)	(83-100)	
Melissa and Wendy	Baseline	87	97	76	100	91
	(3, 100)	(78-100)	(92-100)	(67-88)	—	
	Post-training	94	100	66	79	86
	(2, 50)	(92-95)	—	(64-67)	(67-91)	
	Coaching: Modeling	84	95	79	82	84
	(5, 42)	(65-94)	(75-100)	(64-100)	(64-100)	
	Coaching: Mand model	88	92	76	92	87
	(3, 30)	(83-94)	(80-100)	(64-83)	(83-100)	
	Coaching: Time delay	89	96	90	81	89
	(2, 50)	(85-93)	(91-100)	(80-100)	(70-91)	

members of the research team. The data analysis process included development of codes, grouping codes into categories, and finally the development of themes (Creswell, 2012).

Results

Parent and Child Behavior

To answer the first two research questions (i.e., is there a functional relation between the intervention and changes in parent and child behavior), we used a multiple-baseline, single-case

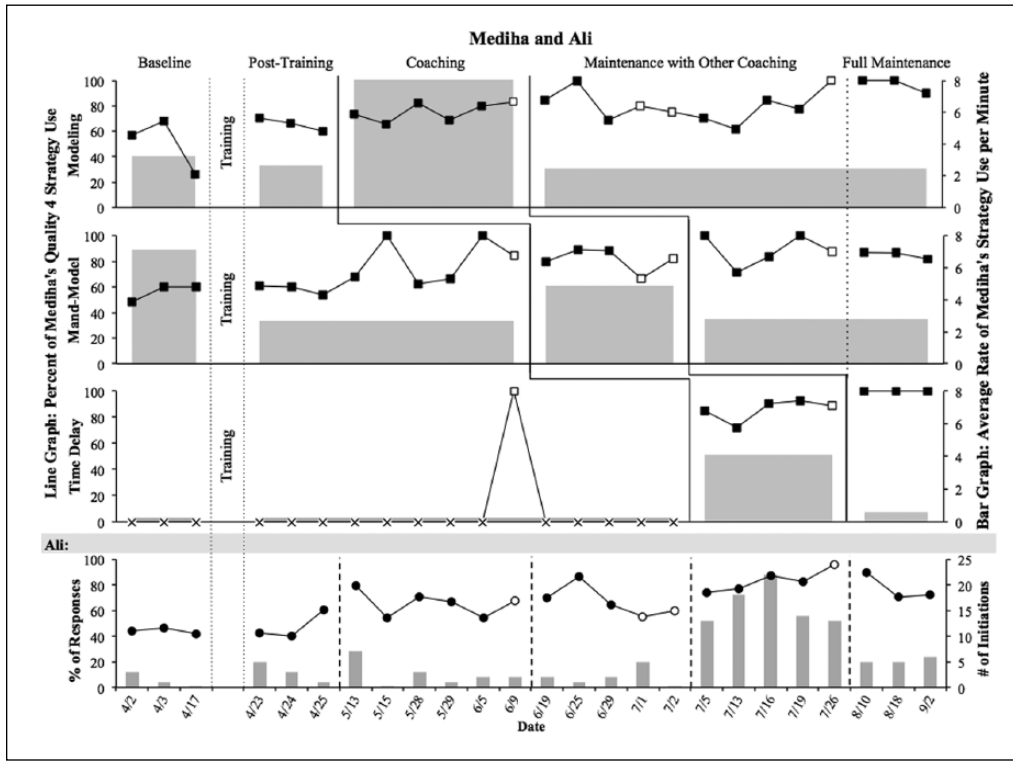

Figure 1. Mediha and Ali's performance.

Note. Mother's and child's performance. In Tiers 1-3, line graphs represent the mother's percent high-quality (score = 4) strategy use; open symbols represent probes for generalization (i.e., no training or coaching provided); xs represent sessions during which the mother never used the strategy; shaded bars reflect the average rate at which the mother used the strategy during each phase; data points in maintenance to the left of the dotted vertical line in Tiers 1 and 2 are sessions when coaching is done on another strategy (i.e., maintenance with other coaching) and points to the right represent sessions after the mother met performance criteria for all strategies and all coaching had ended (i.e., full maintenance). Bottom tier represents child's communication behavior; line graph shows the percentage of opportunities (i.e., the mother's strategy use) to which the child responded, and shaded bars reflect the number of times the child initiated communication.

design, and visually analyzed graphed data for each dependent variable. The data from the single-case study are presented in Figures 1, 2, and 3. Each figure presents the data for one family. The top three tiers of the figure present the parents' performance data in the multiple-baseline design across the three teaching strategies (i.e., modeling, mand-model, and time delay). In these three tiers, the line graph represents the percent of Quality 4 (i.e., the highest quality) strategy use in each session. The sessions marked with an "x" are sessions during which the parent never used the strategy. The shaded bars represent the average rate that the parent used the strategy, at any quality, in each phase. The sessions marked with an open symbol are generalization probes during which parent–child interaction was videotaped with no coaching or feedback provided. Although unsolicited feedback related to a strategy was not provided after the parents met criterion, if parents asked a question about a previously mastered strategy, coaches responded. Thus, maintenance data on modeling and mand-model that were collected while receiving coaching on time delay are labeled as "maintenance with other coaching" and separated (by a dotted line) from maintenance data collected when all coaching had ended (labeled "full maintenance"). The fourth tier in each figure presents the child's communication data gathered during the same videotaped parent–child interaction sessions. The line graph represents the percent of the parent's

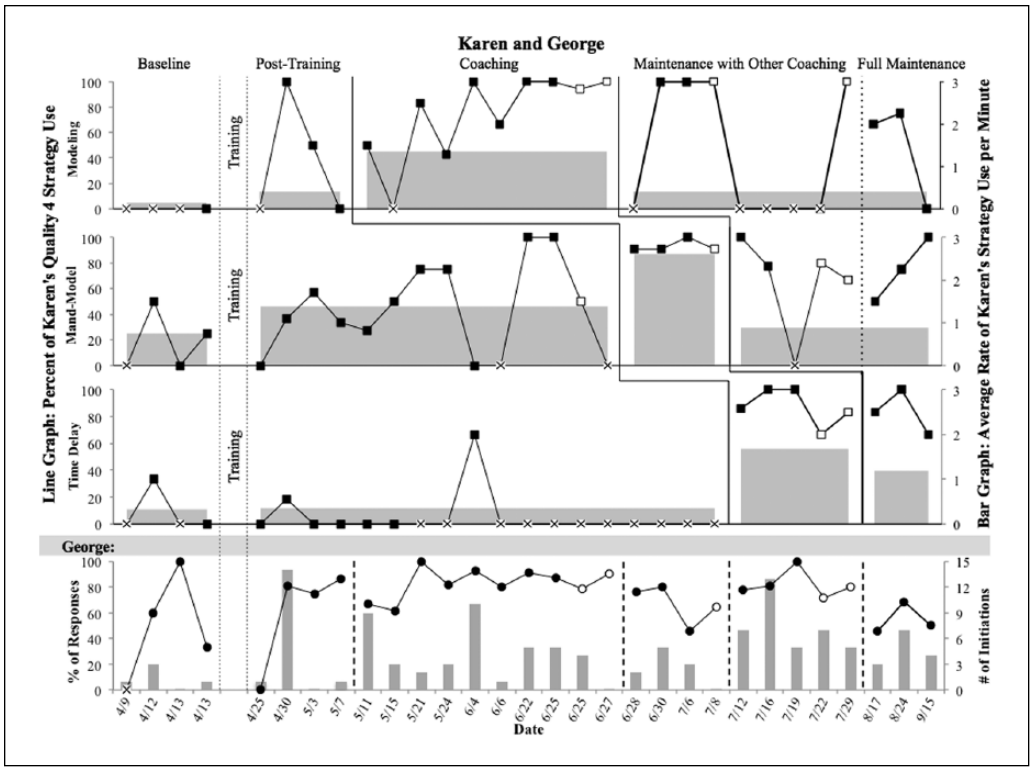

Figure 2. Karen and George's performance.

Note. Mother's and child's performance. In Tiers 1-3, line graphs represent the mother's percent high-quality (score = 4) strategy use; open symbols represent probes for generalization (i.e., no training or coaching provided); xs represent sessions during which the mother never used the strategy; shaded bars reflect the average rate at which the mother used the strategy during each phase; data points in maintenance to the left of the dotted vertical line in Tiers 1 and 2 are sessions when coaching is done on another strategy (i.e., maintenance with other coaching) and points to the right represent sessions after the mother met performance criteria for all strategies and all coaching had ended (i.e., full maintenance). Bottom tier represents child's communication behavior; line graph shows percentage of opportunities (i.e., the mother's strategy use) to which the child responded, and shaded bars reflect the number of times the child initiated communication.

strategy use to which the child responded with a communication act. The shaded bars represent the number of times the child initiated communication in each session. Open symbols represent generalization probes when no coaching or feedback was provided to the parent. Sessions marked with an "x" are sessions during which the child never initiated or responded.

When analyzing the data in the top three tiers to determine whether a functional relation was established between the introduction of the intervention and parent implementation of the target strategy, we considered both the percentage of high-quality strategy use (i.e., line graph) and the rate of strategy use (i.e., bar graph). A parent may use the strategy at a high rate but with low quality or at a low rate with high quality. For example, if the parent uses the strategy only once but implements the strategy at Quality 4, the percentage of high-quality strategy use will be 100% for that session. However, when taking rate into consideration, this percentage may be considered an anomaly and not representative of the parent's overall mastery of the strategy. The goal of the intervention was to increase the quality with which the parents used each strategy and to maintain that quality across numerous applications of the strategy (i.e., at increased rates). To facilitate interpretation of the effect of the intervention on parent behavior, we also created a

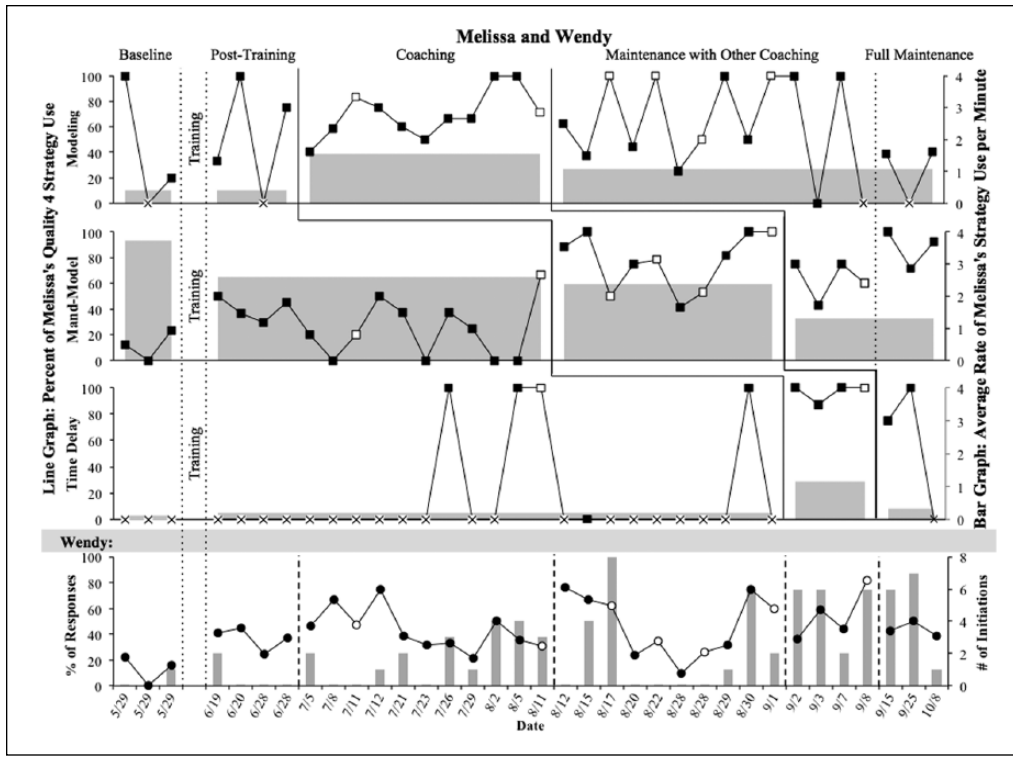

Figure 3. Melissa and Wendy's performance.
Note. Mother's and child's performance. In Tiers 1-3, line graphs represent the mother's percent high-quality (score = 4) strategy use; open symbols represent probes for generalization (i.e., no training or coaching provided); xs represent sessions during which the mother never used the strategy; shaded bars reflect the average rate at which the mother used the strategy during each phase; data points in maintenance to the left of the dotted vertical line in Tiers 1 and 2 are sessions when coaching is done on another strategy (i.e., maintenance with other coaching) and points to the right represent sessions after the mother met performance criteria for all strategies and all coaching had ended (i.e., full maintenance). Bottom tier represents child's communication behavior; line graph shows the percentage of opportunities (i.e., the mother's strategy use) to which the child responded, and shaded bars reflect the number of times the child initiated communication.

"performance score" for each phase by multiplying the average percentage of Quality 4 strategy use for a phase by the average rate at which the strategy was used in that phase. Performance scores were calculated for each target strategy in each phase and are presented in Figure 4.

Mediha and Ali's Results

Parent behavior. Mediha's data are presented in Figure 1. In baseline, Mediha used the modeling and mand-model strategies frequently (shaded bars) but achieved high quality (line graph) only on approximately 50% to 60% of the occasions. She did not use the time delay strategy during baseline or post-training—with one exception. After receiving training on all three strategies, changes in Mediha's implementation varied until coaching was introduced. A substantial increase in the rate at which she implemented all three strategies coincided with coaching. This was accompanied by a small increase in the percentage of high-quality use of modeling and increased consistency in the high-quality use of mand-model. Coinciding with coaching, she used time delay with high quality at a stable and high percentage. During maintenance (after coaching

ended), Mediha continued to apply all three strategies with high quality but rarely implemented time delay. The data for the generalization probe sessions were similar to the data obtained during coaching, indicating that Mediha generalized strategy use to interactions with Ali in the absence of proximal coaching or feedback. In sum, although there were few clear or distinct changes in the percentage of high-quality strategy use from one phase to another in Figure 1, Mediha's rate of strategy use increased when, and only when, coaching was introduced.

Child behavior. Visual analysis of the bottom tier in Figure 1 reveals an increase in level (percentage of opportunities) at which Ali responded to Mediha's strategy use during the coaching phases, although the data point on 4/25 renders causal inference tenuous. Because there is no replication of this change, we cannot unambiguously attribute it to the coaching intervention. There is also a clear increase in Ali's initiations during the coaching phase for time delay, but this increase diminishes somewhat during maintenance when coaching stops.

Karen and George's Results

Parent behavior. Karen's data are presented in Figure 2. In baseline, Karen used all three strategies at low rates (shaded bars) with variable but low percentages of high quality (line graph). After receiving training, the rate at which Karen used modeling and mand-model increased somewhat and the percentage of high-quality strategy use increased with notable variability; no change was observed in time delay with the exception of the 6/4 session. When coaching was introduced, Karen's rate and level of high-quality strategy use increased substantially for all three strategies, although her quality of mand-model already was compelling (last two primary data points). During maintenance, Karen applied the strategies at lower rates than during coaching but maintained relatively high levels of quality implementation. The data for Karen's strategy use during the generalization probe sessions were similar to the levels achieved during coaching, except during time delay. In sum, Karen's high-quality strategy use increased and stabilized during the coaching phase, but rates decreased during maintenance.

Child behavior. Visual analysis of the bottom tier in Figure 2 reveals improvement in George's responsiveness, after training was introduced, that was maintained throughout the remainder of the study. When coaching on time delay was introduced, an increase was evident in Karen's rate of implementation that was accompanied by an increase in George's frequency of initiations. Finally, during maintenance, his frequency of initiations remained well above baseline levels, but his response to his mother's strategy use declined to baseline levels.

Melissa and Wendy's Results

Parent behavior. Melissa's data are presented in Figure 3. In baseline, Melissa used modeling rarely, mand-model often, and time delay never. Her high-quality use of modeling varied dramatically due to sessions with very low rates, and she rarely achieved high-quality implementation with mand-model. After receiving training, her rate decreased for mand-model and remained low for modeling and time delay. The quality of her implementation increased, but the variability muted any clear change. When coaching was introduced, Melissa's rate of application increased for both the modeling and time-delay strategies. Although Melissa's rate of mand-model strategy use was similar in the post-training and coaching phases, the level of high-quality strategy use was markedly higher during the coaching phase. During maintenance, Melissa applied the strategies at somewhat lower rates than during coaching and was more variable in the quality of her implementation of modeling. Melissa's performance during generalization probe sessions was variable but similar in level to that achieved during coaching.

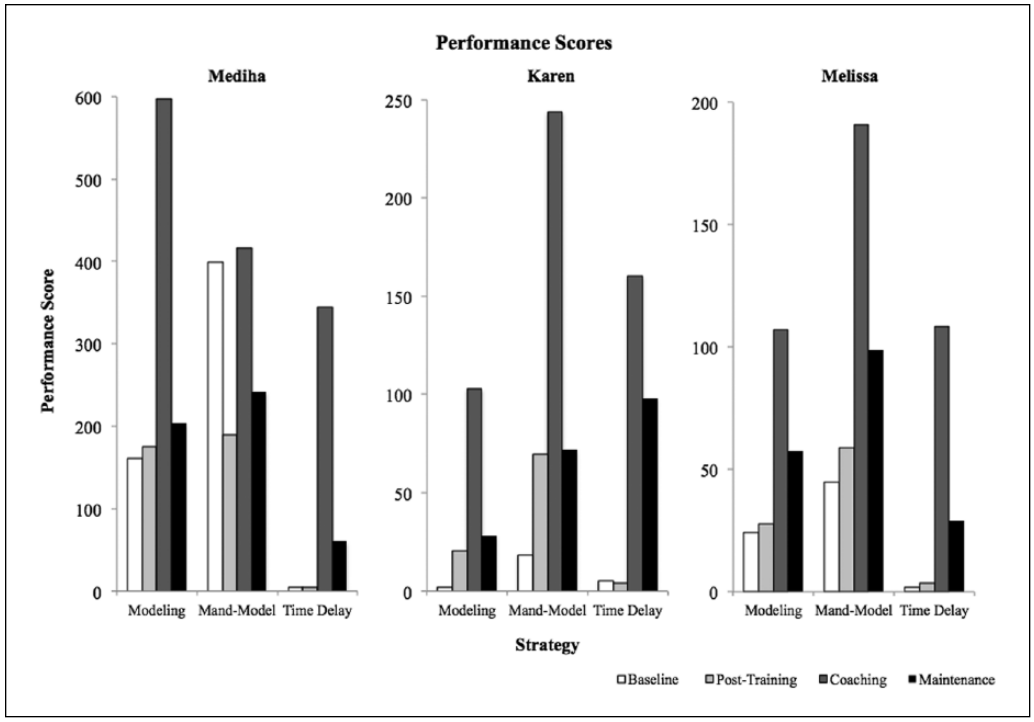

Figure 4. Bar graph of Mediha's, Karen's, and Melissa's performance score for each strategy, calculated by multiplying the average percentage of high-quality strategy use by the average rate of strategy use for each phase.

In sum, Melissa's strategy use from baseline to maintenance reveals increases in rate (shaded bars) for modeling and time delay; mand-model use decreased (see "Discussion" section for a rationale). Melissa's high-quality implementation (line) improved from baseline to maintenance for the mand-model and time delay strategies.

Child behavior. Visual analysis of the bottom tier in Figure 3 revealed a small but consistent increase in Wendy's responsiveness to her mother's strategy use after the training was introduced. Wendy's responsiveness remained at a similar mean level across coaching phases with notable variability. Initiations appear to have increased during coaching phases with the highest and most stable level occurring during time delay.

Performance Score Results Across Families

Although the mothers' data presented in Figures 1, 2, and 3 contribute to the identification of changes in mothers' data across phases when examining the independent effects of high quality and average rate of strategy use, a metric demonstrating their combined effect may provide additional understanding of the overall impact (see mothers' performance scores in Figure 4). Visual inspection of these histograms reveals three key patterns with two exceptions. First, mothers' performance scores reflect a possible gain from baseline to post-training, but this improvement is clear on only three of the nine potential occasions. Second, coaching appears to be the intervention component that has the largest impact on the combined measure of quality and rate of strategy use (clear on all nine occasions); however, a potential sequence effect needs to be

considered. That is, coaching always follows training, and therefore the effect observed with coaching may be dependent on the prior training. Third, although all three mothers' performance scores clearly diminished between the coaching and maintenance phases, their performance in maintenance outpaced that of baseline on all occasions for all three strategies with one exception: Mediha's performance in maintenance was lower than that in baseline for the mand-model strategy (a rationale for this exception is described in the "Discussion" section).

Social Validity

All three parents indicated high satisfaction with the goals, procedures, and outcomes of the i-PiCS program. Parents reported that participating in i-PiCS changed their behavior. They felt that they had learned new skills and strategies to use when they interacted with their children, and that the implementation resulted in positive changes in these interactions. Parents also reported that they felt empowered by the knowledge and skills they learned, and felt comfortable teaching others (e.g., spouse, friends, extended family members) how to use the teaching strategies (e.g., Mediha said, *I felt empowered to teach [the strategies] to other members of the community.*).

Similar to the findings from the face-to-face PiCS intervention, parents who participated in this study and were taught and coached via telepractice expressed high levels of satisfaction with the procedures related to the teaching strategies and felt that they were able to apply the strategies frequently in a variety of different contexts. Finally, while the parents noted many positive aspects of the i-PiCS program, the most encouraging feature was that parents reported that they interacted with their child in new and improved ways. As Karen reported, *I feel like there's more interactions and more positive interactions with George. These strategies are natural and [the researchers] taught me to do them so he could benefit*. The parents also indicated that their children experienced (a) increased involvement in family activities, (b) increased positive interactions, and (c) improved verbal and nonverbal communication.

Discussion

The present study extends previous research in two key ways. First, it provides support for the effectiveness of delivering parent training and coaching from a distance instead of in person. Second, it offers additional support for the PiCS and i-PiCS programs as effective models of training and coaching to facilitate parent-implemented communication intervention. We found that parents learned to implement the targeted naturalistic teaching strategies with fidelity when they were provided with training and coaching over Skype. The parents' implementation of these strategies also corresponded with positive changes in their children's communication skills.

Although the delivery of EI services in children's natural environment (e.g., home) has been identified as a recommended practice (Bruder, 2010; Individuals With Disabilities Education Act [IDEA], 2004), many interventions, including parent-implemented interventions, are not conducted within family homes (Roberts & Kaiser, 2011) due to the daunting challenges encountered. The most vexing challenges are the distances that EI service providers must travel to reach families and the intensity or dosage of the intervention required that is often compounded by distance (Johnson, Brown, Chang, Nelson, & Mrazek, 2011; Kelso, Fiechtl, Olsen, & Rule, 2009). By providing services to families over the Internet, many of the barriers and challenges to home-based service delivery (e.g., the cost of service delivery, the amount of travel time required of the provider, complications with scheduling home visits) may be alleviated (Blaiser, Edwards, Behl, & Muñoz, 2012; Kelso et al., 2009; Olsen et al., 2012; Pickering & Joseph Walsh, 2011; Rock, Zigmond, Gregg, & Gable, 2011). Given that the results of this study are commensurate with the findings from a study using the same procedures in the participants' homes (see Meadan,

Angell, et al., 2014), this study adds to the growing empirical evidence for the validity of telepractice service-delivery models.

One challenge service providers face when supporting parent-implemented intervention is ensuring that the teaching and coaching focus on evidence-based instructional strategies. By creating a training and coaching model for implementing naturalistic teaching strategies, the i-PiCS researchers sought to address this challenge. The findings of this pilot study are consistent with those of other research that supports parent training and coaching as effective methods to enhance children's communication (Dunlap, Ester, Langhans, & Fox, 2006; Kaiser et al., 2000; Meadan, Stoner, et al., 2014; Roberts, Kaiser, Wolfe, Bryant, & Spidaleri, 2014). Although there was variability in the data within and across dyads, the results presented in Figures 1 to 3 reveal, with few exceptions, increases in both the rate and quality of strategy use during coaching. In addition, the data in Figure 4 that display the average performance scores (i.e., combined rate and quality) for each phase of the study confirm a substantial increase from post-training to coaching. Performance scores for all three mothers diminished between the coaching and maintenance phases, but their performance in maintenance outpaced that of baseline on all occasions for all three strategies, with one exception (i.e., Mediha's performance for the mand-model strategy).

A possible explanation for Mediha's lower mand-model performance score in maintenance than in baseline and for Melissa's decrease in rate of mand-model use from baseline to maintenance is that, in baseline, both Mediha and Melissa frequently asked their children yes/no questions (e.g., *Are you hungry? Is this a blue star?*). Ali and Wendy failed to respond to most of the yes/no questions, so during coaching on mand-model, we recommended that Mediha and Wendy use different types of mands that required their children to respond with an answer/word that specified the preferred item they would like to receive (e.g., *Do you want to eat banana or apple? What do you want?*). With coaching, both mothers reduced their rate of yes/no questions and began to use other types of mands at higher levels of quality and were more successful in evoking communication from Ali and Wendy. Although both mothers learned to replace one type of mand with others and, thereby, increased their mastery of the mand-model strategy from the baseline to maintenance phases, this change is not obvious in Mediha's mand-model performance score (see Figure 4) because the change reflects a level of detail that was not recognized by our coding system (i.e., distinguishing among types of mands) and is a possible explanation for the decrease in the rate at which Melissa used this strategy over the course of the study (see Figure 3).

There were no clear results across dyads for children's communication behavior in the multiple-baseline analysis (with the possible exception of initiations in the time delay coaching phase). Throughout the study, the level of children's communicative responding was consistent within a child but varied across the three participants; George was most responsive to his mother's communicative acts and Wendy was least responsive, with Ali somewhere between. Child initiations occurred more often during coaching on time delay than in other phases. This was expected because when parents implemented time delay, they waited for their children to communicate on occasions when their children were motivated and when they were given more time to initiate communication.

Our design meets, with reservations, the What Works Clearinghouse standards for single-case research (Kratochwill et al., 2010). For each parent–child dyad, we conducted at least three sessions in each phase and observed three demonstrations of a basic effect (i.e., across the three teaching strategies). In addition, we carefully planned the study to ensure that we addressed the quality indicators described by Horner et al. (2005). The outcomes were, however, modest when visually inspecting the graphs of parent and child behavior (Figures 1-3). We believe that the outcomes were moderated by three important considerations: the influence of (a) both rate and quality on assessing intervention effects, (b) naturalistic communication strategies on parent implementation, and (c) children's communication targets.

Influence of Rate and Quality

To interpret the results of this study, the percentage of high-quality strategy use and the rate at which the parents used the strategies must be considered in combination. We believed that if we focused on only rate or only quality, we would overlook a fundamental feature of the parents' behavior. To that end, the contribution of each feature is included in the graphs shown in Figures 1 to 3. However, only when the parent used a strategy frequently and also achieved a high percentage of quality strategy use can we conclude that the parent had mastered the strategy. Using visual inspection, the interpretation of the data representing the dependent variables in Figures 1 to 3 is challenging. Thus, we created performance scores (i.e., rate multiplied by percentage of high-quality use) and displayed the average performance score for each phase of the study in histograms (see Figure 4).

Interestingly, the performance scores assume a similar pattern across the three strategies for each family. The patterns of data, in most cases, confirm our expectations. We anticipated low rate and quality of strategy use before training occurred and only small changes in parents' performance following training, as training alone has consistently been shown to have minimal effects on strategy implementation within the context of classroom coaching (Joyce & Showers, 2002). During coaching, when the parents had the opportunity to practice the teaching strategies and to receive feedback on their performance, we expected an increase in both rate and quality of strategy use. Joyce and Showers (2002) claimed that coaching, within the classroom context, facilitates the transfer of training by providing targeted support over time; providing coaching, in addition to training, leads to an increase in both the knowledge of the targeted content and the implementation of the skills. Support for the importance of coaching within the family context was strengthened in recent reviews of the family coaching literature (Barton & Fettig, 2013; Lieberman-Betz, 2015; Roberts & Kaiser, 2011). We found evidence for the impact of coaching with all three parents (i.e., frequent increases in level and trend from post-training to coaching phases).

Influence of Naturalistic Communication Strategies

Naturalistic teaching strategies are designed to closely reflect natural communication exchanges by superimposing behavioral principles onto typical communication exchanges between adults and children (Hart, 1985). Often parents may have already established consistent patterns of interaction, requiring the coach to assist the parent in relinquishing engrained procedures and replacing them with the specific steps delineated in evidence-based practices. We observed this phenomenon in Mediha's and Melissa's unexpected data pattern for the mand-model strategy. In addition to replacing established patterns, the number of naturalistic communication strategies that can be implemented in a 5- to 7-min observation period is limited (i.e., a ceiling effect). Consistent with this hypothesis were two outcomes: reductions in the rate of one strategy's use when coaching was introduced to a new strategy and reductions in the rate of strategy use in maintenance when all strategies had undergone coaching.

Influence of Children's Communication Targets

It is possible that the measures we used to assess child behavior did not focus on the essential features or were not sufficiently sensitive to detect the meaningful changes in the children's communication skills. We coded only the children's initiations and responses to the parents' strategy use; we did not code the topography (e.g., signing, vocalizing, verbalizing) or the function (e.g., request, reject, comment) of the communication behavior. Using a more sensitive coding system or focusing on different features (e.g., topography, function) might have resulted

in clearer findings of the effect of the parents' implementation of these strategies on their children's communication. For example, at the beginning of the study George used his mother's hands to sign *more*, but toward the end of the study, after we coached his mother to encourage George to sign independently, he was signing without touching her. Both these topographies were coded as initiations. This change in topography was not reflected in the data presented.

The third research question of the study focused on its social validity. Analysis of the social validity interviews revealed that all three parents indicated satisfaction with the i-PiCS project, demonstrating that they believed the project (a) improved their teaching, empowerment, and advocacy skills; (b) improved their children's communication (i.e., interactional exchanges, increased participation); and (c) affected family members' use of strategies. One of the key features of best practices in early childhood education is engaging in family-centered practice that empowers parents and families to support their children with disabilities. This feature should be considered when evaluating the effectiveness and usefulness of any intervention (Meadan, Stoner et al., 2014).

Limitations

This study, like any other study, has a number of limitations. We have chosen to discuss five that are among the most salient. One is the variability, and therefore clarity, of the data within and across the three families. In large part, this was due to low frequencies of strategy use that formed the denominator for high-quality calculations. Variability may also have been introduced because we were monitoring two dependent measures of parent strategy use, rate and quality, and the two may not be directly correlated, such that a change in one may not accompany a similar change in the other. Although variability and ambiguity may have been introduced by focusing on these two dependent variables, we believe that it is essential to examine both if we are to obtain an accurate assessment of parent strategy use. Therefore, we included performance scores that were derived by simply multiplying rate times quality; these scores revealed clear changes in each of the three strategies for all three mothers when coaching was introduced (with the exception of mand model for Mediha). In the future, researchers might explore better (more sophisticated) means of capturing rate and quality of strategy use, as well as incorporating the linkage to context (i.e., particular contexts render one strategy more appropriate than others). An important concept that also needs to be explored further is the required dosage of strategy use to produce changes in child behavior.

Characteristics of the parents who participated in the study represent a second limitation. We were collaborating with three highly motivated mothers, two of whom had experience in special education (Karen and Melissa) and all whom had children who were successfully enrolled in EI or early childhood services. These characteristics limit the potential generality of the results and represent a test of the intervention under optimal conditions with regard to participants. Families who face more challenges may not have responded similarly, and these are the families we eventually want to affect. However, when first introducing a novel service-delivery model, testing its efficacy with motivated participants may be warranted. Future investigators need to explore factors that may influence parent responsiveness to this intervention and that might account for variability within and across families (e.g., parent education level, social-economic status, race, training and coaching schedules, and relevant prerequisite skills).

A third limitation of this study is the insensitivity of the measures selected. The behavioral recording (i.e., objective measures) we used may not have been sufficiently sensitive to reveal the changes that the research team and the parents observed and reported (i.e., subjective measures). For example, the child behavior coding system did not include information about the topography or function of children's communication, and the parent behavior coding system did not include information about the type of question the parents asked (e.g., open-ended questions

vs. yes/no questions; see Chung, Snodgrass, Meadan, Akamoglu, & Halle, 2016, for a secondary analysis of George and Wendy's communication). Researchers may find it helpful to develop more sensitive coding systems that are capable of detecting small changes in child and parent behavior that reflect the hypothesized outcomes. In addition, it is important to note that the coaches were the primary observers, and this should be considered as a limitation of the study because of the potential bias it introduces; however, acceptable IOA achieved with naïve coders lessens this concern.

The results of the maintenance assessment, when the coach was not providing feedback, reflect a fourth limitation. All of the maintenance performance scores displayed in Figure 4 decreased relative to the coaching phase but remained higher than in baseline (with the exception of mand model for Mediha). Figures 1 to 3 offer a similar interpretation of the rate data, but the enhanced quality of strategy use appeared to maintain relative to the coaching phase with two possible exceptions. The quality of strategy implementation during maintenance exceeded that of baseline in eight of the nine possible occasions; only modeling for Melissa might have been an exception. Future researchers could explore methods for maintaining rate and quality of implementation by requiring a more rigorous criterion for mastery of each strategy or by shifting more responsibility to the parents for conducting the sessions and asking them to embed sessions in varying routines throughout the day.

A final limitation pertains to interpreting the effects of the intervention. Readers should consider the potential influence of the sequence of the intervention components. We delivered training on all target strategies at once, and then delivered coaching in staggered fashion, one strategy at a time. Coaching appeared to have an effect on parent performance, but the contribution of coaching was not examined independent of the training delivered immediately prior to the coaching. That is, any effect observed during the coaching phases may have depended on the prior training component. At this time, we cannot parse the independent effects of these two intervention components.

Implications for Practice

Although research findings are not yet compelling, telepractice will no doubt become a primary service-delivery option in the future, and, even today, practitioners are beginning to capitalize on the potential of this medium by either replacing or supplementing their in-person services. Specific to the current study, EI providers might adopt or adapt the i-PiCS model to deliver training and coaching to parents focusing on naturalistic communication strategies to encourage language development in their children with substantial delays. If telepractice or i-PiCS is to become a reality for delivering services to families, certain requisite phases need to be met, including (a) ensuring access to high-speed Internet, (b) familiarity with technology, (c) time availability, and (d) motivation to participate. The challenge for practitioners is that the families most in need of services are likely the same ones for whom these requisite conditions may not exist.

Conclusion

The findings of this study contribute to the evidence base supporting parent-training and coaching interventions that enhance the communication skills of children. Specifically, we administered an intervention package that included evidence-based practices (i.e., parent-implemented naturalistic interventions; Odom et al., 2010) embedded in a training and coaching model and demonstrated modest effects on both parent performance and child communication. In addition, we found that providing training and coaching to parents from a distance using videoconferencing and other Internet-based technologies was an effective modality of service delivery. Service

providers may adopt a similar model, often referred to as *telepractice*, to mediate some of the challenges they encounter when providing in-person services to families in their homes.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This project was supported in part by funding from the Office of Special Education Programs, U.S. Department of Education: Project LEAD (H325D100062).

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