Pre-service teacher use of communication strategies upon receiving immediate feedback

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Abstract

The purpose of this research was to investigate the impact of immediate feedback through bug-in-ear eCoaching on early childhood special education pre-service teachers' use of communication strategies using an activity-based intervention approach. Three early childhood special education pre-service teachers participated in this study. A multiple-probe, single-case design was used to determine the effects of immediate feedback through bug-in-ear eCoaching on teachers' use of communication strategies. Results indicate that immediate feedback through bug-in-ear eCoaching enhanced pre-service teachers' use of communication strategies within small-group activities. Implications for practice and future research are discussed.

Keywords: bug-in-ear coaching, communication strategies, pre-service teachers, autism, personnel preparation

Pre-service Teacher Use of Communication Strategies upon Receiving Immediate Feedback

Communication interventions for young children at risk for disabilities as well as those with disabilities is important as oral language is a critical skill that predicts reading comprehension (Lonigan & Shanahan, 2009) and school readiness (Rimm-Kaufman, Pianta, & Cox, 2000). Children who exhibit communication delays are at risk for developing problem behaviors and delays in literacy development (Horner, Carr, Strain, Todd, & Reed, 2002; Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001; Tager-Flusberg et al., 2009). Children with autism frequently experience delays in communication and benefit from interventions targeting specific communication skills (Tager-Flusberg et al., 2009). Therefore, it is important to identify interventions that produce promising communication outcomes for these children.

Embedded Instruction for Young Children with Autism

Embedded-communication interventions are those strategies occurring within typical classroom routines and activities that are designed to increase children's functional communication skills. Numerous studies have demonstrated the effects of embedded-communication interventions on the communication development of children with autism (Rogers & Vismara, 2008; Tager-Flusberg et al., 2009). Unfortunately, it is often a challenge for teachers in inclusive settings to use embedded interventions (Dinnebeil, Pretti-Frontczak, & McInerney, 2009; Jung, Gomez, Baird, & Keramidas, 2008). With strong evidence indicating the effectiveness of embedded interventions to support young children's development (Ozen & Ergenekon, 2011; Rakap & Parlak-Rakap, 2011; Sandall, Schwartz, & Joseph, 2001), it is critical to train pre-service early childhood teachers to use embedded interventions within typical classroom environments.

Embedded-communication interventions are most effective when the intervention begins early, includes social uses of language, and occurs with sufficient intensity to facilitate acquisition and generalization of new skills (Hancock & Kaiser, 2002). Importantly, teaching communication skills in children's natural environments has resulted in increased vocabulary, maintenance, generalization, and spontaneous use of language for children with autism (Mancil, 2009). One approach that is implemented in the natural environment, includes the social use of language, and allows for high intensity and duration of learning opportunities is activity-based intervention (ABI).

ABI is a child-directed approach to teaching that embeds learning opportunities on children's goals and objectives during routines, as well as planned and child-initiated activities (Macy, 2007; Ozen & Ergenekon, 2011; Pretti-Frontczak & Bricker, 2004). Teachers use logically occurring antecedents and consequences to develop functional and generalizable skills (Ozen & Ergenekon, 2011; Pretti-Frontczak & Bricker, 2004). ABI is a well-known, evidence-based naturalistic teaching strategy used throughout the day with children having a wide range of special needs (McBride & Schwartz, 2003; Ozen & Ergenekon, 2011). Although ABI is an effective approach (Pretti-Frontczak, Barr, Macy, & Carter, 2003), it is used infrequently or with limited fidelity by classroom teachers (Horn & Banerjee, 2009; McBride & Schwartz, 2003). Various intervention strategies, including those specific to communication, can be embedded using ABI. Thus, ABI can be particularly beneficial for children with autism, as their communication needs can be addressed multiple times throughout the day within highly motivating activities (Woods, Wilcox, Friedman, & Murch, 2011).

Preparing Pre-Service Teachers to Support Young Children with Autism

Given that evidence-based practices, including ABI, are often not being implemented by teachers in the classroom, a research-to-practice gap exists (McLeskey & Billingsley, 2008). Researchers recognize that learning is enhanced when pre-service teachers are provided multiple opportunities to practice skills (Allsopp, DeMarie, Alvarez-McHatton, & Doone, 2006). Therefore, it is important to allow pre-service teachers opportunities to practice newly acquired skills, such as the ABI approach, during field experiences as this can help teachers apply knowledge and develop proficiency in new skills (Ostrosky, Mouzourou, Danner, & Zaghlawan, 2013) so that children with autism receive the highest quality instruction.

Feedback

Feedback is one characteristic of quality early childhood special education (ECSE) field experiences that is malleable (Macy, Squires, & Barton, 2009); university supervisors and others working with pre-service teachers can modify and adjust feedback to enhance pre-service teacher learning. From their literature review of effective methods for providing feedback, Scheeler, Ruhl, and McAffee (2004) concluded that corrective, immediate, positive, and specific feedback are promising practices that result in changes in teacher behavior. Research indicates that teachers are able to adjust their practices when provided immediate feedback (Hemmeter, Snyder, Kinder, & Artman, 2011; Hsieh, Hemmeter, McCollum, & Ostrosky, 2009; Scheeler et al., 2004). Researchers have since challenged this finding by suggesting that even delayed performance feedback has the potential to change teacher behavior (Solomon, Klein, & Polityl, 2012). Although there is evidence demonstrating positive change in both delayed and immediate performance feedback, a plethora of researchers have examined the immediacy of feedback using bug-in-ear (BIE) coaching (Lindell, 2001; Scheeler, Congdon, & Stansbery, 2010). For

example, Herold, Ramirez, and Newkirk's (1971) research provided early support that immediate feedback given to teachers using BIE coaching was more effective than traditional methods of providing feedback at the conclusion of a supervision session.

Other researchers found less compelling results. For example, Giebelhaus (1994) found that pre-service teachers receiving BIE coaching from cooperating teachers outperformed a control group of pre-service teachers who received traditional feedback from cooperating teachers on only one of the 14 measured behaviors. Further, outcomes of Lindell's (2001) experimental study with pre-service teachers either receiving BIE feedback, delayed feedback, or no feedback were similar, with teachers in the BIE group outperforming the other groups in only one of seven behaviors. Although findings from these two studies seem bleak, there were several implications from these and other early BIE studies (Thomson, Holmberg, Baer, Hodges, & Moore, 1978; Van der Mars, 1988) that have influenced the implementation and, thereby, effectiveness of BIE coaching for pre-service teachers. For instance, university supervisors using BIE coaching now use promising practices such as targeting a small number of discrete-teaching behaviors (Scheeler & Lee, 2002), fading BIE coaching (Scheeler, McAfee, Ruhl, & Lee, 2006), planning for generalization (Scheeler, Bruno, Grubb, & Seavey, 2009), and measuring the type and content of BIE feedback (Kahan, 2002).

The improvements in implementation of BIE coaching have resulted in better outcomes for pre-service teachers. For example, the five pre-service special education teachers in Scheeler and colleagues' (2009) study improved upon their complete use of three-term contingency trials to at least 90% when receiving BIE coaching. In another of Scheeler and colleagues' (2006) studies, BIE coaching was used to improve pre-service teachers' instructional practices, and as a result, some children in their classrooms also improved in their targeted outcomes.

Recently, BIE technology has been used to provide distance, electronic coaching (eCoaching) to pre-service teachers (Rock et al., 2009; Rock et al., 2012; Scheeler, McKinnon, & Stout, 2012). In their seminal study, Rock and colleagues (2009) examined the use of BIE eCoaching on graduate-level teachers' change in teaching behaviors and classroom climate. Their online, wireless technology included an ultra-wide angle web camera, a Bluetooth Headset™, a Bluetooth USB Adapter, and Skype™ video-conferencing software. Rock and colleagues found that BIE eCoaching improved teachers' use of high-access teaching behaviors and praise statements. Furthermore, student engagement increased from 73.8% to 92.7%. Findings from these studies have led researchers to suggest that BIE eCoaching can improve pre-service teachers' instructional practices and children's outcomes.

Scheeler and colleagues (2012) also demonstrated that BIE eCoaching can be an effective and feasible means to provide pre-service teachers with immediate feedback on their teaching practices. Furthermore, Rock and colleagues (2014) provide evidence that the pre-service teachers' and children's outcomes were sustainable with the removal of BIE eCoaching. While these studies provide evidence that immediate feedback provided via BIE eCoaching can increase teachers' use of evidence-based practices, this advanced technology has not been applied to ECSE pre-service teachers teaching in an inclusive environment where children with autism are a part of typical classroom activities and routines. ECSE settings are unique as they are typically inclusive environments where teachers are charged with a challenging task: meeting the needs of diverse learners including those who are typically developing as well as those with developmental delays and disabilities through naturally occurring activities and routines. Further research is needed to identify the effect of feedback on ECSE pre-service teachers' practices, specifically related to effective-teaching strategies (ABI and communication strategies), in

inclusive environments, with children from high-need populations (i.e., autism). This study extends the research on BIE eCoaching by using short 10-min feedback sessions targeting ECSE pre-service teachers in inclusive environments while teaching at least one young child with autism. Further, using a new form of technology, Swivl, allowed the pre-service teachers the flexibility to navigate the classroom environment as they typically would during teaching sessions, which may enhance the feasibility of BIE eCoaching in ECSE settings where teachers are often moving around the classroom as they follow a child's lead.

Research Questions

Although immediate feedback using BIE technology has been found to be effective in changing educators' instructional practices (Scheeler et al., 2004), using immediate feedback through BIE eCoaching is limited and using BIE eCoaching to prepare future teachers in inclusive settings where a young child with autism is present is a new phenomenon. To our knowledge, short (10-min), immediate feedback sessions via BIE eCoaching have not been used with ECSE teachers to increase their use of embedded, evidence-based practices in environments that present challenges for teachers related to embedding optimal learning opportunities for children. Additionally, replication of a practice (i.e., BIE eCoaching) is important to demonstrate a practice is indeed effective (Dunst, Trivette, & Cutspec, 2002; Horner et al., 2005; Odom et al., 2005). The purpose of this study was to examine the impact of 10-min, immediate feedback sessions delivered via BIE eCoaching on pre-service teachers' use of communication strategies within an ABI framework. This study addressed two research questions:

(1) How does immediate feedback provided during field experiences via BIE eCoaching impact ECSE pre-service teachers' use of communication strategies within an ABI framework?

(2) How do pre-service teachers rate the effectiveness of immediate feedback via BIE eCoaching in increasing their use of communication strategies?

Method

Participants and Setting

Participants included three female pre-service teachers (Jordan, Shay, Noelle; pseudonyms) enrolled in a 15-week student teaching internship during their final semester in an undergraduate ECSE licensure program at a large university in the Mid-Atlantic region of the United States. All participants were Caucasian, in their early 20s, and had two years or less experience working with children with disabilities. The first author invited pre-service teachers enrolled in student teaching who were not involved in other research projects (n = 4) to participate in the study. One pre-service teacher declined participation resulting in three participants.

Intervention sessions took place using BIE eCoaching (described below) to provide immediate feedback from a distance during the pre-service teachers' regular student teaching hours. The pre-service teachers were placed in separate inclusive public-preschool classrooms in three elementary schools in the district serving the university community. Each classroom included up to 16 typically-developing children and four children with disabilities between three and five years of age. Implementation of immediate feedback intervention sessions using BIE eCoaching occurred during small-group activities (e.g., an insect dominoes game, an activity measuring plants, playing in sand table with funnels and scoops) planned and carried out by the pre-service teachers as part of their internship. Approximately four children participated in each activity. While group participation in the activities changed (e.g., one child may have participated in some activities but not in others), at least one child with autism was included in

each activity. The children with autism were diverse. Some of the children used single words and other used two-word phrases. All of the children with autism engaged in activities, but presented behavioral challenges at various times throughout the study. The children with autism were always included in the activities and a part of interactions, but the pre-service teachers were provided feedback based on their interactions with all children participating in small-group activities as the goal of this research was to determine the impact of immediate feedback on the pre-service teachers' use of the communication strategies. Pre-service teachers were instructed to use strategies with children who were identified with autism, children presenting developmental delays, and children who were typically developing.

Measures and Materials

Observational measure. An observational event-recording measure was used to record prompts provided by the first or second author and pre-service teachers' use of communication strategies during the first 10-min of each activity. During feedback, we coded the number of prompts delivered, the prompt type (choice making, in sight out of reach, sabotage, wait time; see Table 1), and whether the pre-service teacher responded to the prompt by using it (+) or not using it (-). We also coded the number of times the pre-service teacher used the strategies spontaneously (using a communication strategy without a prompt delivered). Feedback sessions were coded live by the first or second author as feedback was delivered and reviewed via video recordings immediately following each session to check for coding accuracy.

Interobserver agreement. An undergraduate student and a graduate student naive to the study design coded 25% of randomly-selected video-recorded sessions across participants and phases. Interobserver agreement (IOA) was calculated using the total agreement method (Kennedy, 2005). Using this method to calculate IOA, the frequencies with which each behavior

occurred is tallied for the total session. Then, the number of agreements are divided by the total number of agreements plus disagreements and multiplied by 100%. IOA was 93.45% for number of prompts delivered by the coach, 82.89% for pre-service teachers' correct prompted use of strategies, and 80.24% for pre-service teachers' spontaneous use of strategies.

Feedback effectiveness questionnaire. At the end of the study, pre-service teachers completed an online questionnaire developed by the third author to assess the overall effectiveness of the intervention. The purpose of the questionnaire was to answer research question two. The questionnaire included 12 Likert-scale items related to pre-service teachers' perceptions of the effectiveness of BIE eCoaching.

Research Design

Our multiple-baseline, multiple-probe design study (Gast & Ledford, 2010; Horner & Baer, 1978; Horner et al., 2005) was developed based upon What Works Clearinghouse's Standards for Single-Case Design (Kratochwill et al., 2010), meeting standards as the independent variable was manipulated, inter-assessor agreement for at least 20% of data was collected over time, the effect was demonstrated three times , at least five data points were collected in baseline and intervention, and three probe points were collected just prior to introducing intervention for each case. Although only two data points were collected for maintenance and generalization, these phases are not evaluated when judging the overall quality of a single-case research design (Kratochwill et al., 2010). A probe design was selected because it minimizes unnecessary baseline data collection when participants are unlikely to develop the targeted skill without intervention. Based on previous research (Ottley & Hanline, 2014) we believed pre-service teachers' use of communication strategies would be unlikely to change without intervention.

Five baseline data points were collected for all participants prior to the start of intervention with Jordan. When we began intervention with Jordan, we collected additional baseline data for Shay and probe data for Noelle. Intervention continued until a participant met the a priori criterion of using communication strategies more frequently than baseline in eight consecutive sessions. The a priori criterion was established to exceed What Works Clearinghouse's Standards (minimum of five intervention data points; Kratochwill et al., 2010). Eight sessions was the highest dosage of intervention the research team could provide within restrictions related to pre-service teachers' timelines for completing their internship. After participants reached criterion, we collected data during two maintenance probes to analyze their use of the communication strategies without feedback, as well as during two generalization probes in a different type of activity (e.g., circle time, breakfast, choice time) to analyze whether the participants could take the skills learned in one activity and transfer them to another activity.

Intervention

The National Professional Development Center on Autism Spectrum Disorders has grouped ABI, Enhanced Milieu Training (EMT), and other interventions that share common naturalistic elements into the category of Naturalistic Intervention (Wong et al., 2014). The feedback that the first and second authors provided was focused on four communication strategies within an ABI approach. The communication strategies are environmental components of EMT, a naturalistic early language intervention that has demonstrated effectiveness of increasing language complexity and functional communication of children with disabilities (Kaiser & Roberts, 2013). These four specific strategies were chosen as they can be embedded into ABI, and they demonstrate research evidence of effectiveness in enhancing communication outcomes for young children with autism (Coogle, Floyd, Hanline, & Kellner-Hiczewski, 2013).

Only four teaching behaviors were chosen as previous BIE researchers have demonstrated the effectiveness of focusing on a small number of targeted teacher skills (Scheeler et al., 2004). The four communication strategies included choice making, in sight out of reach, sabotage, and wait time. Choice making is offering a choice between two or more materials or activities (i.e., would you like the brown or blue paper); in sight out of reach is providing materials in a child's line of vision but in a place where they could not reach it (i.e., pre-service teacher holding bingo chips in her hand as opposed to placing them in front of the child); sabotage is creating a situation where help is needed (i.e., providing the paper but not the paint to complete a picture); and wait time is pausing before a predictable action (i.e., while singing a song, pausing to wait for a communication attempt). See Table 1 for definitions.

The intervention consisted of a brief training and immediate-feedback sessions. The brief training was provided to pre-service teachers via a narrated PowerPoint presentation that provided information related to using four communication strategies (see Table 1). Pre-service teachers were provided the narrated presentation using Dropbox once they completed baseline sessions and before they started feedback sessions. The immediate-feedback sessions lasted 10 min and were delivered by the first or second author via BIE eCoaching directing the pre-service teachers to use four communication strategies while they were leading planned small-group activities.

Several pieces of technology were used to facilitate the immediate feedback via BIE eCoaching while pre-service teachers were engaged in the act of teaching. The Swivl, a technology released in January 2014, was used in the pre-service teachers' classrooms to hold an iPad with a built in web-camera and Skype™. The Swivl holds the iPad and allows it to move so that the camera function can capture the appropriate view by tracking the teacher's movement

(using a remote in a lanyard). This permitted the pre-service teachers to move about the classroom as they typically would without having to carry the iPad with them. All sessions were recorded using ECamm™ (for Mac) and Evaer™ (for PC) software which allowed for simultaneous video-recording of the pre-service teacher and children, and audio-recording of the first or second author providing feedback. This software was compatible with Skype™ and installed on the first and second authors' computers to allow for recording of sessions.

During intervention sessions, the first or second author delivered prompts from her university or home office to the pre-service teacher in the classroom using BIE eCoaching, which included a wireless Blue Tooth™ device (an ear piece worn by the pre-service teacher) and Skype™ with video installed on the first and second authors' computers and the iPad. The first or second author was able to see and hear the pre-service teachers and children, but the pre-service teachers only received audio-feedback via the Blue Tooth™ device. The video setting on Skype™ was turned off and the Blue Tooth™ was used to transmit audio-feedback so that the pre-service teachers could hear the feedback while minimizing distractions in the classroom.

During feedback sessions, the first or second author would receive a call from a participant on Skype™ from her university or home office. The first or second author delivered a maximum of 9 prompts per session (mean = 6.60, range = 3-9). The first or second author's goal was to provide one prompt per minute; however, as pre-service teachers began using strategies spontaneously and based on the type of activity, this was not always feasible (pre-service teachers were maximizing the strategies that could be used based on the type of activity they were implementing). During each prompt, the first or second author directed the participant to use one of the four communication strategies (e.g., "Give Max a choice of which color scissors he would like to use." [choice making]; "Put the glue out of reach and wait for him to request it."

[in sight out of reach]. At least two types of communication strategies were prompted in each session. The first or second author provided affirmative feedback for prompts used correctly [e.g., "Good job giving him a choice."] or corrective feedback for prompts used incorrectly [e.g., "Next time wait before giving him the crayons."]). These feedback prompts are consistent with Scheeler and colleagues' (2004) literature review on effective methods to provide performance-based feedback, namely to provide specific prompts with immediate, positive, and corrective feedback opportunities.

Fidelity of implementation. Fidelity of implementation (FOI) was coded for the same 25% of videos that were coded for IOA using a FOI checklist (see online supplementary materials) developed by the second author that examined: prompts delivered (i.e., number of prompts; type of prompts; specific nature of prompts); feedback given on participants' correct and incorrect use of intervention strategies; the number of different communication strategies prompted (i.e., at least two); and, adaptation of number of prompts provided based on participants' spontaneous use of the strategies. FOI was calculated by dividing the number of checklist items completed by the total number of items and multiplying the quotient by 100%. FOI for the current study was 93.22%.

Procedure

Prior to initiating the study, permission was received to conduct the study from the university institutional review board and school district. The first author obtained informed consent from pre-service teacher participants and children enrolled in the classrooms in which the intervention would take place. Children whose parents did not provide consent were directed by the classroom teacher to engage in other activities during research sessions.

Baseline. No training was provided prior to baseline. Pre-service teachers had, however, received instruction on using communication strategies within two university courses prior to student teaching as part of their regular coursework. During baseline, pre-service teachers were asked to use a flip camera to record between five (Jordan) and 10 (Noelle), 10-min videos of themselves leading a small-group activity that included at least one child with autism. Videos were analyzed for number of spontaneous communication strategies used by the pre-service teacher.

Intervention. After establishing a stable baseline, Jordan was asked to watch a narrated PowerPoint presentation that provided a description and examples of the four communication strategies. Then the first or second author delivered 10-min feedback sessions via BIE eCoaching two times per day for four days. The intervention was introduced to the remaining two participants following the multiple-baseline staggered-introduction schedule. The first and second author delivered a total of eight sessions to Jordan and Shay, but only seven sessions to Noelle due to difficulty establishing an Internet connection during one session.

Maintenance and generalization. Participants recorded maintenance data when they reached the a priori criterion (i.e., eight sessions above baseline); given the technical difficulties noted above, Noelle began recording maintenance data after seven sessions. During maintenance, the first author asked participants to use a flip camera to record themselves leading two 10-min small-group activities across two days. After completing the two maintenance sessions, the first author asked participants to record themselves teaching for 10 min during a routine other than small-group activities (e.g., mealtime, circle time, choice time).

Data Analysis

The third author graphed pre-service teachers' prompted and spontaneous use of communication strategies in each session. The authors analyzed data using visual inspection of graphs and calculation of effect sizes. The authors examined graphs for changes in level, trend, and variability within each phase (Kratochwill et al., 2010). In addition, the authors examined data across phases for immediacy of the effect, overlap, and the consistency of the data across participants during baseline and intervention phases (Kratochwill et al., 2010). The first and second authors calculated effect sizes using percentage of all non-overlapping data (PAND; Parker, Hagan-Burke, & Vannest, 2007; Parker, Vannest, & Davis, 2011) and robust improvement rate difference (IRD; Parker, Vannest, & Brown, 2009; Parker et al., 2011).

PAND was selected for its utility in detecting power in multiple-baseline designs (Parker et al., 2007). PAND is the percentage of data remaining after all overlapping data points have been removed (Parker et al., 2011). PAND was calculated by removing overlapping data points, calculating the ratio of remaining data to all data points, and subtracting the ratio from 1 to convert the effect size to a 0 to 100 scale (Parker et al., 2011). PAND is correlated with other effect size metrics including Phi^2 (.90) and R^2 (.87; Parker et al., 2007).

Robust IRD was calculated as a second effect-size measure because it is equivalent to robust Phi, thus providing a common metric for future meta-analyses that might include this study (Parker et al., 2011). Robust IRD is the difference in improvement rates between phases A and B. The first and second authors calculated Robust IRD by removing overlapping (i.e. improved) data points and then adding half of the total improved points to the proportions for each phase (Parker et al., 2011). Robust IRD is the difference between these proportions. Distributing the improved data points across phases is what distinguishes robust IRD from

traditional IRD in which improved data points are accounted for only in the phase in which they occurred. Robust IRD is equal to Cramer's V and Cohen's Kappa (Parker et al., 2011).

For each participant, the first and second authors calculated effect sizes between baseline and intervention, baseline and maintenance, and baseline and generalization phases. For intervention, the first and second authors calculated effect sizes for both spontaneous and prompted use of communication strategies, whereas only spontaneous effect sizes were calculated for maintenance and generalization because prompting did not occur during these phases. The first and second authors calculated omnibus effect sizes across participants by averaging effect sizes across participants as recommended by Parker and colleagues (2009). Finally, Likert-scale item responses on the teachers' questionnaires were summarized.

Results

Jordan

Within the baseline phase, Jordan had a zero-celerating slope with one instance of communication strategies used across all five baseline sessions (see Figure 1). Once intervention began, there was an immediate effect on Jordan's prompted use of communication strategies, and an accelerating and improving trend. During intervention, Jordan produced a correct response for 89.47% of prompts. Variability ranged from 3-9 prompted uses per session with a mean (level) of 6.38. There were no overlapping data points between baseline and intervention. Similarly, the data revealed an immediate effect on Jordan's spontaneous use of communication strategies and an accelerating and improving trend. Variability ranged from 0-30 uses per session with a mean of 11.88. There was one overlapping data point between baseline and intervention. In maintenance sessions, Jordan used 12 and 7 strategies spontaneously, with no overlapping data between baseline and maintenance conditions. In generalization sessions, Jordan used 0 and 23

strategies spontaneously with one overlapping data point between baseline and generalization. The effect sizes for Jordan ranged from 65% to 100% across intervention, maintenance, and generalization phases as measured by PAND and Robust IRD, indicating a moderate to strong effect of immediate feedback via BIE eCoaching on Jordan's use of communication strategies (see Table 2; Parker et al., 2007, 2009, 2011).

Shay

Within the baseline phase, Shay had a zero-celerating slope with one instance of communication strategies used across all eight baseline sessions. Once intervention began, there was an immediate effect on Shay's prompted use of communication strategies, producing an accelerating and improving trend. Variability ranged from 3-7 prompted uses per session with a mean (level) of 5.13. There were no overlapping data points between baseline and intervention. Shay responded correctly to 80.39% of prompts. The data revealed a gradual effect on Shay's spontaneous use of communication strategies and an accelerating and improving trend. Variability ranged from 0-17 uses per session with a mean of 7.75. There was one overlapping data point between baseline and intervention. In maintenance, Shay used 7 and 12 strategies spontaneously with no overlapping data between baseline and maintenance conditions. In generalization sessions, Shay used 4 and 5 strategies spontaneously with no overlapping data points between baseline and generalization. Shay had an effect size ranging from 63% to 100% as measured by PAND and Robust IRD, suggesting a moderate to strong effect throughout all phases (see Table 2).

Noelle

Within the baseline phase, Noelle had a zero-celerating slope with zero instances of communication strategies used across eight baseline and two probe sessions. Once intervention

began, there was an immediate effect on Noelle's prompted use of communication strategies, producing an accelerating and improving trend. Variability ranged from 2-8 prompted uses per session with a mean (level) of 5.29. There were no overlapping data points between baseline and intervention. Noelle responded correctly to 84.09% of prompts. Similarly, the data revealed an immediate effect on Noelle's spontaneous use of communication strategies and an increasing and improving trend. Variability ranged from 2-20 uses per session with a mean of 10.14. There were no overlapping data points between baseline and intervention. In maintenance, Noelle used 16 and 24 strategies spontaneously with no overlapping data between baseline and maintenance conditions. In generalization, Noelle used 25 and 12 strategies spontaneously and had no overlapping data points between baseline and generalization. Noelle maintained an effect size of 100% throughout all phases of the study signifying a strong effect (see Table 2).

Results across Participants

Data patterns were similar across participants, with minimal use of the strategies by any pre-service teacher prior to intervention. The amount of accurately implemented prompted strategies was also similar across participants at about six uses per 10-min session. This level of implementation is consistent with the amount of prompts that the first or second author was providing to participants. The change in spontaneous use of strategies was immediate for two participants and gradual for one, with positive accelerating trends for all participants. Variability was observed across participants for maintenance and generalization. Three demonstrations of an effect of the intervention (immediate feedback via BIE eCoaching) were observed, and because there are not specific guidelines for maintenance and generalization, this study meets What Works Clearinghouse Standards for Single Case Design Research (Kratochwill et al., 2010). Therefore, effect sizes were calculated to determine the magnitude of the intervention's

effect for the participants. The omnibus test was used to calculate the size of effect across participants. The results indicated a strong effect of the intervention across participants evidenced by an effect size of 86% to 100% across all participants measured by PAND and Robust IRD (see Table 2).

Social Validity

Social validity is a critical component of research as it measures the practical application of research (Horner et al., 2005). The feedback effectiveness questionnaire was used to rate pre-service teachers' perceptions of immediate feedback via BIE eCoaching on their use of communication strategies. Results suggest that pre-service teachers perceived immediate feedback via BIE eCoaching to be an effective way to change pre-service teacher practices and child outcomes (see Table 3). Specifically, pre-service teachers indicated immediate feedback through BIE eCoaching was a helpful intervention that improved their communication practices and helped improve the quantity and quality of children's communication. Additionally, teachers were confident that they would continue using communication strategies in the future.

Discussion

Our results support prior BIE eCoaching findings that suggest feedback provided from a distance enhances teacher practices (Rock et al., 2009; Rock et al., 2012; Scheeler et al, 2012). This study adds to the literature base of BIE eCoaching by investigating a unique population of participants, ECSE pre-service teachers in inclusive environments serving young children with diverse abilities, including those with autism. Inclusive environments have become more common placements for children with disabilities, but have also been identified as environments that present challenges for teachers (Berry, 2010). This study addresses how 10-min immediate feedback sessions impact ECSE pre-service teachers' use of embedded-communication strategies

within naturally occurring activities, which is an additional novelty to this research. Further, this study provides information regarding immediate feedback, generalization across routines, unique participant and setting influences, and implementation science, all of which are novel to this line of inquiry.

Effectiveness of the Intervention

Our first research question addressed whether or not pre-service teachers would increase their use of communication strategies when provided immediate feedback using BIE eCoaching. As in other BIE eCoaching studies, the participants in our study increased their use of the targeted skill (Rock et al., 2009; Rock et al, 2012; Scheeler et al., 2012). Specifically, all participants increased their use of communication strategies. Additionally, data suggest that participants were able to maintain these strategies without feedback and generalize these strategies into some new routines. Our finding that teachers maintained their use of strategies aligns with results obtained by previous researchers (Rock et al., 2014; Scheeler et al., 2012) and our results that generalization may be possible extend the BIE eCoaching research. Additionally, it is important to consider the benefit of ABI as it is an effective teaching method in which teachers use naturally occurring routines and activities to embed learning goals tailored to the diverse needs of children within an inclusive ECSE teaching environment (McBride & Schwartz, 2003; Ozen & Ergenekon, 2011). This method, however, is infrequently used by teachers (McBride & Schwartz, 2003). These findings demonstrate immediate feedback using BIE eCoaching may be an effective means in increasing pre-service teachers' use of evidence-based communication strategies within an ABI framework in inclusive ECSE settings. An additional point of consideration related to the effectiveness of the intervention is the social validity data that suggest pre-service teachers found this intervention helpful in producing both teacher and

child change, which is consistent with previous BIE eCoaching findings (Rock et al., 2009; Rock et al., 2012; Scheeler et al., 2012).

Generalization across Routines

Our study is unique to other BIE eCoaching studies as we collected generalization data. Data suggest pre-service teachers were able to generalize strategies into some new routines; however, variability exists related to the types of routines. Jordan, for example, used 0 communication strategies during circle time; however, when she was working one-on-one with a child during choice time, she used over 20 communication strategies. Shay and Noelle, demonstrated generalized use of the strategies during their generalization sessions which took place during a mealtime routine, choice time, and gross motor play, all of which were child-led activities. These preliminary data indicate pre-service teachers were successful in generalizing strategies to individual or small-group child-led routines and activities; however, Jordan did not generalize communication strategies into a large-group, teacher-led activity (i.e., circle time). Because Jordan was the only pre-service teacher who engaged in a large-group, teacher-led activity within the generalization phase, it is difficult to determine if this was a result of the type of activity or pre-service teacher difference. Nevertheless, this finding suggests a need to conduct further research related to immediate feedback and generalization across routines to examine how effective strategies can be implemented in all types of activities. It is likely also necessary to specifically plan or program for generalization (Stokes & Baer, 1977) of strategies to determine whether the strategies coached in one routine (e.g., small group activities) generalize into other routines (e.g., circle time) that may present more challenges for early childhood teachers.

Participant and Setting Influences

Although all participants increased their use of communication strategies and had an accelerating trend within the intervention phases, there was a high level of variability in participants' spontaneous use of strategies. This finding could have several explanations. Our anecdotal observations suggest this may be due to the participants' comfort level, the nature of the instructional setting, and/or child characteristics. Pre-service teachers may need different levels of support. Jordan appeared to manage multiple contextual variables (receiving technology-enhanced feedback, leading an activity, managing technological issues, etc.) with more ease than Shay and Noelle. In addition, Jordan was in a highly-structured, adult-directed setting whereas Shay and Noelle were in less structured and more child-directed environments. Additionally, the children in each of the settings had different characteristics. For example, some children with autism were more communicative and more engaged than others, which anecdotally appeared to impact the number and types of communication strategies being used. Future research should continue to investigate the associations between contextual variables and targeted outcomes of BIE eCoaching.

Although data suggest the intervention was effective for all participants, these findings indicate a need to differentiate supports between participants when providing immediate feedback using BIE eCoaching. This may mean providing an increased dosage of feedback for certain participants. Additionally, developing systematic fading procedures as participants progress through phases of the study may be effective in decreasing variability and increasing the effect of intervention across phases. Overall, as participants moved through each intervention session, they increased their use of the strategies. Most importantly, all participants significantly increased their use of communication strategies within all phases subsequent to baseline. These

findings provide information to consider such as dosage and fading procedures when developing future research related to tailoring intervention procedures to participants.

Teacher Perceptions and Implementation Science

Our second research question addressed how pre-service teachers rated the effectiveness of immediate feedback via BIE eCoaching. Similar to other BIE eCoaching research (Rock et al., 2009; Rock, 2012; Scheeler et al., 2012), pre-service teachers had positive experiences with BIE eCoaching. Specifically, all pre-service teacher responses to the feedback effectiveness questionnaire suggested perceived positive change for both the pre-service teacher and child participants. This finding is an important consideration as the social validity of interventions is critical when considering mechanisms to bridge the research-to-practice gap. For example, Odom, Cox, and Brock (2013) describe how adopters of evidence-based interventions for students with autism consider the "appropriateness and feasibility of the practice or program" (p. 236) when choosing which evidence-based practices to adopt and implement.

Finally, this research adds to the implementation science literature base. That is, moving an effective practice (communication strategies within an ABI model in this case) from a known effective practice with little implementation in classrooms, to a practice taking place in the real world (Fixsen, Blase, Naoom, & Wallace, 2009; Odom et al., 2013). Notably, Fixsen and colleagues (2009) identify coaching as an essential core component of implementing evidence-based practices in real-world settings. The data from this study provide preliminary evidence that providing immediate feedback to pre-service teachers using BIE eCoaching while working with children with diverse abilities, including those with autism, may provide an additional pathway to ameliorate the research-to-practice gap in inclusive early childhood classrooms and aid pre-service teachers in the application of evidence-based practices.

Implications for Practice and Future Research

Future research to extend this line of study includes examining settings, dosage and fading procedures, and child outcomes. Examining the impact of immediate feedback across various routines and educational settings are topics for researchers to consider in learning more about pre-service teacher preparation and their use of evidence-based practices in inclusive settings. Further, differentiating the intensity with which prompts are delivered to participants may be an effective support option. In addition, intervention practices that use specific procedures, such as a fading phase, may support participants in maintaining a higher level of the dependent variable and in generalizing use of intervention strategies to new activities. For example, providing feedback across activities (e.g., small-group, circle time, mealtimes) to potentially support pre-service teachers in learning how to generalize these strategies across activities may have beneficial outcomes. An additional consideration is providing a fading phase to provide learning opportunities to children when support is lessened and removed. Examining child outcomes as a result of teacher use of evidence-based practices would provide insightful information regarding the impact of immediate feedback beyond its impact on teacher behaviors (Ottley, Ferron, & Hanline, in press).

Limitations

Although this research demonstrates promising practices for increasing pre-service teachers' use of evidence-based communication strategies, it is important to identify the limitations of this research. First, this study was specific to three pre-service teachers with similar demographic characteristics and the findings should not be overgeneralized. The extent to which these findings will replicate with different participants in other settings warrants further investigation. Second, more data points within maintenance and generalization would have

increased our confidence in the findings regarding the maintenance and generalized use of the communication strategies. Third, providing the narrated presentation right before the start of intervention may be a limitation as it is difficult to determine if the use of the strategies is the result of BIE eCoaching or the training plus BIE eCoaching. Finally, different procedures were used to collect baseline, maintenance, and generalization data than intervention data (flip camera versus iPad). Therefore, this may have created some limitations related to the pre-service teachers' understanding of what was taking place in each phase.

Conclusion

Findings from this study suggest using 10-min immediate feedback sessions via BIE eCoaching has the potential to increase pre-service ECSE teachers' use of one evidence-based practice: embedded-communication strategies through activity-based intervention. Findings indicate immediate feedback paired with BIE eCoaching may increase pre-service teachers' application of embedded intervention practices such as communication strategies in inclusive environments with a growing population of children, those identified with autism. This research supports BIE eCoaching literature in two ways: participants' increased use of targeted skills and their perceived effectiveness of BIE eCoaching. However, our research adds to the BIE eCoaching literature base by using new technology (i.e., swivl) and a complex single-case design (multiple probe) to investigate the impact of 10-min feedback sessions during naturally occurring activities on ECSE pre-service teachers' use of communication strategies. An additional unique aspect of our research is that our results suggest immediate feedback via BIE eCoaching increased teacher's use of communication strategies in an ECSE inclusive setting while supporting a growing population of children, those with autism. Unlike prior BIE eCoaching

studies, we provide both maintenance and generalization data, and identify considerations for the implementation science literature base.

Special educators are learning much about evidence-based practices and enhancing child outcomes for children with autism. Still, it is critical to consider how to bridge the gap between research and practice. One way to ameliorate this gap is defining and providing high-quality pre-service teacher preparation. Instruction on evidence-based practices in the higher-education classroom alone is not enough to promote pre-service teachers' use of these practices with children (Hemmeter et al., 2011; Hsieh et al., 2009; Rock et al., 2013). Although the pre-service teachers in our study completed coursework on evidence-based practices, including communication strategies, in the semester prior to the study, their baseline data suggested they were not using these strategies in the classroom. This mirrors previous findings which suggest that although traditional didactic approaches to pre-service teacher training lack effectiveness, professional development activities associated with practice, interaction, collaboration, and linkage to outcomes are associated with increased teacher use of targeted skills (Hemmeter et al., 2011; Hsieh et al., 2009; Rock et al., 2013). It is critical that university supervisors provide pre-service teachers practice opportunities using effective feedback methods. The findings from this study are unique as they demonstrate that using short (10-min) sessions with immediate feedback through BIE eCoaching has the potential to bridge the research-to-practice gap by increasing pre-service teachers' use of one evidence-based practice, specifically, embedded-communication strategies using an ABI approach within an ECSE inclusive setting while working with young children identified with autism.

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Table 1

Communication Strategies

Strategy	Definition	Examples	Exclusions
Choice making	A choice between at least two items where any response would be appropriate	Would you like the blue or yellow paint? Which Lego would you like (among more than 2 options)?	Does not include basic, teacher directed questions that only have one correct response
In sight out of reach	Placing desired objects in a place where the child can see it but cannot reach it	Placing pointer needed for calendar activity on high shelf Holding onto container with blocks and asking child to request blocks rather than giving all blocks at once	Does not include objects that are up high without purposeful placement

Sabotage	Creating a situation where help is needed that provides a purposeful communication opportunity	Providing materials that require assistance to access (e.g., game pieces in a clear jar with tight lid) Not providing all necessary materials (e.g., paint without the paper or paint brush)	Does not include content related items unless obviously used to create a communication opportunity (e.g., asking a child to count 100 beads)
Wait time	A 3-sec or longer pause before providing necessary or desired materials	Before providing the child their milk at breakfast wait for child to communicate Before getting a favorite toy wait for child to communicate	Does not include when used with another strategy (e.g., placing an object in sight out of reach and pausing for the child to request)

Table 2

PAND[a] and Robust IRD Within and Across Participants

Phase	Intervention (prompted)	Intervention (spontaneous)	Maintenance	Generalization
Participant 1				
PAND	100%	92%	100%	86%
Robust IRD	100%	94%	100%	65%
Participant 2				
PAND	100%	81%	100%	100%
Robust IRD	100%	63%	100%	100%
Participant 3				
PAND	100%	100%	100%	100%
Robust IRD	100%	100%	100%	100%
Omnibus				
PAND	100%	91%	100%	95%
Robust IRD	100%	86%	100%	88%

[a]PAND is Percentage of All Non-overlapping Data.

Table 3

Feedback Effectiveness Questionnaire

	Participant 1	Participant 2	Participant 3
Receiving immediate feedback via bug-in-ear was helpful in changing my communication practices with young children.	Strongly Agree	Agree	Strongly Agree
Receiving immediate feedback using bug-in-ear is something that I would recommend to other students in pre-service teacher training programs.	Strongly Agree	Agree	Strongly Agree
The Swivl technology was helpful in the receipt of bug-in-ear feedback.	Agree	Agree	Strongly Agree
Using the technology to receive feedback was manageable.	Strongly Agree	Neutral	Agree
I currently use *wait time* very well.	Agree	Agree	Agree
I currently use *choice making* very well.	Agree	Strongly Agree	Strongly Agree
I currently use *sabotage* very well.	Agree	Agree	Agree

I currently use *in sight, out of reach* very well.	Agree	Agree	Strongly Agree
I am confident that I will continue to use *wait time* without receiving bug-in-ear feedback.	Agree	Agree	Strongly Agree
I am confident that I will continue to use *choice making* without receiving bug-in-ear feedback.	Agree	Strongly Agree	Strongly Agree
I am confident that I will continue to use *sabotage* without receiving bug-in-ear feedback.	Agree	Agree	Strongly Agree
I am confident that I will continue to use *in sight, out of reach* without receiving bug-in-ear feedback.	Agree	Strongly Agree	Strongly Agree
When I used the communication strategies, the children communicated more regularly.	Strongly Agree	Strongly Agree	Strongly Agree
When I used the communication strategies, the children communicated more effectively.	Strongly Agree	Strongly Agree	Agree

Figure 1

Results