A Comparison of Staff Training Methods for Effective Implementation of Discrete Trial Teaching for Learners with Developmental Disabilities

by

Kaneen Barbara Geiger

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Approved by

Linda A. LeBlanc, co-chair, Professor of Psychology
James E. Carr, co-chair, Professor of Psychology
M. Christopher Newland, Professor of Psychology
Jennifer M. Gillis, Associate Professor of Psychology

Abstract

Discrete trial teaching is an effective procedure for teaching a variety of skills to children with autism. However, it must be implemented with high integrity to produce optimal learning. Behavioral Skills Training (BST) is a staff training procedure that has been demonstrated to be effective. However, BST is time and labor intensive, and with the high staff turnover in human service delivery settings, a more efficient staff training method is needed. A computer-based instruction (CBI) program could be an alternative if the program is as effective as BST but is more efficient and cost-effective. The current study compared computer-based instruction to BST to train novice undergraduate students to conduct discrete trial teaching. The two procedures were designed to include optimal instructional components but the delivery and specific response requirements varied across the two experimental conditions. Participants were matched on pre-test performance, randomly assigned to one of the conditions and reevaluated at the completion of training. This study compared the effectiveness, efficiency, and acceptability of the two training procedures to determine if CBI offered a viable alternative to BST. Results indicated that although both BST and CBI were effective at training participants to implement discrete trial teaching, BST was slightly but significantly more effective.

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Autism is a developmental disorder first identified by Leo Kanner (1943) based on his careful observations of 11 patients. Kanner described the patients as being socially aloof, generally having adequate language but not using it to communicate, and exhibiting an insistence on sameness or resistance to change. The definition of autism has been refined over time to allow for more precise diagnosis (Volkmar, Chawarska, & Klin, 2005). Currently, autism is classified in the Diagnostic and Statistical Manual of Mental Disorders (4th ed., text revision) under the class of Pervasive Developmental Disorders (American Psychiatric Association, 2000). The core deficits include qualitative impairments in communication and social interaction and excesses in restricted, repetitive and stereotyped patterns of behavior. Common communication problems include language delays, problems initiating or sustaining a conversation, and use of stereotyped, repetitive or idiosyncratic language. Social interaction problems include poor peer relationships, poor use of nonverbal behaviors (e.g., eye contact, facial expressions) to regulate interactions, and a lack of social or emotional reciprocity. Finally, ritualistic and repetitive behavior includes intense interests, strict adherence to nonfunctional routines, and stereotyped and repetitive movements (e.g., hand flapping).

Autism, which has increasingly come to be viewed as a spectrum disorder encompassing milder to more severe forms, has been diagnosed much more frequently over the past two decades. Previous epidemiological studies estimated approximately 3.4 in 1000 live births resulted in autism (Yeargin-Allsopp et al., 2003) while the current estimate has doubled to approximately 6.7 in 1000, or 1 in 150 children diagnosed with an autism spectrum disorder (Centers for Disease Control and Prevention, 2007). Males are four times more likely to be affected by autism than females (Yeargin-Allsopp et al., 2003), though females are more likely to have comorbid mental retardation (Centers for Disease Control and Prevention, 2007).

Treatment for Autism

Of the many treatments for autism, applied behavior analysis (ABA) offers the only intervention that has produced consistent empirical evidence of significant improvements in core deficits and overall intellectual and adaptive functioning (Eldevik et al, 2009; Green, 1996; Rogers & Vismara, 2008). Early intensive behavioral intervention (EIBI) generally consists of up to 40 hours per week of intensive one-to-one training with the child using common ABA instruction techniques, such as prompting, reinforcement, shaping, and modeling to teach new skills (Green, 1996). Early intensive behavioral intervention was initially developed as the UCLA Young Autism Project, which was detailed in Lovaas' (1987) landmark paper. Lovaas (1987) found that EIBI produced a significant improvement in IQ and adaptive functioning over control groups with 47% of the EIBI group with normal intellectual functioning and successfully integrated in general education post intervention, compared to 2% of the control group. A number of recent studies have replicated the finding that EIBI produced significant increases in the intellectual and adaptive repertoires of children with autism (Cohen, Amerine-Dickens, & Smith, 2006; Eldevik, Eikeseth, Jahr, & Smith, 2006; Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Sallows & Graupner, 2005; Smith, Eikeseth, Klevstrand, & Lovaas, 1997).

In their replication of Lovaas' (1987) seminal early intervention paper, Cohen et al. (2006) found that after three years, the EIBI group had significantly higher IQ and adaptive behavior scores than the comparison group with a typical special education curriculum. Of the 21 participants in the EIBI group, 6 advanced to regular education without support and 11 advanced with support, compared to only 1 of 21 who advanced to regular education in the comparison group (Cohen et al., 2006). Howard et al. (2005) found similar results when they compared EIBI with "eclectic" special education interventions and non-intensive special education curricula. The EIBI group had higher mean standard scores than both groups in cognitive and adaptive functioning (Howard et al., 2005).

Recently, researchers have examined variations of the traditional UCLA 40-hour a week in-home delivery model and showed similar effectiveness (e.g., Eldevick et al., 2006; Sallows & Graupner, 2005). Sallows and Graupner compared the traditional EIBI intervention to a parent-directed group with equal hours of instruction, but less supervision. After four years of treatment, they found the groups to have similar improvements in intellectual and adaptive skills (Sallows & Graupner). Additionally, out of both groups, 48% of the children had advanced to regular education classrooms, which was consistent with Lovaas' original findings. Alternatively, Eldevick et al. compared lower intensity EIBI (12 hours per week) with eclectic interventions. After two years of treatment, they found the EIBI group made larger improvements than the eclectic group (Eldevick et al.). However, the results were not as robust as previous research with more hours per week of the EIBI intervention, suggesting that length of instruction is a critical variable to effectiveness.

Discrete trial teaching (DTT) is the technique most often used in EIBI (Leaf & McEachin, 1999; Smith, 2001). The discrete trial is a brief learning unit that lasts approximately 5 to 20 seconds (Smith, 2001). Discrete trials are presented rapidly (approximately 3 to 12 per minute) to maximize the learning opportunities in each teaching session (Smith, 2001). The discrete trial is broken up into five parts, the discriminative stimulus (S^D), the prompt, the learner's response, the consequence and the intertrial interval (Leaf & McEachin; Smith). In the context of instruction, the S^D refers to the stimulus, or stimuli, that will signal the availability of reinforcement and will come to evoke the target response. The S^D is commonly referred to as the instruction, but it may also include additional instructional stimuli (e.g., pictures) for some skills. The prompt is another discriminative stimulus that reliably evokes the target response, and is used at the same time as or immediately after the instruction to increase the likelihood that the target response is emitted and reinforced. The prompt is eventually faded and removed so that only the terminal target S^D evokes the target behavior. The learner's response refers to either emitting the target behavior or an incorrect response. The consequence refers to the instructor's response to the learner's correct target behavior or error. Occurrences of the target behavior result in immediate reinforcement, such as praise, small snacks, or toys, whereas occurrences of incorrect responses result in extinction or error correction. Finally, the intertrial interval refers to the brief period of time (approximately 1 to 5 seconds) between the consequence and the presentation of the next S^D, where no instruction occurs. Discrete-trial teaching can be used to teach a number of language and academic skills including vocal and motor imitation, simple and conditional discriminations, tacts, and intraverbals (Smith 2001, Sundberg & Partington, 1999).

The behavior analytic research upon which EIBI and DTT procedures are based, was conducted with a high level of procedural integrity to demonstrate a functional relationship between the intervention and the outcomes (e.g., Davis, Smith, & Donahoe, 2002). In practice, similarly high levels of treatment integrity may be required if clinicians expect similar change in consumers' functioning. Unfortunately, behavioral interventions implemented in applied settings are at a risk for low procedural fidelity (McIntyre, Gresham, DiGennaro, & Reed, 2007) which can limit the effectiveness of the procedure. Malouf and Schiller (1995, p. 423) articulated the importance of treatment integrity in applied settings saying, "The process of applying research in special education can never be better than the local practitioner is able to make it." Training studies have shown a positive relationship between improved instructor accuracy and improved learner performance (Crockett, Flemming, Doepke, & Stevens, 2007; Downs, Downs & Rau, 2008; Koegel, Russo, & Rincover, 1977; Lefasakis and Sturmey, 2007). Additionally, Bibby, Eikeseth, Martin, Mudford, and Reeves (2001) and Smith, Buch, and Gamby (2001) have found that parent-directed EIBI programs produced, at best, modest effects and attributed at least part of the reduced effectiveness to decreased quality of training and lower treatment integrity. More recently, researchers have experimentally examined the effects of errors of commission during error correction for discrete trial teaching and found that higher treatment integrity resulted in better acquisition whereas lower treatment integrity resulted in poor acquisition (DiGennaro Reed, Reed, Baez, & Maguire, 2011; Grow et al., 2009).

A high level of precision is required to implement discrete trial procedures well (LeBlanc, Gravina, & Carr, 2009) and many staff members and parents struggle to achieve high levels of procedural integrity (Johnson & Hastings, 2002; Symes, Remington, Brown, & Hastings, 2006). Incorrect implementation of discrete trial procedures could lead to faulty stimulus control, false skill mastery, prompt dependence, and problem behavior, all of which can stall the learner's progress and waste time and money. One of the pivotal skills taught in DTT is auditory-visual conditional discriminations, otherwise known as receptive identification or listener responding (Smith, 2001). This skill is important for language comprehension, and other pre-academic and academic skills taught in EIBI curricula (Green, 2001; Smith, 2001). Auditory-visual conditional discriminations involve the teacher presenting an auditory stimulus (e.g., "Dog") followed by an opportunity for the learner to select the corresponding stimulus (e.g., a picture of a dog) from an array of comparison stimuli (Green, 2001). Thus, in order for the learner to correctly respond, both the auditory and the visual stimuli must exert stimulus control over the selection response.

Many researchers have documented difficulties in teaching conditional discriminations (e.g., Harrison & Green, 1990; Johnson & Sidman, 1993; McIlvane, Dube, Kledaras, & Iennaco, 1990) to individuals with autism or intellectual disabilities. Green (2001) reviewed the conditional discrimination literature and published a list of recommendations for implementing conditional discrimination training in a manner designed to minimize faulty stimulus control and learner errors. The recommendations include, a) presenting different auditory samples across trials for the same comparison stimuli so that the percentage of trials in which each stimulus in the array is correct or incorrect is equated across all of the stimuli; b) having at least three stimuli in the array and varying the position of the correct stimulus across trials; c) presenting each sample equally as often as the others and in a random order; d) requiring learners to make an observing response; e) repeating the auditory stimulus approximately every 2 seconds; f) rearranging the array out of the learner's sight; g) using errorless teaching methods; and h) ensuring the learner has the necessary prerequisite skills to perform the task. Given the complexity of these recommendations, it can be difficult to implement conditional discrimination teaching with high integrity.

Adding the component of errorless teaching to conditional discrimination training further complicates the procedure. Errorless teaching methods include a number of different prompting strategies that minimize learner errors to enhance the efficiency of learning (MacDuff, Krantz, & McClannahan, 2001). One of the most common types of errorless teaching methods involves the instructor providing response prompts immediately after the instruction based on a hierarchy of intrusiveness, starting with the most intrusive and gradually fading to the least intrusive

(MacDuff et al., 2001). A common prompt hierarchy starts with full physical guidance (e.g., hand over hand prompting) then fades to partial physical guidance (e.g., partially moving the hand in the correct direction), then fades to gestural prompts (e.g., pointing to the target stimulus). Timely prompt fading is critical to maintain the efficiency of errorless learning and to minimize the potential of prompt dependence. Therefore, many clinicians use frequent probes with least-to-most prompting to determine the current level of prompting necessary for each target skill to be performed correctly by the learner (e.g., Libby, Weiss, Bancroft, & Ahearn, 2008). In order to implement errorless teaching correctly, staff must frequently alternate between least-to-most probes and errorless teaching trials, where the prompt level that must be delivered varies for each target in the program. Hence, errorless teaching of conditional discriminations requires a high degree of precision to be implemented correctly.

Several practical employment variables can negatively impact the quality of DTT delivery in EIBI program. First, children who have challenging behavior or who have few identified reinforcers are often the most difficult to teach, particularly at the high rate of instructional presentation that is usually involved in DTT (Symes et al., 2006). Therefore, staff or caregivers must not only be competent in delivery of DTT but must also be fluent in implementation of DTT under conditions that may be stressful and may require manual dexterity and implementation of multiple components simultaneously. Second, the typical levels of education and wages in EIBI settings are low for the level of required precision for effective instruction. These employees then face a job with very high effort for implementing procedures effectively and with the danger associated with being a likely target for problem behaviors like aggression (LeBlanc et al., 2009). Because of these features of EIBI employment, staff turnover is as high as or higher in EIBI settings than in other human service settings (LeBlanc et al., 2009). High staff turnover in EIBI settings can be costly due to the extensive training required to prepare a new staff member to effectively implement DTT with a child with autism and can lead to reduced access to therapeutic services for the child (Larson & Hewitt, 2005; Smith, 2001).

Extensive training is necessary, but not always provided prior to service delivery. Studies have indicated that approximately 25 to 60 hours of training and supervision are required for a new instructor to be able to implement DTT with high procedural integrity (Koegel, Russo, & Rincover, 1977; Smith, Parker, Taubman, & Lovaas, 1992). Because of time restrictions and financial limitations, many EIBI sites are unable to offer this level of training to front line staff (Jacobson & Mulick, 2000). Alternatively, some EIBI sites may provide this level of training gradually or at periodic in-services that occur after the new staff has had contact with the client and potentially exposed the client to incorrect implementation of procedures. Therefore, efficient and cost-effective training programs are necessary in order for EIBI sites to provide DTT training that will produce optimal outcomes.

Staff Training Practices in Delivery of Behavioral Treatment Services

Staff members may implement any treatment with low accuracy because they do not have the knowledge or skills required to implement with high integrity (Austin, Carr, & Agnew, 1999). For example, Wickstrom et al. (1998) found that treatment integrity was higher for components that involved less skill to implement, such as having all intervention materials present, than components that involved more skill to implement, such as following target behaviors with the appropriate programmed consequence. One possible source of this problem is when there is a disparity between the level of the staff's technical expertise and the level required to correctly implement the treatment. The behavior analyst must assess whether this gap in skills can be eliminated with appropriate training or select another treatment that is more appropriate to the staff members' skill level. Many staff and caregiver training studies, which will be described in further detail later, have demonstrated effective training of discrete trial procedures to novices, indicating that most typically developing people can correctly implement this procedure after appropriate training.

Often, staff implement a procedure incorrectly because ineffective training procedures have been used to teach them how to do their job (Allen & Warzak, 2000). If the instructional technology does not actively program for skill generalization then even skills mastered during the training may not be used effectively during implementation. Some examples of failing to program for generalization include failing to train a sufficient number of exemplars, training in a setting that differs greatly from the target setting, and training skills that only distally relate to those required during ongoing treatment delivery (Allen & Warzak). Additionally, ineffective training often only incorporates a verbal or written description of the procedure without providing direct instruction with established behavior analytic procedures such as modeling, corrective feedback and differential reinforcement (Allen & Warzak).

Staff training is a critical variable in the effective implementation of a treatment (Larson & Hewitt, 2005). Some general recommendations for staff training include using criterion-based training rather than training for a specified amount of time (McIntyre et al., 2007), utilizing ongoing training rather than just training before implementation (DiGennaro, Martins, & McIntyre, 2005), and making materials available for review before, during, and after training (LeBlanc et al., 2009). Additionally, there are evidence-based training packages that have shown to be effective for teaching staff new skills.

Behavioral skills training. The most prominent evidence-based training package is Behavioral Skills Training (BST; Miltenberger, 2003). The BST package is a four part training strategy that involves a) clear explicit instructions for the target behaviors, b) modeling or demonstration, c) rehearsal or practice of the target behaviors, and d) feedback on the performance that occurred during rehearsal (Miltenberger, 2003). Behavioral Skills Training has been demonstrated to be an effective training package for teaching staff new skills (Dib & Sturmey, 2007; Ducharme & Feldman, 1992; Fleming, Oliver, & Bolton, 1996; Lafasakis & Sturmey, 2007; Sarokoff & Sturmey, 2008; Wood, Luiselli, & Harchik, 2007). Additionally, some studies have found positive effects on consumer behavior as a result of BST staff training (Dib & Sturmey; Nigro-Bruzzi, & Sturmey, 2010; Parsons, Reid, & Green, 1993). Finally, the training package has been found to be acceptable by staff (Miltenberger, Larson, Doerner, & Orvedal, 1992; Parsons et al., 1993; Sarokoff & Sturmey, 2008).

Nigro-Bruzzi and Sturmey (2010) used BST to train five instructors to implement mand training with children with autism. For baseline, participants were first provided with written and verbal instructions for how to conduct mand training; then they conducted 20-min mand training sessions. During baseline, participant procedural implementation was low, though variable, and was associated with low percentages of independent mands from the learners. Training consisted of three 30- to 60-min training sessions that included written instructions, video models, and role play rehearsal with feedback. After training, all five participants had improved procedural implementation and all five children had increased percentages of independent mands. Generalization probes showed similarly high levels of procedural implementation.

Sarokoff and Sturmey (2004) used BST to teach three instructors to implement DTT for a matching program with a child with autism. The three instructors had previously been trained on discrete trial procedures, but were implementing the matching program on average below 50% integrity. During training, the experimenters provided written and verbal instructions and graphic and verbal feedback on individual performance during baseline. Next, the instructors rehearsed the procedure with the child and the experimenters gave immediate verbal feedback on the instructor's performance. Following rehearsal, the experimenters modeled three trials of DTT with the child and then allowed the instructor to rehearse again if she implemented the procedure incorrectly in the previous rehearsal. Information about the number of rehearsals or the amount of time before reaching the mastery criterion was not reported. Post-training data indicated that the instructors were able to implement DTT for matching with a high level of treatment integrity (mean range 97%-99%).

Three studies have examined the generalization of the effects of BST in teaching discrete-trial training (Lafasakis & Sturmey, 2007; Lerman, Tetreault, Hovanetz, Strobel, & Garro, 2008; Ward-Horner & Sturmey, 2008). Lefasakis and Sturmey used BST to train parents to implement DTT to teach motor imitation skills with their children. The experimenters used instructions, graphic feedback of performance in baseline, and modeling, then allowed the participants to rehearse the procedure with their child and receive feedback from the experimenter. After training, the parents demonstrated improved implementation of DTT for motor imitation. Those effects generalized to other skills within the motor imitation program and to another program, vocal imitation, which was a procedure that had not been directly trained. Additionally, improvements in implementation were associated with increases in child correct responding on the target skills. In another experiment, Ward-Horner and Sturmey demonstrated that training DTT in one program (i.e., gross motor imitation) generalized to another program (i.e., vocal imitation). Additionally, Lerman et al. demonstrated that individuals trained to used three prompting procedures (i.e., least-to-most, most-to-least, and time delay) within DTT were able to use the procedures effectively across targets and learners. This research suggests that careful selection of target exemplars during training will produce generalized responding within and across programs.

Downs et al. (2008) used BST in the context of an 8-hour in-service to train six teachers to implement DTT to teach a variety of skills (e.g., receptive and expressive identification, imitation, pre-academic, and daily living sills). The experimenters used didactic training, modeling, and practice opportunities with feedback. After training, instructors' accuracy ranged from 63% to 80%. The experimenters then conducted observations with immediate verbal feedback on the instructors' implementation of the procedures and after four observations, the instructors implemented DTT between 97% and 100% correctly. Additionally, high rates of accuracy maintained at the 10-week follow-up. Improvements in accuracy of implementation were associated with increases in child correct responding on the target skills.

Some experimenters have incorporated video modeling into BST as a substitute for live modeling (Burch, Reiss, & Bailey, 1987; Crockett et al., 2007) or have used video modeling as a standalone training procedure (Catania, Almeida, Liu-Constant, & DiGennaro Reed, 2009; Moore & Fisher, 2007). Video modeling involves the learner watching a video of a person performing the target behavior (i.e., implementing an intervention procedure) followed by an opportunity to imitate the target behavior (Bellini & Akullian, 2007). Crockett et al. used BST with video modeling to teach two mothers to implement DTT with their sons with autism. The mothers attended six to nine 2-hour training sessions which included instructions, video models, and rehearsal and feedback first with a confederate, then with their child. The participants not only watched the videos, but scored whether each trial was correct or incorrect and why. Both mothers implemented DTT with moderate to high accuracy after training, and DTT skills generalized to untrained programs. Improvements in parent implementation were associated with small improvements in child performance.

While BST as a package has been demonstrated to be effective, some studies have conducted experiments to identify the critical components that lead to training effectiveness. Sterling-Turner, Watson and Moore (2002) conducted a component analysis to examine the critical variables of BST for staff training. The authors demonstrated that instructions alone were ineffective at producing changes in staff behavior. However, once modeling, role-play, and feedback were implemented, the procedure was effective at producing changes in staff behavior. Additionally, Roscoe and Fisher (2008) found that written instructions were ineffective at training staff to implement preference assessments. Once video feedback and rehearsal were completed, the participants were able to implement the preference assessments with high treatment integrity.

The large body of evidence supports the use of BST to teach staff or other caregivers to implement DTT with high accuracy. However, the training package involves a considerable time investment (e.g., 8-18 hours of training) for a trainer with at least some portion of the training requiring individual rehearsal and feedback opportunities (Crockett et al., 2007; Downs et al., 2008). Given the high staff turnover rate in early intervention sites, it may not be cost effective to train staff using this method. Additionally, BST requires that the trainer be present to observe each staff member's rehearsals and provide feedback, which may not be practical for large or multisite agencies or when training caregivers in remote locations. There is a need for a training package that is as effective as BST, but is easily accessible and requires less time investment for the trainer.

Computer-based instruction. Interactive computer training, or computer-based instruction, involves the presentation of training material via a computer or internet site and requires the learner to answer questions about the material or engage in some activity related to the material (Williams & Zahad, 1996). It is proposed to be an effective alternative when face-to-face instruction is not possible (LeBlanc et al., 2009). Interactive computer training has been demonstrated to be more effective than lecture (Williams & Zahad) and reading (Eckerman et al., 2002). Some of the benefits of computer-based instruction include increased accessibility to instruction that is private and self-paced, and increased efficiency and cost-effectiveness, once the training materials are created (Blanchard & Thacker, 2004). The primary disadvantages of computer-based instruction are the expense and time to develop the training materials (Blanchard & Thacker). Therefore, the content must remain consistent and be used widely enough in order for computer-based training to be a cost-effective method for training staff. Another potential disadvantage to computer-based training is that the responses required within the training platform (e.g., answering multiple choice questions) may not be similar to the responses required during implementation of the procedure. Depending on the extent of the difference, high performance in the training platform may not generalize to implementation of a procedure with high procedural integrity. In order to maximize potential generalization, responding in the computer-based training platform should be as similar as possible to responding when implementing the procedure.

Computer-based instruction has become a widely used method of staff training for various skills in a number of different disciplines, many of which require a high degree of precision, such as psychological diagnostics and treatment decisions (Desrochers, Clemmons, Grady, & Justice, 2001; Lambert, 1989), medical procedures (Dawson, Cotin, Meglan, Shaffer,

& Ferrell, 2000; Eckerman et al., 2002), and aviation (Koonce & Bramble, 1998). Some computer-based training packages for DTT are commercially available (e.g., Rethink Autism, Autism Training Solutions), however, it appears that the trend is for software that provides behavioral instruction directly to the child (e.g., TeachTown, NECC Playroom, DT Trainer) with written instructions for staff or caregivers to provide supplemental teaching.

Rethink Autism (2008) is a website that provides a teaching curriculum with written instructions and video models to train each program. The website also offers optional multiple choice examinations to assess staff members' understanding of the program material. Although the website does not report research on the effectiveness of its training program, given the success of video models in staff training (Catania et al., 2009; Koegel, Russo, & Rincover, 1977), it is reasonable to expect that staff could implement the procedure. However, the instructions in this training website may not be explicit enough for novice staff to implement all aspects of the teaching procedure. For example, in an instructional video on how to conduct imitation training, the instructions explain that at first the staff person should immediately provide a physical prompt to complete the task. When describing prompt fading, the instructions simply say to, "Fade prompts by providing less physical assistance," which might leave some staff with questions about when and how to fade the prompts.

Autism Training Solutions (2011) is another website that provides a teaching curriculum with instructions, video models, and multiple choice questions to assess understanding of the material. Autism Training Solutions reported some outcomes measures on their website about the effectiveness of the tutorials. Three paraprofessionals with variable levels of accuracy of implementation of mand training (mean 15% of steps completed accurately, range 0% to 80%) in baseline were trained with Autism Training Solutions. After training, the paraprofessionals showed a modest increase in percentage of steps completed accurately to a mean of 62% (range 25% to 95%). Improvements in procedural implementation were associated with increases in mand use by learners with autism. This study showed that the Autism Training Solutions training modules produced acceptable performance for one participant and sub-optimal performance for the other two. Additionally, this study has not been published in a peer-reviewed journal.

Randell, Hall, Bizo and Remington (2007) used computer-based training to teach undergraduates to conduct discrete trial teaching to teach conditional discriminations. Participants were randomly assigned to one of three groups, DTkid, observe, and control. In the DTkid condition, the authors used a computer program called DTkid in which participants were provided with general instructions on autism and EIBI and specific instructions on how to conduct a discrete trial. Following instructions, the participants in the DTkid group interacted with a simulated child, SIMon, using a mouse to click and drag materials on the table and to click on buttons representing something an instructor would say (e.g., “Match,” “Nice work.”). During their interactions with SIMon, the computer immediately provided textual feedback if a part of the procedure was implemented incorrectly. The participants in the observe group watched videos of the DTkid interactions but did not interact with the software and the participants in the control group played a computer game. The results indicated that participants in the DTkid group were better able to score videos as correctly or incorrectly implemented and were better able to run a DTT session with SIMon than the observe and control groups. DTkid participants had an opportunity to respond in ways that were similar to behaviors in actual implementation and performed best on measures of implementation and understanding of the procedure. However, the experiment did not include an assessment of participants’ ability to run a live DTT session after DTkid training, so more research is needed to determine if this product is effective at teaching implementation of the DTT procedure. At this time, DTkid is not commercially available.

Nosik and Williams (2011) used a computer-based instructional program to train four newly hired staff to implement DTT, using least-to-most prompting, for a matching program and a receptive instructions program. The computer-based training program consisted of instructions, video models of exemplars, and multiple choice questions. Additionally, participants used checklists to score videos of exemplars and non-exemplars of the DTT procedure. In baseline, all four participants implemented DTT with poor procedural integrity (less than 60% of procedural steps correct). The computer-based training program improved participants' implementation of DTT to approximately 70% to 90% of steps correct. After scoring videos, participants' implementation of DTT further improved to approximately 90% to 100% of steps correct.

Rationale for the Current Study

In sum, DTT is an effective procedure for teaching a variety of skills to children with autism. However, it must be implemented with high integrity to produce optimal acquisition patterns. Conditional discrimination training, in particular, requires a high degree of precision to be effective, particularly when best practice guidelines are followed (e.g., errorless teaching procedures). Behavioral Skills Training is a staff training procedure that has been demonstrated to be effective. It appears that the critical components of BST are the opportunity for rehearsal with feedback on performance. However, BST is time and labor intensive, and with the high staff turnover associated with EIBI sites, a more efficient staff training method is needed.

Currently, more research is needed to examine the effectiveness of computer-based instruction as well as to compare it to well-established procedures like BST. A computer-based instruction program that includes opportunities to respond that are similar to that of actual implementation of the procedure could offer a training system that is as effective as BST but is more efficient and potentially cost-effective. The purpose of this study was to compare computer-based instruction to BST to train novice undergraduate students to conduct discrete trial teaching to teach conditional discriminations. These two training procedures were compared using a between groups repeated measures design to examine potential differential effectiveness, efficiency, and acceptability of the two training procedures to determine if computer-based instruction offers a viable alternative to BST.

Method

Participants and Setting

Fifty undergraduate students at a large university in the Southeastern U.S. participated in this study. Undergraduate students were chosen to participate because they represent the target population that would be likely to work in EIBI settings with children with autism. A recent survey of clinical practices in EIBI found that 84% of front line staff had some college training or had a bachelor's degree (Love, Carr, Almason, & Petursdottir, 2009). Participants were awarded extra credit hours based on the amount of time they spent participating in the study rounded up to the nearest half hour (e.g., 75 min equaled 1.5 hours of participation). The extra credit hours were applied to Psychology courses in which the participant was enrolled. Participants were excluded from the study if they had previous experience working in an EIBI setting (e.g., autism preschool, private in-home program), already could perform the procedure correctly (as indicated by the pre-training baseline probe, detailed later), or were unable to perform the procedure or complete the training due to physical disabilities (e.g., cerebral palsy, severe vision problems). Only one participant was excused from the study for meeting one of the above criteria. The participant had previous experience volunteering at an EIBI preschool.

Participants were randomly assigned, using a random numbers generator, to one of two groups to learn how to teach conditional discriminations. The participants for one group experienced individually administered instruction using BST with video models (BST) while a second group experienced individually administered online computer-based instruction (CBI) with embedded video models and response opportunities. All of the participants experienced the research activities individuall with the experimenter and an undergraduate research assistant (i.e., there were no group trainings). Training activities took place in a room in Cary Hall with a computer with internet access on a desk (for CBI), a data projector (for BST), a table, and chairs. Probes took place in an adjacent room with a table, chairs, a data sheet, stimuli, reinforcers, a video camera, and an undergraduate research assistant.

Twenty five participants were in the CBI group and twenty five were in the BST group. There were no statistically significant differences between the groups on any demographics yielded from the Background Information Form (see Appendix A for the Background Information Form and Table 1 for the statistics on the participant demographics). The CBI group was made up of 64% females and 36% males and the BST group was made up of 64% females and 36% males. The mean age for the CBI group was 20.56 years old (*SD* = 2.18) and for the BST group was 21.88 years old (*SD* = 6.06). The mean Psychology courses completed for the CBI group was 3.20 (*SD* = 2.29) and for the BST group was 2.32 (*SD* = 1.70). The mean for the number of Psychology practica completed for the CBI group was 0.20 (*SD* = 0.50) and for BST was 0.08 (*SD* = 0.27). Finally, the mean for the number of other previous developmental disability experiences for CBI was 0.12 (*SD* = 0.33) and for BST was 0.12 (*SD* = 0.33). The duration of these other experiences was not reported.

Materials

Background information form. Participants first completed an eight-question background information form (see Appendix A) answering questions about their age, sex, major, disabilities that may preclude their ability to participate in the study, the number and content of Psychology courses that they have completed, prior practicum experiences, and prior experiences with people with intellectual disabilities or autism. This form was used to determine the participant's eligibility to participate in the study based on the eligibility described above.

Probe session materials. During the pre-training, post training, and post feedback probes, the participant used a data sheet (see Appendix B), a pen, three 7.6 cm X 7.6 cm picture card stimuli, and edible and tangible reinforcers. Prior to the session, the experimenter verified that the materials were present and in working order (e.g., pen has enough ink) before beginning the probe.

Computer-based instruction program. The CBI program was accessed from a computer with speakers located in the research lab space. The CBI program (see Appendix C for example screen shots and Table 2 for specific details on the tutorial) presented textual information with narration on the teaching procedures. It also showed pictures, animations, and videos of exemplars and non-exemplars of the procedures. Some lessons contained active response opportunities pertinent to implementation of the procedures. These active response tasks included click-and-drag activities to arrange stimuli or order procedures chronologically, and clicking on a virtual data sheet to collect data on an ongoing video of a teaching session. Each part of the procedure was taught in a lesson in the CBI program. At the end of each lesson, the participants completed a quiz to assess their understanding of the material. The quizzes contained a combination of standard multiple choice factual and application questions along with scoring whether and when a procedure was implemented correctly or incorrectly in a video sample, and identifying the appropriate next step in a video sample.

Behavioral skills training presentation. The BST presentation (see Appendix D for example slides and Table 2 for specific details on the tutorial) was presented in PowerPoint 2007 and projected on to a white wall in the research space. The presentation included textual information with pictures, animations and videos of exemplars and non-exemplars of the procedure. Each part of the procedure was taught in sections. The instructor presented the information and advanced the slides.

Acceptability questionnaire. Once the participant completed all of the research activities (i.e., the final probe was complete), he or she completed a questionnaire on the acceptability of the training procedures (see Appendix E). The 16-question likert-type rating form was adapted from an established acceptability measure in the staff training literature (Rothwell & Sredl, 1997) and an acceptability measure currently used in an online computer-based training program (Fox, n.d.). The questionnaire items referenced the tutorial content, presentation of the material, and the participant's overall impression of the training program.

Procedures

Pre-experimental assessment. See Appendix F for an overview flowchart of the experimental procedures. The experimenter greeted the participant upon entering the research lab space and said, "First I would like you to fill out this brief background information form," and handed them a background information form (see Appendix A) to provide information on their age, sex, major, disabilities that may preclude their ability to participate in the study, the number and content of Psychology courses that they have completed, prior practicum experiences, and prior experiences with people with intellectual disabilities or autism. The experimenter remained in the room while the participant filled out the form to answer any questions. Once the form was completed, the experimenter reviewed the form for all exclusionary criteria (described above). If the participant did not meet the exclusion criteria, he or she continued to participate in the rest of the research activities. If a participant met the exclusion criteria, the experimenter said, “Thank you so much for coming to participate. Because of [exclusion criteria met] we do not need any additional information from you and so your participation is complete. You will receive [amount of time spent rounded up to the nearest half hour] extra credit hours.” The experimenter then excused the participant.

Pre-training probes. The experimenter and an undergraduate research assistant escorted the participant into an adjacent room. The experimenter said, “Now we are going to do a pre-test. This is [actor’s name], she is going to work with you today and will pretend to be a young learner with autism. You are going to try, to the best of your ability, to use discrete trial teaching, to teach [actor’s name] listener responding, which means to point to a picture when you say it’s name. Here are all of the materials you need; you have a pen, a data sheet, the pictures, and some reinforcers. You’re going to do blocks 1 and 2. I will watch, but during the pre-test, I can’t help you or answer any questions.” Then the experimenter handed the participant all of the necessary materials to complete the pre-training probe (i.e., data sheet, pen, 7.6 cm X 7.6 cm stimuli, reinforcers) and allowed the participant to start. If the participant had questions about the instructions (e.g., “What’s listener responding?”) the experimenter answered them (i.e., repeated the script “means to point to a picture when you say the name”). If the participant asked questions about the procedure, the experimenter said, “I can’t answer that question, so just do what you think you should do.” Each participant completed a pre-training probe where they conducted 24 trials of DTT to teach an actor pretending to be a child with autism auditory-visual conditional discriminations.

The actor responded (i.e., prior training) in a specific sequence (see Table 3 for the actor's response sequence) to make errors on some of the trials but not others so that each participant had the same number and type of opportunities to respond to errors and correct responses. While the participant was conducting the teaching session in the probe, the experimenter collected data on the participant's accuracy of implementing DTT (see Appendix G for the data sheet and Appendix H for the operational definitions). During the probe, no feedback was provided. If the participant implemented DTT with at least 70% accuracy in the pre-training probe, he or she would have been excused from the study. However, none of the participants scored above 70% in the pre-training probe. All of the participants who implemented the teaching session with less than 70% fidelity during the pre-training probe were randomly assigned to either experience BST or CBI training.

Behavioral skills training. The experimenter accompanied the participant into the laboratory where a data projector was set up for visual display. The experimenter said "Now I am going to train you how to teach listener responding to learners with developmental disabilities. I am going to present some information, show you some videos, and every now and then we'll stop so that you can practice the skills with me. If at any time you have a question, stop me and I'll be happy to answer it." The experimenter (i.e., the instructor) presented a PowerPoint presentation with verbal instructions for how to complete the teaching procedure. The instructor sat next to participant while the presentation was projected on to a white wall across from the participant. In addition to text, the presentation displayed pictures and video models of exemplars and non-exemplars of the procedures. The participant was allowed to ask questions at any time during the instructions and the experimenter answered them. Opportunities to rehearse and receive feedback on performance were embedded in the instruction so that each component of the procedure was taught, modeled, and then rehearsed with feedback before moving on to the next component (i.e., similar to a module). Instruction did not progress to a new module until the participant had completed the component correctly by performing the target skill three times in a row with 100% accuracy. Once the entire presentation was completed, the experimenter said, “Let’s practice everything you just learned,” and had the participant rehearse 12 trials of DTT. If at any time the participant made an error, the experimenter immediately stopped the teaching session to provide verbal feedback and then let the teaching session resume. The participant continued to practice the teaching procedure until he or she was able to complete 12 teaching trials with at least 90% accuracy.

Computer-based instruction. Participants sat at a desk with a computer and speakers on it. The experimenter accessed the CBI program and then said, “Now you are going to complete this online training program to learn how to teach listener responding to learners with developmental disabilities. It is going to present some information, show you some videos, and ask you to complete some quiz questions to make sure you understand the material. I will be here in case the computer stops working, but I’ll be working on other activities. I can’t answer any questions about the training program or provide any additional demonstrations.” Then the experimenter allowed the participant to start the program. The experimenter remained close by in case of computer malfunction, but did not have any training interactions with the participant. Additionally, the experimenter appeared to be working on a task to minimize any participant discomfort associated with having someone in the room while they completed the tutorial. The participant completed the computer training program that displayed textual information with narration, pictures, animations, and videos to instruct the participant about the procedure. The participant answered quiz questions and completed assessment activities that ensured understanding of the material and provided analogues to rehearsal of the procedural steps. For each quiz question or practice activity, the participant was provided with textual feedback indicating that his or her answer was correct or incorrect. If the participant answered a quiz question incorrectly, he or she had to view the lesson again before being able to attempt the quiz again and move on to the next module. Once the quiz for a lesson was correctly completed, the participant did not have to view the lesson again. At the end of the tutorial, the participant completed a cumulative quiz with multiple choice questions about the entire procedure. Once the participant completed all lessons and correctly answered the cumulative quiz questions (i.e., at least 90% accuracy), the CBI training was complete.

Post training probes. The procedures for the post training probe were the same as the procedures for the pre-training probe (described above).

Feedback. After the post training probe was complete, the instructor immediately reviewed the scores for the participant's accuracy of implementation. If the participant implemented the teaching session with less than 85% accuracy during the post training probe, the instructor provided feedback on the participant's performance. The instructor provided details on the specific procedural steps that were performed incorrectly, explained how each step should have been completed, and modeled the correct implementation of the step. If the participant asked questions, the instructor answered them and provided additional models, if necessary. Once the participant received feedback, he or she was allowed to complete a post-feedback probe, which had the same procedures as the pre- and post-training probes.

Participants who achieved 85% accuracy or higher during the post-training probe were told that they implemented the procedure correctly, and did not complete the post-feedback probe.

Behavioral skills training with a modified curriculum. After the error analysis showed that the majority of participants made errors in data collection during the post training probes, it was hypothesized that the data collection system may have been too difficult for the participants to implement. The experimenter modified the curriculum of the BST tutorial to simplify the data collection system and trained seven additional participants with the modified curriculum to determine if it would result in fewer errors in data collection in the post training probe. The simplified data collection required that participants record the prompt level needed to obtain a correct response in probes, and whether each teaching trial was correct or incorrect. The same procedures, outlined above, were used for the additional seven participants.

Experimental Design and Measurement

This study used a randomized 2-group repeated measures design, in that participants were randomly assigned, via a random numbers generator, to either the BST or CBI group. The main dependent measure was the percentage of steps correctly completed during the pre- and post training probes, and the post feedback probe, if applicable. The experimenter and other trained observers collected data in vivo and from videos of the participant's performance during probes (see Appendix G for the data sheet and Appendix H for the operational definitions). Each step was scored independently (i.e., if a step was scored as incorrect for a trial, later steps in that trial could still be scored as correct). The percentage of steps completed correctuly was calculated by dividing the number of steps completed correctly by the total number of steps and converting to a percentage.

Several secondary dependent measures were collected including a) the amount of time the experimenter spent to develop the materials and train all of the participants, b) the mean amount of time invested by the participants to complete training, c) the acceptability of the training procedure, and d) the types of errors made in post training probes. The amount of time the investigator spent to develop the materials and train the participants included the sum of the time spent a) writing the content for the tutorial, b) creating the PowerPoint (for BST) or creating the web-based tutorial (for CBI), c) participants' total training time where they were interacting with the instructor in BST (excluding pre- and post training probes), and d) the total time during which the instructor provided feedback if the participant failed to meet the mastery criterion in the post training probe. The amount of time required to complete training was measured from the beginning of the training session to the end of the training session and did not include time used to conduct pre-training, post training, or post feedback probes. For CBI, the web-based tutorial recorded the total time required for training from when they first started the tutorial to when they completed the final question of the final quiz. For BST, the instructor started a stopwatch at the beginning of training and stopped the stopwatch once training was complete. For acceptability of the training procedure, the instructor provided the Training Acceptability Questionnaire (see Appendix E).

The types of errors made in the post training probe were collected from the Participant Accuracy Data Sheet (See Appendix G) and analyzed to determine if any one error was more common than others. Procedural steps assessed in the error analysis included arranging the stimuli, getting the learner's attention, presenting the instruction, waiting three seconds during probes, immediately providing prompts during teaching trials, providing the correct prompt level, no response and removing stimuli following errors, immediately providing a prompt that was one level more intrusive during error correction, providing praise and reinforcers after correct responses, and recording data. The data on types of errors made were analyzed as the percentage of participants who made an error on any given step for each group. The percentage of participants who made an error was calculated by dividing the number of participants who made at least one error on a specific step by the total number of participants in the group and converting to a percentage. Finally, the average attempts until the mastery criterion was met in training were reported for each group, but were not compared statistically because the types of within-training performance (i.e., answering questions in CBI, performing the teaching procedure in BST) were not identical.

Interobserver agreement. A second trained observer collected interobserver agreement (IOA) data on participant's accuracy (the primary measure) for 44% of CBI participants and 60% of BST participants across all probes. For participant accuracy, agreement was scored if both observers identified a procedural step as being completed correctly or incorrectly. Percentage agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements and converting to a percentage. Mean IOA for CBI for pre-training probes was 95% (range, 86% to 100%), for post training probes was 97% (range, 93% to 100%), and for post feedback probes was 98% (range, 94% to 100%). Mean IOA for BST for pre-training probes was 96% (range, 75% to 100%), for post training probes was 99% (range, 97% to 100%), and for the one post feedback probe was 99%. Interobserver agreement data were not collected for the secondary measures, including investigator's time investment, total training time, and acceptability of the training procedure.

Experimenter procedural integrity. Procedural integrity was calculated as the percentage of steps correctly completed by the instructor (during BST and when providing feedback after post training probe) and the percentage of steps correctly completed by the actor (in the post training and post feedback probes). For BST, procedural integrity was measured with a checklist (see Appendix J) where the observer recorded whether the instructor provided correct instructions, rehearsal opportunities, and feedback for each module of the BST tutorial. Experimenter procedural integrity for BST was measured for 80% of BST sessions. For all sessions measured, experimenter procedural integrity was 100%. For the post training and post feedback probes (see Appendix I), procedural integrity was measured on if the actor provided the correct learner response (as indicated by the sequence of actor responses), and whether the experimenter provided corrective feedback if the participant scored below 85% accuracy or refrained from providing corrective feedback if the participant scored above 85% accuracy. The procedural integrity percentage was calculated by dividing the number of steps performed correctly by the total number of steps and converting to a percentage. Experimenter procedural integrity in the probes was measured for 40% of CBI participants and 52% of BST participants. Mean procedural integrity for the CBI probes was 95% (range, 86% to 100%) and for the BST probes was 99% (range, 96% to 100%).

Data analysis. A repeated-measures 2 x 2 ANOVA was used to compare the effects of BST and CBI on participants’ accuracy during the pre-training and post training probes. Data from the post feedback probe were not included in the repeated-measures ANOVA calculation as the sample size was much smaller. An independent samples t-test was used to compare learner time invested and acceptability of the training procedure. A chi-square test was used to compare the percentage of participants who made an error on specific steps during the post training probe. A regression analysis was used to assess whether participant characteristics (i.e., age, sex, Psychology courses completed) accounted for a substantial portion of the variability in the post training scores.

Results

Effectiveness of the Training Procedures

Figure 1 displays participants' percentage of procedural steps completed accurately during the pre-training, post training, and post feedback probes. All of the participants performed poorly during the pre-training probe. The mean percentage of total steps completed accurately in pre-training for CBI was 12% (range, 0% to 41%) and for BST was 8% (range, 0% to 44%). All of the participants' accuracy improved substantially after training. The mean percentage of total steps completed accurately in post training for CBI was 87% (range, 65% to 97%) and for BST was 96% (range 74% to 100%). Both the effect sizes for CBI (d = 7.48) and BST (d = 11.56) were well above Cohen's (1988) convention for a large effect (d = .80). The number of people who met the mastery criterion (at least 85% of steps completed accurately) in CBI was 16 and in BST was 23. Finally, everyone who received feedback and performed the post feedback probe improved their scores and met the mastery criterion. The mean percentage of total steps completed accurately in post feedback for CBI was 95% (range, 88% to 99%) and for BST was 99% (range, 98% to 99%). A 2 x 2 repeated measures ANOVA showed a significant main effect of Probe Condition (pre-training vs. post training), $F(1, 48) = 2023.00$, $p < .01$ and a significant interaction effect of Probe Condition x Training Type, $F(1, 48) = 13.96$, $p < .01$. These results indicate that both BST and CBI were effective at improving participants' accuracy of implementation, though BST was significantly more effective than CBI. A subsequent regression analysis was conducted on participant age, sex, number of Psychology courses taken, number of Psychology practica, and number of other experiences with people with developmental disabilities. The regression analysis yielded no significant results, indicating that these predictor variables did not account for the variability in the post training scores.

Figure 2 displays the percentage of participants who made at least one error on a given procedural step during the post training probe. Additionally, the figure displays the number of errors that each participant made on a given procedural step. The steps with statistically significant differences between groups were getting the learner's attention, providing the correct prompt level, not responding to learner errors and removing the stimuli, providing the prompt at the next level of intrusiveness during error correction, and recording data. For getting the learner's attention, 52% of the CBI group and 16% of the BST group made errors, and the difference was significant, $\chi^2(1, N = 50) = 7.22$, $p < .01$. For providing the correct prompt level for the trial, 80% of the CBI group and 28% of the BST group made errors, and the difference was significant, $\chi^2(1, N = 50) = 13.61$, $p < .01$. For making no response and removing the stimuli following learner errors, 52% of the CBI group and 20% of the BST group made errors, and the difference was significant, $\chi^2(1, N = 50) = 5.56$, $p < .05$. For providing the prompt at the next level of intrusiveness during error correction, 76% of the CBI group and 32% of the BST group made errors, and the difference was significant, $\chi^2(1, N = 50) = 9.74$, $p < .01$. Finally, the most common error for both groups was recording data with 100% of the CBI group and 80% of the BST group making errors on this procedural step, and this difference was significant, $\chi^2(1, N = 50) = 5.56$, $p < .05$. The steps that did not have statistically significant differences between the groups were arranging the stimuli, presenting the instruction, waiting three seconds, immediately providing the prompt during teaching trials, and providing praise and a tangible reinforcer following the learner's correct response. For arranging the stimuli, 48% of the CBI group and 28% of the BST group made errors. For presenting the instruction, 40% of the CBI group and

24% of the BST group made errors. For waiting three seconds, 16% of the CBI group and 8% of the BST group made errors. For immediately providing the prompt during teaching trials, 52% of the CBI group and 28% of the BST group made errors. For providing praise and a tangible reinforcer following the learner's correct response, 76% of the CBI group and 60% of the BST group made errors.

Figure 3 displays the mean number of trials required to meet the mastery criterion for progressing through training during rehearsals in BST. The mastery criterion for all of the skills, except teaching the entire block, was three correct implementations of the procedure in a row. For teaching the entire block, the mastery criterion was completing one entire teaching block (i.e., 12 trials) with at least 90% accuracy. The mean trials to criterion for arranging the stimuli was 3.32 (range, 3 to 6). The mean for getting the learner's attention was 3.76 (range, 3 to 7). The mean for presenting the instruction was 3.20 (range, 3 to 5). The mean for identifying whether a learner's response was correct or an error was 3.04 (range, 3 to 4). The mean for reinforcing correct responses was 4.32 (range, 3 to 10). The mean for providing gestural prompts was 3.56 (range, 3 to 7). The mean for providing partial physical prompts was 3.32 (range, 3 to 4). The mean for providing full physical prompts was 3.12 (range, 3 to 5). The mean for implementing a probe trial was 4.68 (range, 3 to 7). The mean number of rehearsal trials for implementing a teaching trial was 6.84 (range, 3 to 16). Finally, the mean for implementing an entire teaching block was 1.08 (range, 1 to 2).

Figure 4 displays the mean number of quiz attempts required to meet the mastery criterion for quizzes in the various modules of the CBI instructional program. The mastery criterion for all of the quizzes, except the final cumulative quiz, was completing the quiz with 100% accuracy. For the final cumulative quiz, the mastery criterion was completing the quiz with at least 90% accuracy. The mean quiz attempts required to meet the criterion for arranging the stimuli was 1.08 (range, 1 to 2). The mean quiz attempts required for mastery on getting the learner's attention was 1. The mean for presenting the instruction was 1.72 (range, 1 to 3). The mean for identifying whether a learner's response was correct or an error was 1.04 (range, 1 to 2). The mean for reinforcing correct responses was 1. The mean for providing prompts was 1.52 (range, 1 to 3). The mean for the probe trial was 1.16 (range, 1 to 2). The mean for the teaching trial was 1.20 (range, 1 to 3). Finally the mean for the final cumulative quiz was 1.92 (range, 1 to 5).

Efficiency and Utility Analysis

The two training programs were compared with respect to their efficiency as well as their effectiveness. The efficiency and cost-effectiveness of the programs were estimated by comparing the total average duration of instruction during CBI to that of BST and incorporating that information into a utility analysis with the initial time invested in preparation of the instructional materials. The mean duration of learner time invested for CBI was 59.32 min (range, 47 to 84 min) while the mean duration of learner time invested for BST was 51.76 min (range, 40 to 68 min). A *t*-test confirmed that the difference in duration of learner time was significant $t(48) = 3.40$, $p < .01$.

Figure 5 displays the time investment of the trainer for materials development, delivery of the instruction, and providing feedback to participants who failed to meet the mastery criterion for both the CBI and BST conditions. The initial time investment, before any participants were trained, was 142 hours for CBI and 89 hours for BST. As participants were trained, the trainer did not invest any additional time during training for the CBI group, but did invest an additional 27.84 min to provide feedback to 10 participants (mean = 2.78 min) so the total time investment was 142.46 hours. For BST the trainer invested a mean of 51.76 min to train each participant and an additional 8.5 min to provide feedback to 2 participants (mean = 4.25 min) so the total time invested increased to 110.71 hours for training 25 participants. The total amount of time invested in BST was much less than the time invested for CBI to train the participants in this study. However, if additional individuals were to be trained using the two methods, the projected breakeven point (i.e., equal investment) would be 62 participants in a given condition assuming the same mean training duration for future trainees. This means that the trainer would have had to train 62 people in CBI to make the time investment per participant equal to that invested in training 62 people in BST. If the trainer had trained more than 62 people in each group, then CBI would have been more efficient than BST.

Acceptability of the Training Procedures

Figure 6 displays the participants' mean ratings on the training acceptability questionnaire for the two groups. For all of the items, both CBI and BST were rated positively. Only two items resulted in significant differences in participants' ratings. For the item indicating that the learning objectives were successfully achieved, the mean rating for CBI was 4.64 (range, 4 to 5) and the mean rating for BST was 4.88 (range, 4 to 5). Though this difference is small in value, the difference between ratings for this item was significant $t(48) = 2.03$, $p < .05$. For the item indicating if the participant would have preferred to learn the content in the other training format the mean rating for CBI was 2.76 (range, 1 to 5) and the mean rating for BST was 1.68 (range, 1 to 5). These results indicate that on average, the CBI group was between "disagree" and "neutral" for preferring to learn the content with a live instructor and the BST group was between "strongly disagree" and "disagree" for preferring to learn the content on a computer-based tutorial. The difference between ratings for this item was significant $t(48) = 3.74$, $p < .01$.

Behavioral Skills Training with a Modified Curriculum

Figure 7 displays the error analysis comparing the percentage of participants who made an error in each procedural step during the post training probe. The group size between the two groups is very different (BST original curriculum n = 25, BST modified curriculum n = 7), which limits the ability to draw conclusions based on these data. However, these preliminary findings suggest that simplifying the data collection resulted in a lower percentage of people who made errors in recording data. The BST original curriculum group had 80% of participants make an error in data collection and the BST modified curriculum group had 14% of participants make an error in data collection. Additionally, the BST modified curriculum group had a lower percentage of participants who made errors in providing reinforcement for correct responses. The BST original curriculum group had 60% of participants make an error in providing reinforcement whereas the BST modified curriculum group had 28% of participants make an error in providing reinforcement.

Discussion

Effectiveness of the Training Procedures

In sum, both CBI and BST were effective at improving participants' procedural implementation of discrete trial teaching, using the errorless learning prompting technique. These findings are consistent with the previous literature on using BST to train staff to implement DTT (Crockett et al., 2007; Downs et al., 2008; Lafasakis & Sturmey, 2007; Lerman et al., 2008; Sarokoff & Sturmey, 2004; Ward-Horner & Sturmey, 2008) and using CBI to train participants in the use of DTT (Nosik & Williams, 2011; Randell et al., 2007). However, BST was more effective than CBI. Previous research on component analyses of BST has shown that rehearsal and feedback are necessary for optimal effectiveness of the training package (Roscoe

& Fisher, 2008; Sterling-Turner, Watson & Moore, 2002). The BST tutorial in this study allowed participants to rehearse each step of the procedure as well as conducting the entire procedure and they were provided feedback on their performance. The CBI tutorial provided some active response activities that simulated rehearsal with feedback (e.g., collecting data on a virtual data sheet), but did not provide active response activities for every step in the procedure (e.g., providing prompts, reinforcing correct responses) or for conducing the entire procedure. Therefore, it is somewhat unsurprising that participants in the BST group performed better than participants in the CBI group. However, after the CBI participants who “failed” (less than 85% of steps correct) received feedback from the experimenter, they all improved and “passed” the post feedback probe. This finding provides further support that the reason for the difference in scores between the two groups was the lack of rehearsal with feedback in some parts of the CBI tutorial. Future research could examine the use of CBI, with increased active response activities, to train participants to implement DTT. Additionally, future research might examine if CBI plus one rehearsal session with feedback is effective and efficient for training staff to implement DTT.

It is important to note that for this study, CBI was compared to an optimized version of BST. In this study, the BST tutorial used best practice recommendations, such as conducting one-on-one teaching sessions provided by an expert instructor, providing multiple models of both exemplars and non-exemplars, allowing frequent rehearsals of component skills (e.g., present the instruction, provide reinforcement) as well as the terminal skill (i.e., conduct a DTT teaching session), and requiring the participant to rehearse until meeting a mastery criterion. The version of BST used in this study may not reflect the type of training currently being used in the majority of EIBI centers. It is unknown how CBI would compare to common practice BST or other types of training being employed by EIBI centers. Future research might examine how CBI compares to these other versions of training to train staff to implement DTT.

The procedural steps with substantially more errors in CBI than BST involved providing prompts (immediately provide prompt, correct prompt level, provide prompt at next level during error correction) and recording data. The 'providing prompts' module in the CBI tutorial had one active response activity associated with arranging the prompts according to their level of intrusiveness. The 'providing prompts' quiz had a higher mean attempts to criterion (i.e., 1.52) compared to some other quizzes in the tutorial, suggesting that more explicit models and active response activities could be added to further clarify this skill. For example, the tutorial could add an active response requirement that included a picture of a participant with stimuli where the participant clicks on where they would point or touch to provide a specific type of prompt.

Although there was a significant difference in the level of errors in data collection between the two groups, both groups had an unacceptably high proportion of people that made errors on this step. In BST, participants were provided an opportunity to rehearse data collection and receive feedback during the Probe Trials and Teaching Trials modules. In CBI, participants were provided simulated opportunities for rehearsal with feedback, by clicking on a virtual data sheet based on an ongoing video during the Probe Trials and Teaching Trials modules of the tutorial. However, the data collection may have been too difficult for novices to reliably perform. Recording data for probe trials involved identifying what prompt was needed for the learner to be correct in the trial. Recording data for teaching trials involved recording both the item that the learner pointed to first and whether the trial was correct or incorrect. If the actor made an error, the participant would have to remember what the actor selected while performing error correction in order to record the data accurately at the end of the trial. Some participants anecdotally reported during feedback that they forgot what the actor pointed to so they guessed and just circled one of them. Additionally, some participants reported that they were confused about the different data collection for probes versus teaching trials. This data collection system, was selected because if a learner was failing to acquire new skills in a timely manner, a case manager could analyze the patterns in responding to identify potential problems with stimulus control or side biases. However, if only 5 of the 50 participants could perform data collection perfectly, the data would not be reliable enough for a case manager to confidently make treatment decisions based on it. Therefore, it may be in the best interest of procedural integrity if the data collection system was simplified so that the participant would only have to record the prompt level required to get a correct response in probes, and whether each teaching trial was correct or incorrect.

The experimenter modified the curriculum of the BST tutorial to simplify the data collection system and trained seven additional participants with the modified curriculum to determine if it would result in fewer errors in data collection in the post training probe. The preliminary findings suggested that simplifying the data collection resulted in a lower percentage of people who made errors in recording data. The BST original curriculum group had 80% of participants make an error in data collection and the BST modified curriculum group had 14% of participants make an error in data collection. Additionally, the BST modified curriculum group had a lower percentage of participants who made errors in providing reinforcement for correct responses. The BST original curriculum group had 60% of participants make an error in providing reinforcement whereas the BST modified curriculum group had 28% of participants make an error in providing reinforcement. It is possible that the complex data collection system interfered with timely delivery of reinforcement, and the simplified data collection reduced that interference. Again it should be stated that these data are preliminary and should not be used to draw firm conclusions about the data collection system. However, these preliminary data suggest that it may be beneficial to modify the curriculum of the CBI tutorial to simplify the data collection system and examine if the tutorial is effective at training participants to implement DTT, and more specifically to collect data accurately.

The procedural step of presenting the instruction accounted for a very low number of errors for both the CBI and BST groups. The rehearsal data that show a low mean attempts to criterion (mean = 3.20) in BST for presenting the instruction correspond to the high performance on this step in the post training probe. However, in CBI the presenting the instruction quiz had one of the highest mean attempts to criterion (mean = 1.72) of all the quizzes. This mismatch in performance on the quiz and performance on implementing the procedural step in the post training probe suggests that the quiz may be assessing skills that are not necessary for correct implementation or that at least one question in the quiz is unnecessarily difficult. One quiz question involves identifying that the instructor is accidently motioning towards the correct item by looking more at that item and leaning her head towards it. This may be a difficult discrimination for participants to make from a video example and identifying this mistake may not be necessary for participants to correctly provide the instruction during DTT. Future research on using this CBI tutorial might examine removing or changing this question to see if performance on the quiz improves and results in similarly low levels of errors in providing the instruction when participants implement DTT.

Efficiency and Utility of the Training Procedures

Because of the initial time investment for creating the CBI tutorial versus the time investment to create the BST tutorial, CBI required substantially more instructor time investment than BST for training 25 participants. This finding is consistent with the literature, which states that the main limitation of CBI is the initial time and financial investment to create the materials (Blanchard & Thacker, 2004). However, the utility analysis showed that if the tutorials were used to train more than 62 people each, then CBI would be more efficient. These findings suggest that creating in-house CBI training tutorials may not be cost-effective unless the agency is training a large number of staff or are training people who are in geographically remote locations (i.e., where BST is not possible). Future research might address the feasibility of using CBI to train people in remote locations. If rehearsal and feedback are necessary for optimal effectiveness, it might be useful to incorporate video networking software like Skype® so that the experimenter could provide feedback on participants' performance. Additionally, future studies comparing staff training procedures should use a utility analysis such as the one in this study to fully examine how many people would need to be trained for an alternative training procedure to provide an appropriate return on the initial investment to create the training materials.

On average, CBI required slightly more learner time investment (mean = 59.32 min) than BST (mean = 51.76 min). If a new staff member were being trained on multiple programs, the additional time investment could add up to a substantial difference. Because participants are required to view the entire lesson again if they make an error on a quiz, it is possible that improving quiz questions (e.g., presenting instructions quiz) could reduce the mean learner time investment in CBI and make it more comparable to that of BST.

Acceptability of the Training Procedures

Both CBI and BST were rated positively by participants indicating that participants found both training procedures to be acceptable, with useful instructions and models that were presented well, and were enjoyable to interact with. Item 16 on the questionnaire asked participants to rate how much they would have preferred to be trained using the other format. Although participants in both groups on average reported that they would not prefer to be trained with the other format, the mean rating for the CBI group was closer to neutral (mean = 2.76) than the mean rating for the BST group (mean = 1.68). Six participants in the CBI group rated item 16 as agree or strongly agree versus one participant in the BST group. These results indicate that although participants were generally happy with the tutorial they experienced, some participants would have preferred a different format.

Limitations

Several limitations are worthy of note. One limitation of this study is the use of actors instead of children with autism as the learner during the probes. The use of actors limits generality of the findings because it is not known if high performance in the probe with the actor would also result in high performance when implementing DTT with an actual child with developmental disabilities. The use of actors to portray children with autism was chosen for two reasons. The first reason was that it would not be in the best interest of an actual child with developmental disabilities to be frequently exposed to incorrect implementation of DTT in the pre-training probe and, if the training was ineffective, the post training probe. The second reason this study used actors was that because this was a group design it was important to standardize the experience across the groups so that the only variable that could account for a difference in scores was the training that the participant received. If the study used children with autism the children’s performance would vary across children and from day to day in the same child, which might allow for more or fewer opportunities to respond to different types of learner behaviors across participants, thus limiting the experimental control. However, the actors were trained to respond in a specific sequence of behaviors so that every participant had the same number and type of opportunities to respond to correct responses and errors. Thus, for this experiment, external validity was somewhat sacrificed for experimental control. However, now that this study has demonstrated CBI to be effective to train participants to implement DTT with trained actors, a follow-up study should be conducted to examine its effectiveness to train staff to implement DTT with children with developmental disabilities.

Another limitation worth noting is that due to the nature of the programming in the CBI tutorial, it was not possible to collect data on participants' attempts to criterion on the active response activities. Because the active response activities were a simulation of rehearsal of the procedural step, data on performance in these activities may have been more informative than the data on performance in the multiple choice quizzes. Future research could examine the possibility of collecting data on attempts to criterion in active response activities in CBI and if that correlates with performing the actual procedure with learners.

The final limitation of this study was that the data collection system used to code participant accuracy during probes included so many steps that collecting the data was onerous, which reduced interobserver agreement. The trials were broken into multiple steps to allow thorough error analysis. Each trial had between 6 and 21 steps (depending on the trial type and amount of error correction) and collecting data in vivo required circling whether each step was correct or incorrect while the participant was performing them. This could have caused the experimenter to miss observing a step while collecting data for a previous step. For interobserver agreement, the data collector coded video of the probe session so the coder was able to pause the video while she entered the data. However, IOA scores were still at acceptable levels, so the extent to which the onerous data collection affected the data was minimal.

Conclusion

In sum, both BST and CBI have previously been demonstrated to be effective for training staff many different skills, including the implementation of DTT. This study offered the first comparison of CBI to BST. Although in this study, BST was demonstrated to be more effective and efficient than CBI, several variables were identified to be modified that could potentially bridge the gap in effectiveness. Additionally, this study provided further evidence that CBI was effective at training participants a particularly difficult DTT procedure, auditory-visual conditional discrimination training using the errorless teaching prompting method. This study provides further support that CBI may offer an acceptable staff training alternative if optimized BST is not possible or not feasible.

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Table 1

Participant Background Information

	CBI		BST			
	Mean	SD	Mean	SD	*t*(48)	p
Age	20.56	2.18	21.88	6.06	1.02	0.311
Psychology Courses Completed	3.20	2.29	2.32	1.70	1.54	0.130
Psychology Practica	0.20	0.50	0.08	0.28	1.05	0.299
Other Experiences in Developmental Disabilities	0.12	0.33	0.12	0.33	0.00	1.000

Table 2

Data on the Instructional Content of the Tutorials

	Behavioral Skills Training			Computer-Based Instruction			
Lessons	Slides	Practice Opportunities (Rehearsal)	Feedback	Slides	Practice Opportunities (Active Response Activities)	Quiz Questions	Feedback
Introduction	6	0	N/A	7	0	0	N/A
Setting up	2	0	N/A	2	0	0	N/A
Arranging the array	3	3	Verbal	4	1	2	Textual
Getting the learner's attention	5	3	Verbal	8	0	1	Textual
Providing the instruction	3	3	Verbal	6	2	4	Textual
Learner Responses	5	3	Verbal	8	0	3	Textual
Reinforcing Correct Responses	6	3	Verbal	7	0	4	Textual
Providing Prompts	6	3 (Gestural), 3 (Partial Physical), 3 (Full Physical)	Verbal	7	1	2	Textual
Probe Trials	5	3	Verbal	8	1	5	Textual
Teaching Trials	6	3	Verbal	8	1	5	Textual
Teach Entire Block	0	1 block (3 probes, 9 teaching trials)	Verbal	0	0	10	Textual

Table 3

Sequence of Actor Responses for the Probes

Trial	Prompt Type	Target	Actor Response
		Probe 1 (Pre-Training)	
1		Pig	Independent correct
2		Dog	Incorrect until full physical prompt
3		Cow	Incorrect until gestural prompt
		Teaching 1 (Pre-Training)	
1	Full Physical	Dog	Correct
2	Independent	Pig	Incorrect until partial physical prompt (select "dog")
3	Gestural	Cow	Correct
4	Independent	Pig	Incorrect until gestural prompt (no selection)
5	Full Physical	Dog	Correct
6	Gestural	Cow	Incorrect until partial physical prompt (select "dog")
7	Gestural	Cow	Correct
8	Full Physical	Dog	Correct
9	Independent	Pig	Correct
		Probe 2 (Pre-Training)	
1		Cow	Independent correct
2		Pig	Incorrect until gestural prompt
3		Dog	Incorrect until partial physical prompt
		Teaching 2 (Pre-Training)	
1	Gestural	Pig	Incorrect until full physical prompt (no selection)
2	Independent	Cow	Incorrect until gestural prompt (select "pig")
3	Partial Physical	Dog	Incorrect until full physical prompt (select "pig")
4	Partial Physical	Dog	Correct
5	Independent	Cow	Incorrect until partial physical prompt (select "pig")
6	Gestural	Pig	Correct
7	Independent	Cow	Correct
8	Gestural	Pig	Incorrect until partial physical prompt (no selection)
9	Partial Physical	Dog	Incorrect until full physical (select "pig")

Probe 3 (Post Training)			
1		Dog	Independent correct
2		Cow	Incorrect until gestural prompt
3		Pig	Incorrect until partial physical prompt
Teaching 3 (Post Training)			
1	Partial Physical	Pig	Incorrect until full physical prompt (no selection)
2	Independent	Dog	Incorrect until gestural prompt (select “pig”)
3	Gestural	Cow	Incorrect until full physical prompt (select “pig”)
4	Independent	Dog	Correct
5	Gestural	Cow	Incorrect until full physical prompt (select “pig”)
6	Partial Physical	Pig	Correct
7	Independent	Dog	Correct
8	Partial Physical	Pig	Incorrect until full physical prompt (no selection)
9	Gestural	Cow	Incorrect until partial physical (select “pig”)
Probe 4 (Post Training)			
1		Cow	Incorrect until full physical
2		Dog	Incorrect until gestural prompt
3		Pig	Correct
Teaching 4 (Post Training)			
1	Full Physical	Cow	Correct
2	Independent	Pig	Incorrect until partial physical prompt (select “cow”)
3	Gestural	Dog	Correct
4	Independent	Pig	Incorrect until gestural prompt (no selection)
5	Full Physical	Cow	Correct
6	Gestural	Dog	Incorrect until partial physical prompt (select “cow”)
7	Full Physical	Cow	Correct
8	Gestural	Dog	Correct
9	Independent	Pig	Correct

		Probe 5 (Post Feedback)	
1		Pig	Independent correct
2		Dog	Incorrect until full physical prompt
3		Cow	Incorrect until gestural prompt
		Teaching 5 (Post Feedback)	
1	Full Physical	Dog	Correct
2	Independent	Pig	Incorrect until partial physical prompt (select “dog”)
3	Gestural	Cow	Correct
4	Independent	Pig	Incorrect until gestural prompt (no selection)
5	Full Physical	Dog	Correct
6	Gestural	Cow	Incorrect until partial physical prompt (select “dog”)
7	Gestural	Cow	Correct
8	Full Physical	Dog	Correct
9	Independent	Pig	Correct
		Probe 6 (Post Feedback)	
1		Cow	Independent correct
2		Pig	Incorrect until gestural prompt
3		Dog	Incorrect until partial physical prompt
		Teaching 6 (Post Feedback)	
1	Gestural	Pig	Incorrect until full physical prompt (no selection)
2	Independent	Cow	Incorrect until gestural prompt (select “pig”)
3	Partial Physical	Dog	Incorrect until full physical prompt (select “pig”)
4	Partial Physical	Dog	Correct
5	Independent	Cow	Incorrect until partial physical prompt (select “pig”)
6	Gestural	Pig	Correct
7	Independent	Cow	Correct
8	Gestural	Pig	Incorrect until partial physical prompt (no selection)
9	Partial Physical	Dog	Incorrect until full physical (select “pig”)

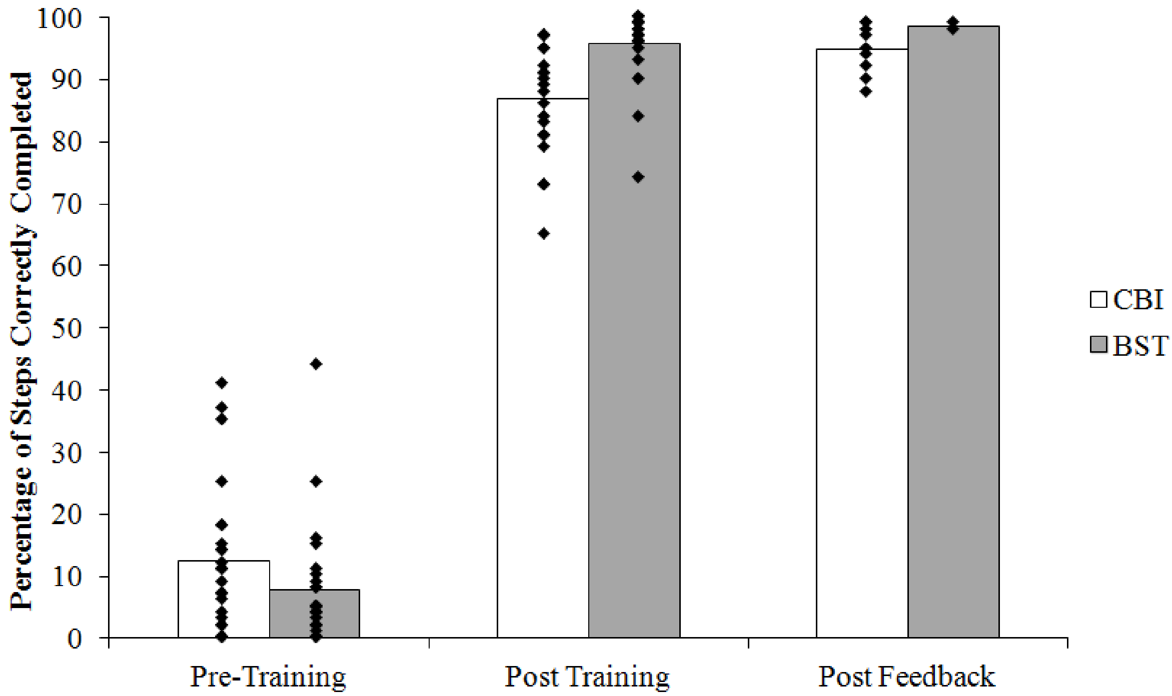


Figure 1. Participants' accuracy of implementation when teaching auditory-visual conditional discriminations. The white bar represents the mean percentage score for participants who experienced computer-based instruction (CBI). The gray bar represents mean percentage correct for participants who experienced behavioral skills training (BST). The black diamonds represent each participant's percentage of steps completed correctly.

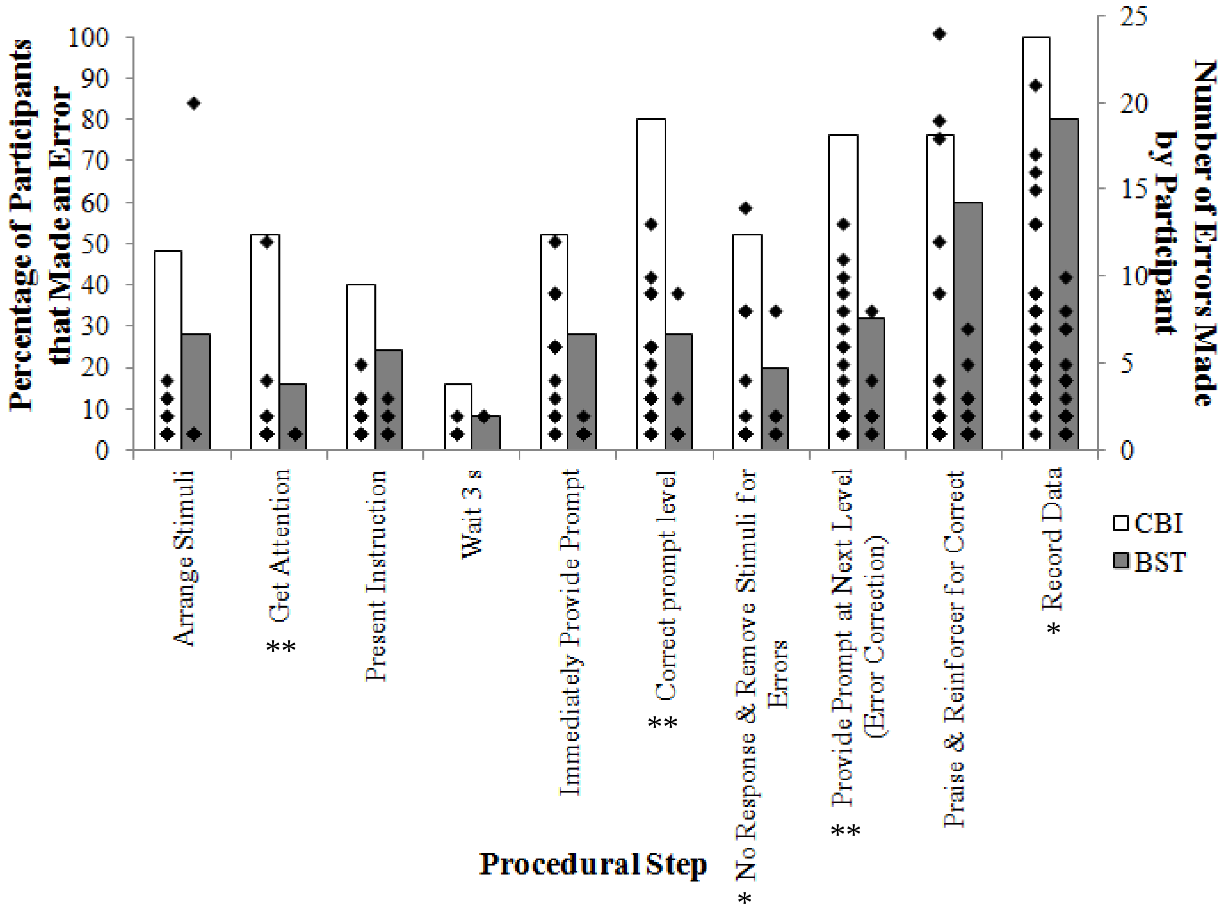


Figure 2. Percentage of participants who made errors on procedural steps during the post training probe. White bars represent participants in the CBI group and the gray bars represent participants in the BST group. The black diamonds represent the number of errors made by each participant. One star indicates a significant difference at $p < .05$ level and two stars indicate a significant difference at the $p < .01$ level.

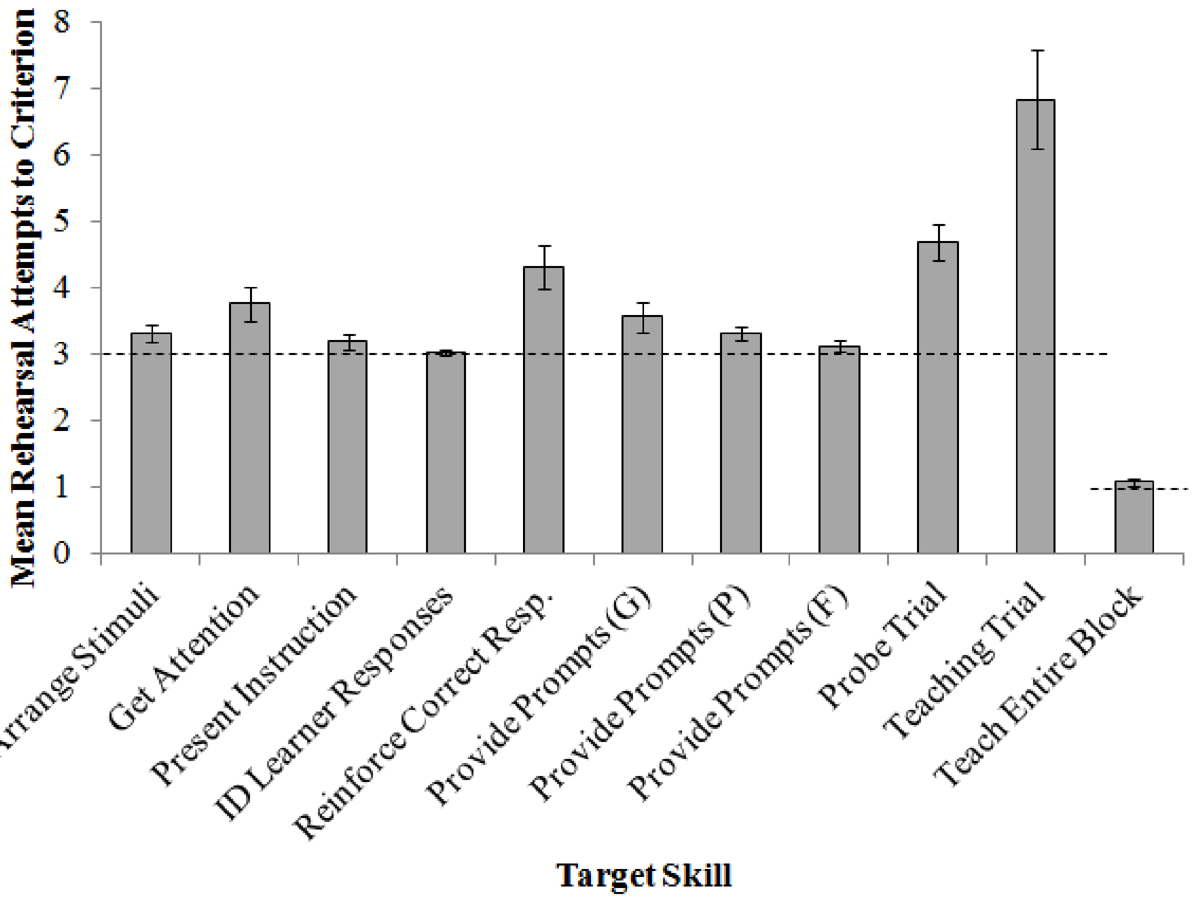


Figure 3. Mean attempts to criterion during rehearsal of BST. The gray bars represent the mean attempts to criterion. The dashed line represents the criterion level. For all of the skills, except teaching the entire block, the mastery criterion was 3 correct implementations of the procedure in a row. For teaching the entire block, the mastery criterion was completing one entire teaching block (i.e., 12 trials) with at least 90% accuracy.

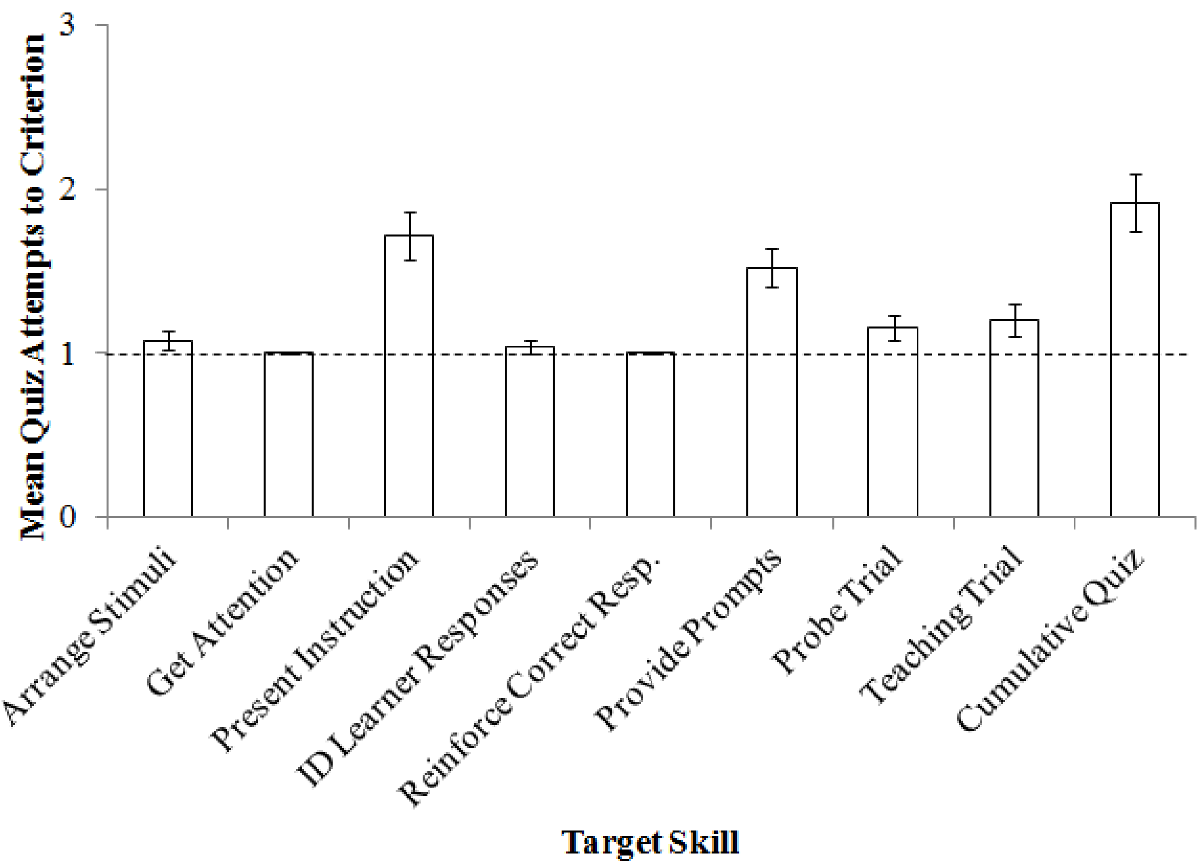


Figure 4. Mean attempts to criterion during quizzes in CBI. The white bars represent the mean attempts to criterion. The dashed line represents the criterion level. For all of the quizzes, except the final cumulative quiz, the mastery criterion was completing the quiz with 100% accuracy. For the final cumulative quiz, the mastery criterion was completing the quiz with at least 90% accuracy.

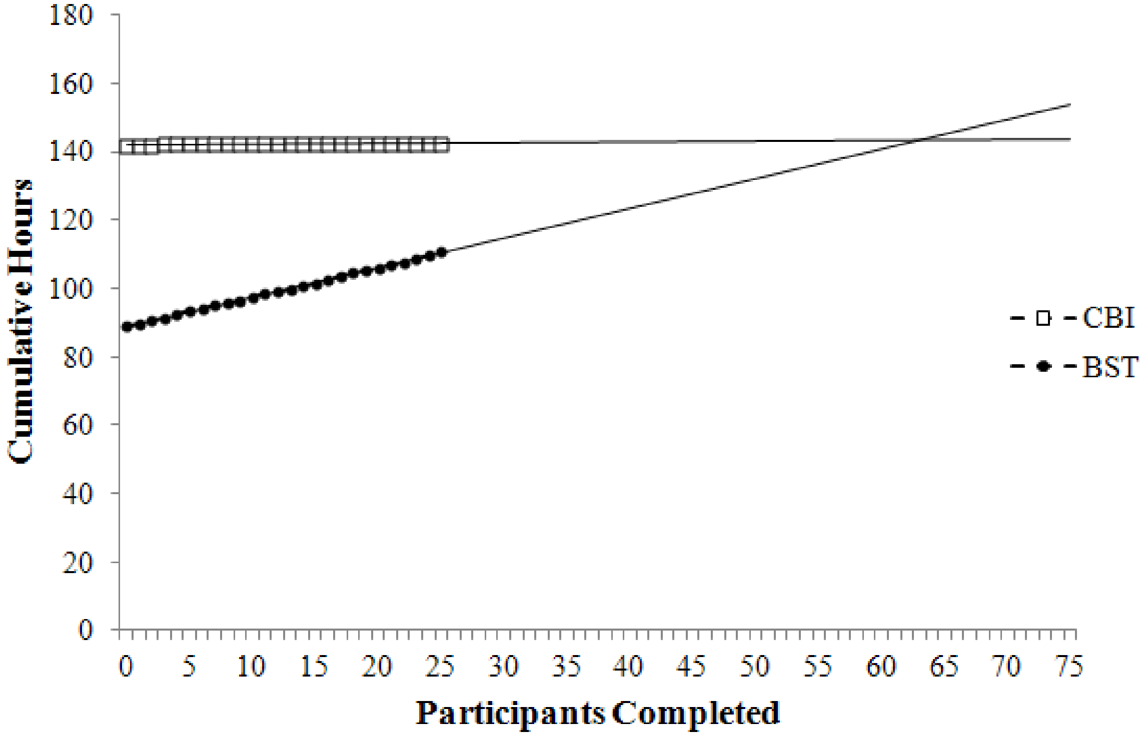


Figure 5. Time investment of the trainer for CBI and BST. The white squares represent total time invested to create the module and train the CBI group and the black circles represent total time invested to create the module and train the BST group. The solid lines are the trend lines for the data sets.

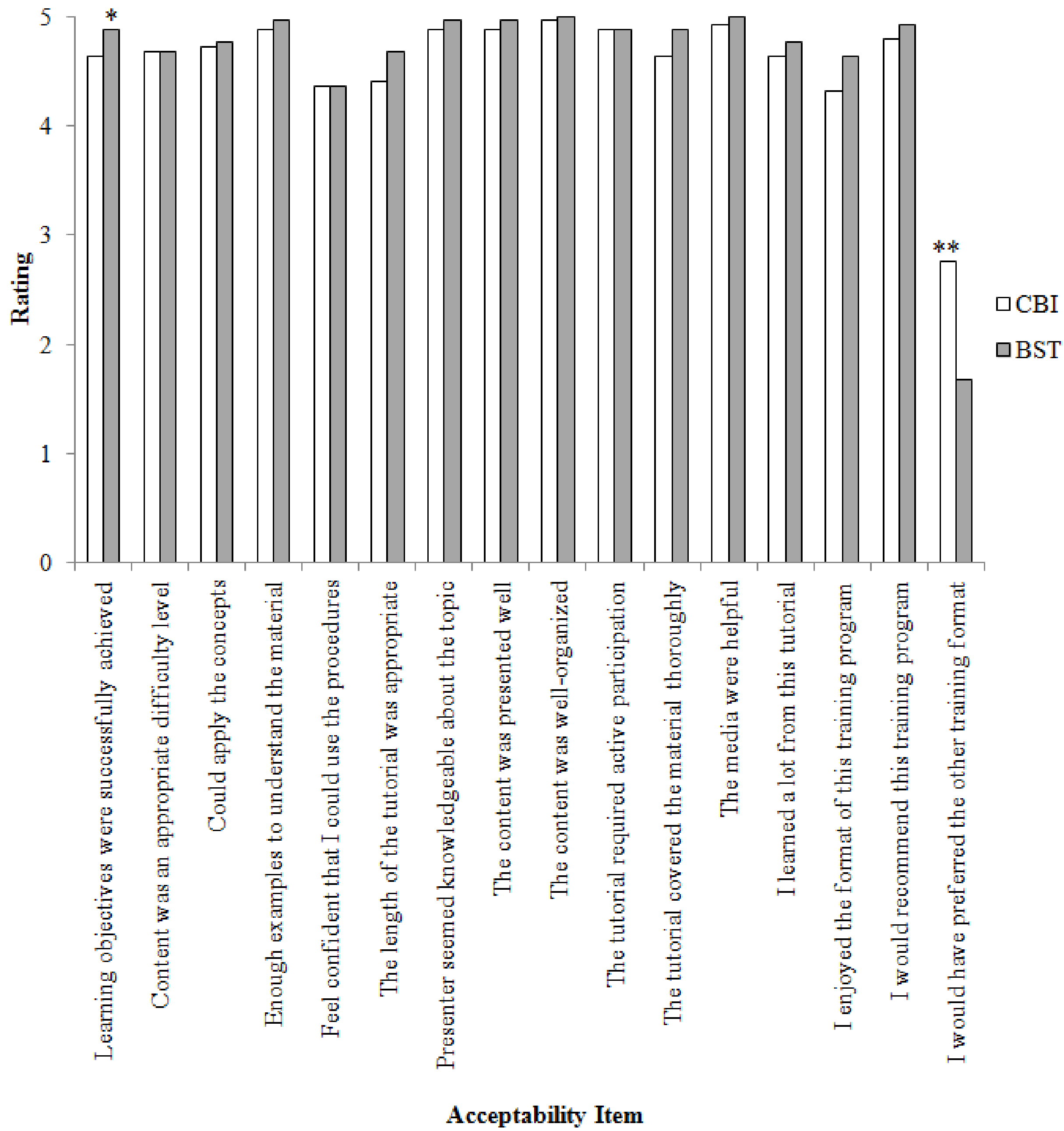


Figure 6. Participants' ratings on the training acceptability questionnaire. A rating of 5 indicates that the participant strongly agreed and a rating of 1 indicates that the participant strongly disagreed. The white bars represent the mean rating for the CBI group and the gray bars represent the mean rating for the BST group. One star indicates a significant difference at $p < .05$ level and two stars indicate a significant difference at the $p < .01$ level.

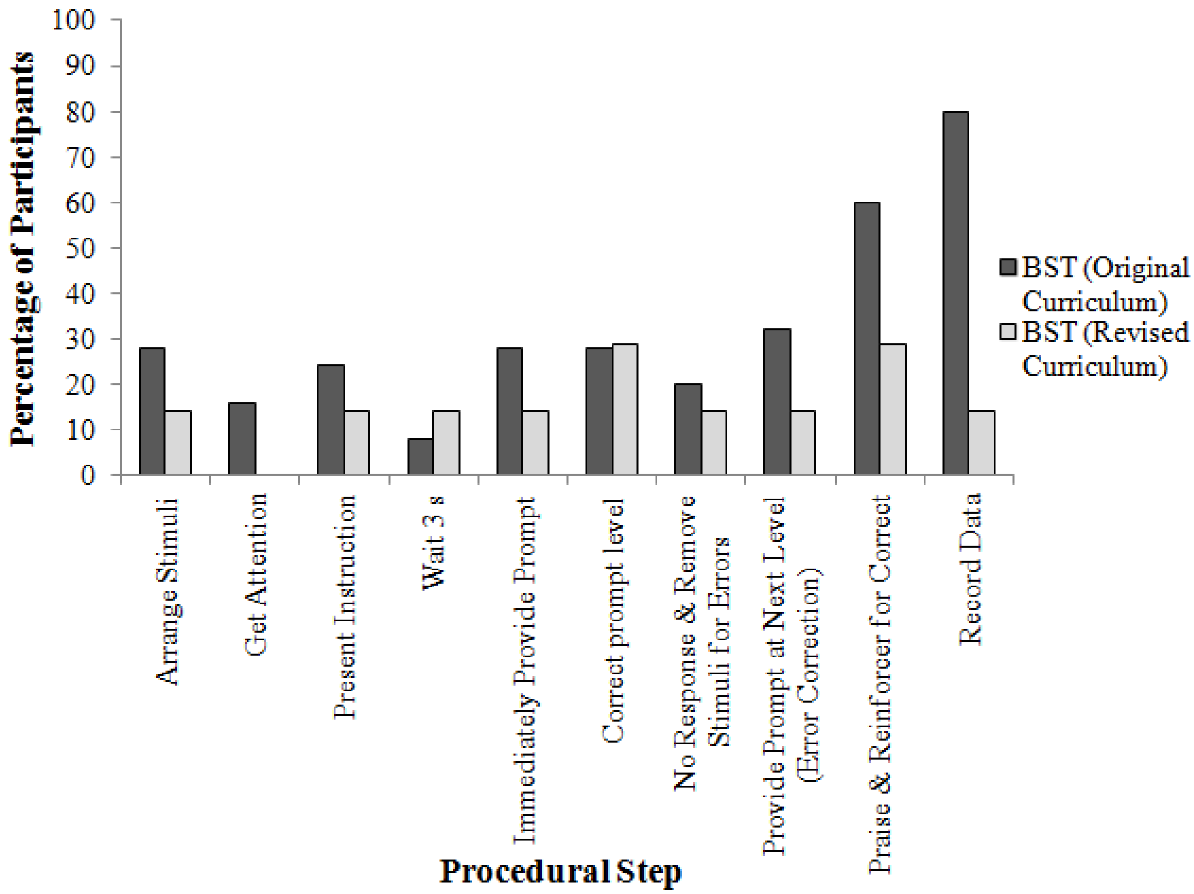


Figure 7. Percentage of participants who made errors on procedural steps during the post training probe. The dark gray bars represent participants in the BST group who experienced the original curriculum (n = 25) and the light gray bars represent participants in the BST group who experienced the modified curriculum (n = 7) in which data collection was simplified.

Appendix A: Background Information Form

Office Use Only	Participant #: ________

Participant Background Information Form

Please fill out this form to the best of your ability. Please **do not** write your name or any other identifying information on the form.

Age: ______

Sex: **Male / Female**

Major: ______________________

Do you have any visual impairments that would prevent you from being able to read text on a computer screen or from a PowerPoint presentation? *circle one* **Yes / No**

Do you have any fine motor dexterity impairments that would prevent you from being able to click on a computer mouse, type on a keyboard, write, or handle cards (slightly smaller than playing cards)? *circle one* **Yes / No**

Have you taken any Psychology courses? *circle one* **Yes / No**

If yes, please list the courses below:

Have you participated in any practica, internships, or clinical experiences for individuals with developmental disabilities or autism? *circle one* **Yes / No**

If yes, please list the practicum, internship, or clinical experiences below:

Do you have any other previous experiences with people with developmental disabilities or autism that you haven't already listed? *circle one* **Yes / No**

If yes, please list previous experiences below:

Appendix B: Learner Data Sheet

Instructor: ____________________ **Date**: __________ **Session #**: _____________

Instructions: For each trial, arrange the stimuli so they are in the order on the data sheet. Provide the instruction so that the bold target is the correct one. Circle the word for the first response the learner gives. In probe trials, circle the prompt level required to get the correct response. In training trials, circle C if the response was correct or E if the learner made an error.

Key: I = Independent Response (No prompt required) G = Gestural Prompt
P = Partial Physical Prompt F = Full Physical Prompt

Block 1

Probes				
	Left	*Center*	*Right*	Prompt Req.
1	Cow	**Pig**	Dog	I G P F
2	**Dog**	Cow	Pig	I G P F
3	Pig	Dog	**Cow**	I G P F
Teaching				
	Left	*Center*	*Right*	Correct/Error
1	**Dog**	Pig	Cow	C E
2	Cow	Dog	**Pig**	C E
3	Pig	**Cow**	Dog	C E
4	Dog	**Pig**	Cow	C E
5	Pig	Cow	**Dog**	C E
6	**Cow**	Dog	Pig	C E
7	Dog	Pig	**Cow**	C E
8	Cow	**Dog**	Pig	C E
9	**Pig**	Cow	Dog	C E

Block 2

Probes				
	Left	*Center*	*Right*	Prompt Req.
1	Pig	Dog	**Cow**	I G P F
2	Cow	**Pig**	Dog	I G P F
3	**Dog**	Cow	Pig	I G P F
Teaching				
	Left	*Center*	*Right*	Correct/Error
1	Dog	**Pig**	Cow	C E
2	**Cow**	Dog	Pig	C E
3	Pig	Cow	**Dog**	C E
4	**Dog**	Pig	Cow	C E
5	Pig	**Cow**	Dog	C E
6	Cow	Dog	**Pig**	C E
7	Dog	Pig	**Cow**	C E
8	**Pig**	Cow	Dog	C E
9	Cow	**Dog**	Pig	C E

Block 3

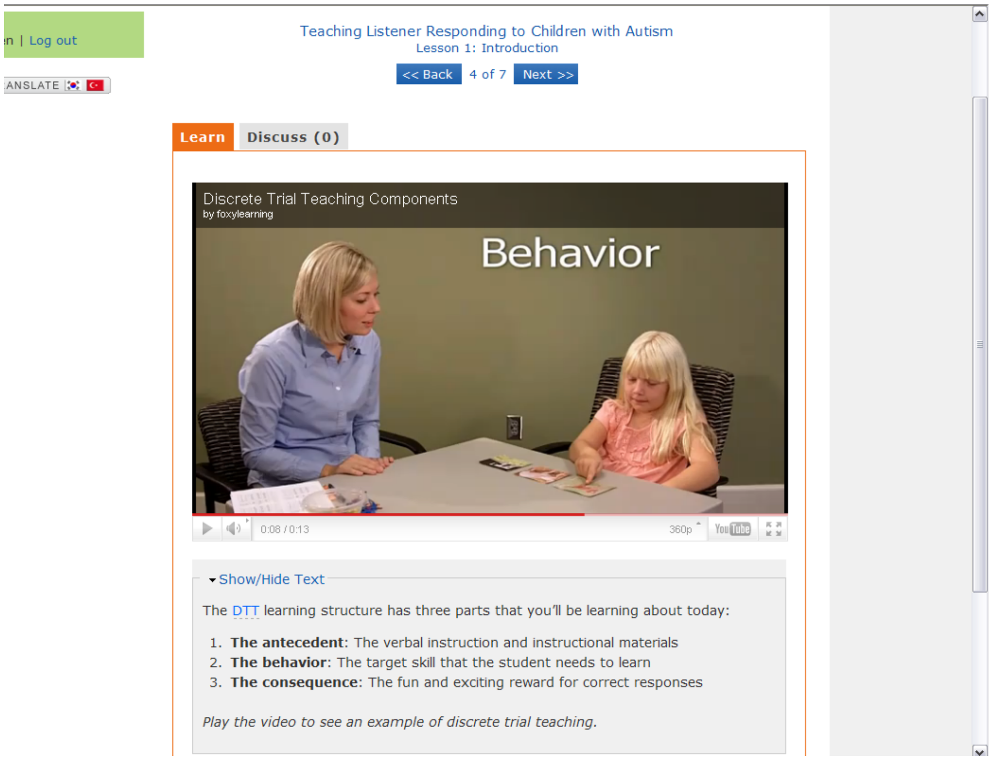
Probes				
	Left	*Center*	*Right*	Prompt Req.
1	Dog	**Cow**	Pig	I G P F
2	Cow	Pig	**Dog**	I G P F
3	**Pig**	Dog	Cow	I G P F
Teaching				
	Left	*Center*	*Right*	Correct/Error
1	Pig	**Cow**	Dog	C E
2	Cow	Dog	**Pig**	C E
3	**Dog**	Pig	Cow	C E
4	Cow	Dog	**Pig**	C E
5	Pig	**Cow**	Dog	C E
6	**Dog**	Pig	Cow	C E
7	**Cow**	Dog	Pig	C E
8	Pig	Cow	**Dog**	C E
9	Dog	**Pig**	Cow	C E

Block 4

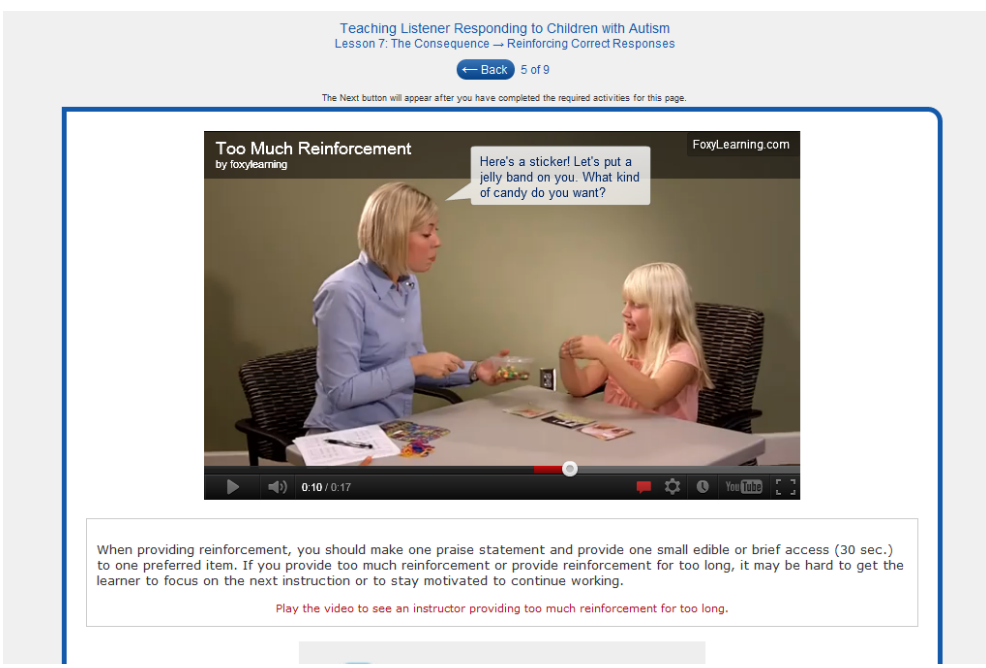
Probes				
	Left	*Center*	*Right*	Prompt Req.
1	Cow	Pig	**Dog**	I G P F
2	Dog	**Cow**	Pig	I G P F
3	**Pig**	Dog	Cow	I G P F
Teaching				
	Left	*Center*	*Right*	Correct/Error
1	Dog	Cow	**Pig**	C E
2	Pig	**Dog**	Cow	C E
3	**Cow**	Pig	Dog	C E
4	Pig	Cow	**Dog**	C E
5	**Cow**	Dog	Pig	C E
6	Dog	**Pig**	Cow	C E
7	**Dog**	Pig	Cow	C E
8	Cow	Dog	**Pig**	C E
9	Pig	**Cow**	Dog	C E

Appendix C: Example screen shots of CBI program

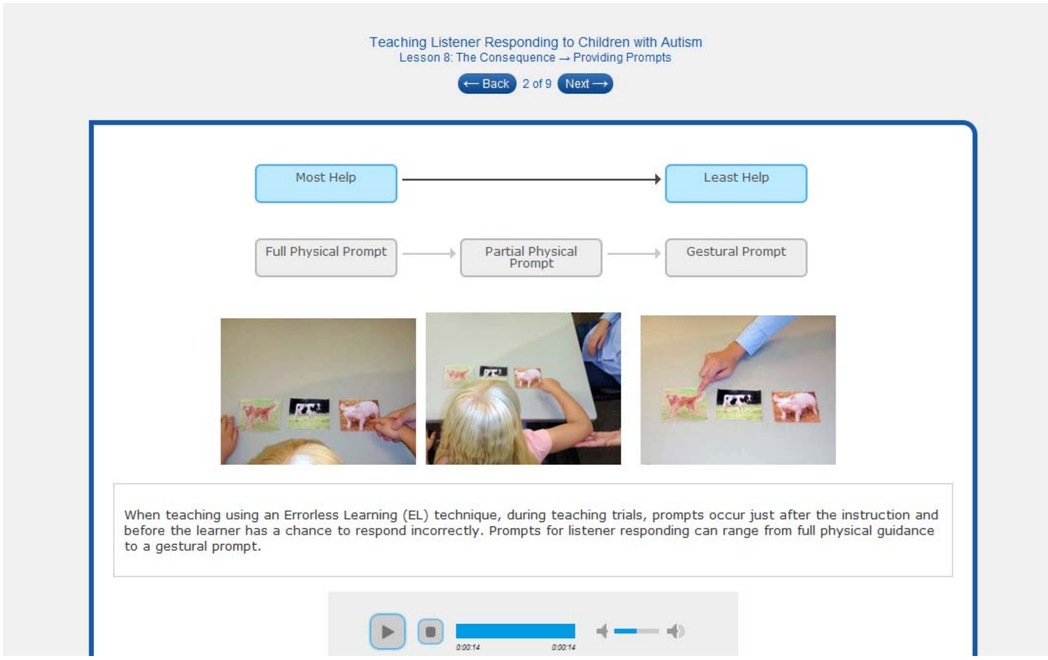
Video Model of a Discrete Trial



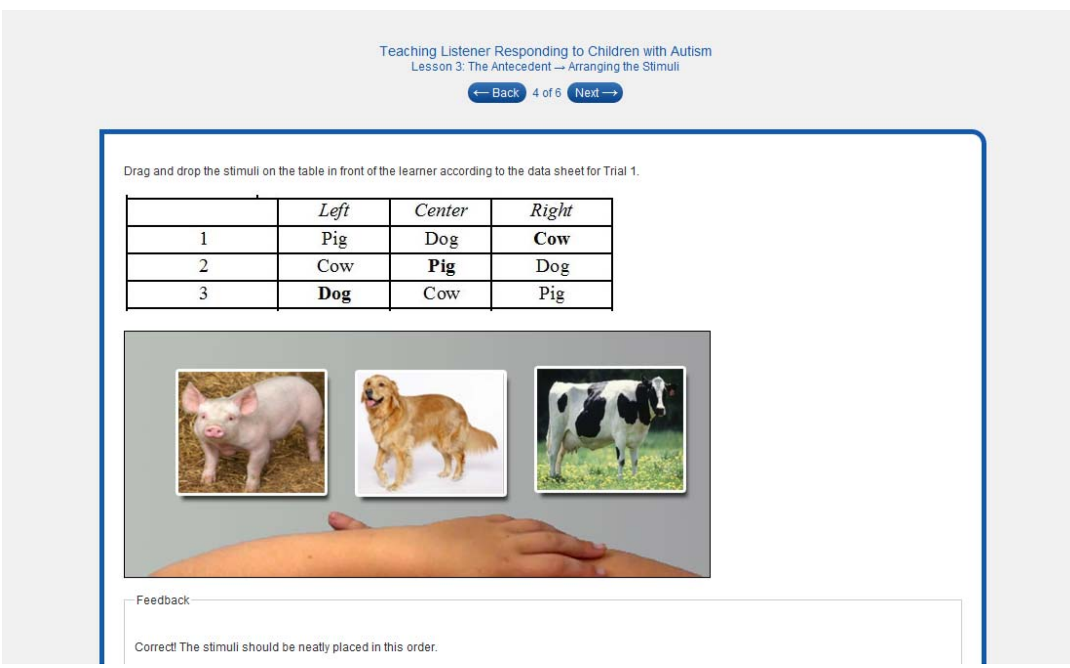
Video Model of a Non-Exemplar for Providing Reinforcement



Pictures and Diagram Representing the Hierarchy of Intrusiveness for Prompts



Active Response Activity for Arranging the Stimuli



Active Response Activity for Collecting Data during Probe Sessions

Watch the video and complete the data sheet as the instructor presents the trials. To enter the data, click on the letter that should be circled for each trial.

Probes				
	Left	*Center*	*Right*	Prompt Req.
1	Pig	Dog	**Cow**	I G P F
2	Cow	**Pig**	Dog	I G P F
3	**Dog**	Cow	Pig	I G P F

Feedback

Quiz Question with a Video Example

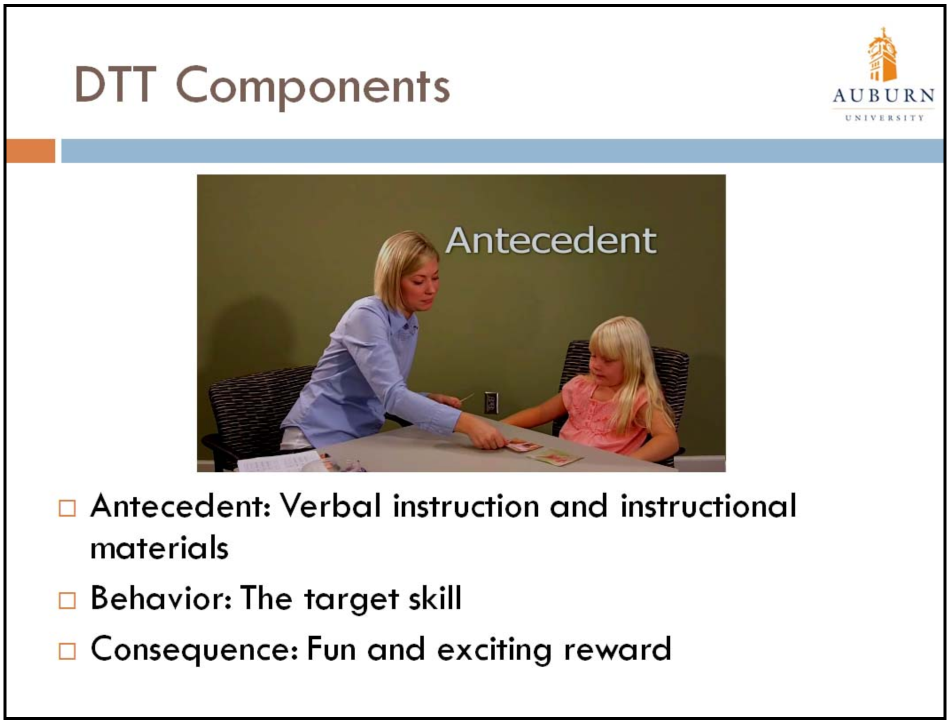
Watch the video clip and then answer the question that follows.

What should the instructor do next?

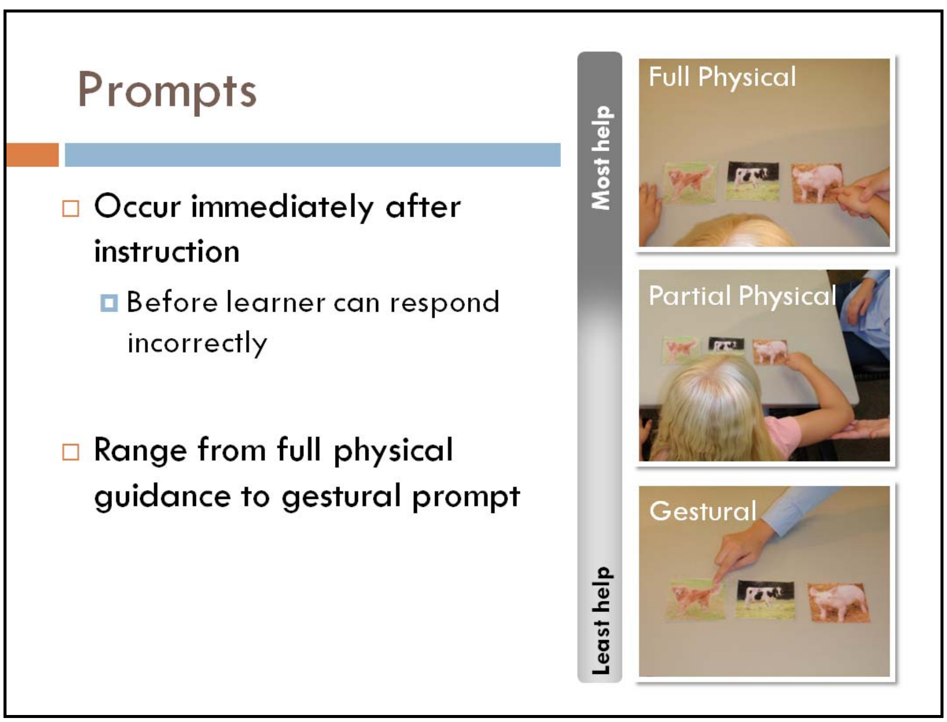
1. Re-present the instruction and immediately use a gestural prompt.
2. Re-present the instruction and immediately use a partial physical prompt.
3. Re-present the instruction and immediately use a full physical prompt.
4. Re-present the instruction and wait 3 seconds to give the learner the opportunity to make the correct response independently.

Appendix D: Example Screen Shots of BST Presentation Slides

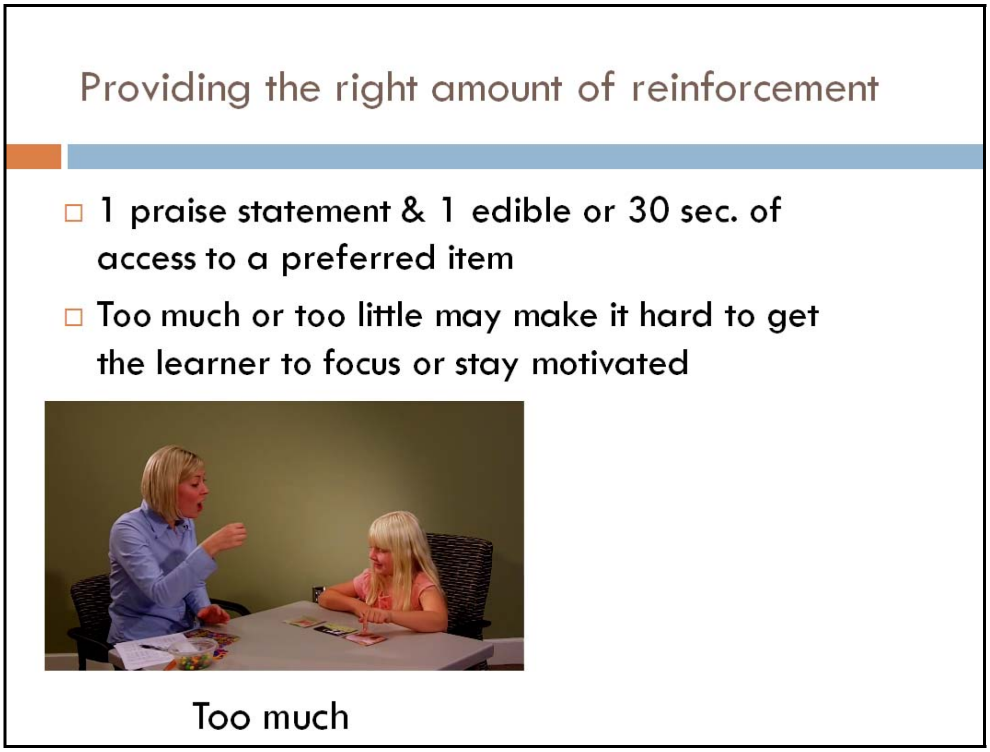
Video Model of a Discrete Trial



Pictures and Diagram Representing the Hierarchy of Intrusiveness for Prompts



Video Model of a Non-Exemplar for Providing Reinforcement



Appendix E: Training Acceptability Questionnaires

Training Acceptability Questionnaire

Participant #: ___________ **Behavioral Skills Training** Date: _____________

Directions: At the end of each statement below, please circle the number (according to the scale) that most accurately describes your reactions to the training you received.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Tutorial Content					
1. This tutorial's learning objectives (teach the learner to be able to implement a Listener Responding program) were successfully achieved.	5	4	3	2	1
2. The tutorial content was at an appropriate difficulty level.	5	4	3	2	1
3. I could apply the concepts presented in the tutorial.	5	4	3	2	1
4. There were enough examples for me to understand the material.	5	4	3	2	1
5. After this training, I feel confident that I could use these procedures.	5	4	3	2	1
6. The length of the tutorial was appropriate.	5	4	3	2	1
Presentation					
7. The author/presenter seemed knowledgeable about the topics covered.	5	4	3	2	1
8. The content was presented well.	5	4	3	2	1
9. The content was well-organized.	5	4	3	2	1
10. The tutorial required active learner participation.	5	4	3	2	1
11. The tutorial covered the material thoroughly.	5	4	3	2	1
12. The media (video, graphics, etc.) were helpful.	5	4	3	2	1
Overall Impression					
13. I learned a lot from this tutorial.	5	4	3	2	1
14. I enjoyed the format of this training program.	5	4	3	2	1
15. I would recommend this training program for others who need to learn to implement a Listener Responding program.	5	4	3	2	1
16. I would have preferred to learn these procedures in a computer-based tutorial.	5	4	3	2	1

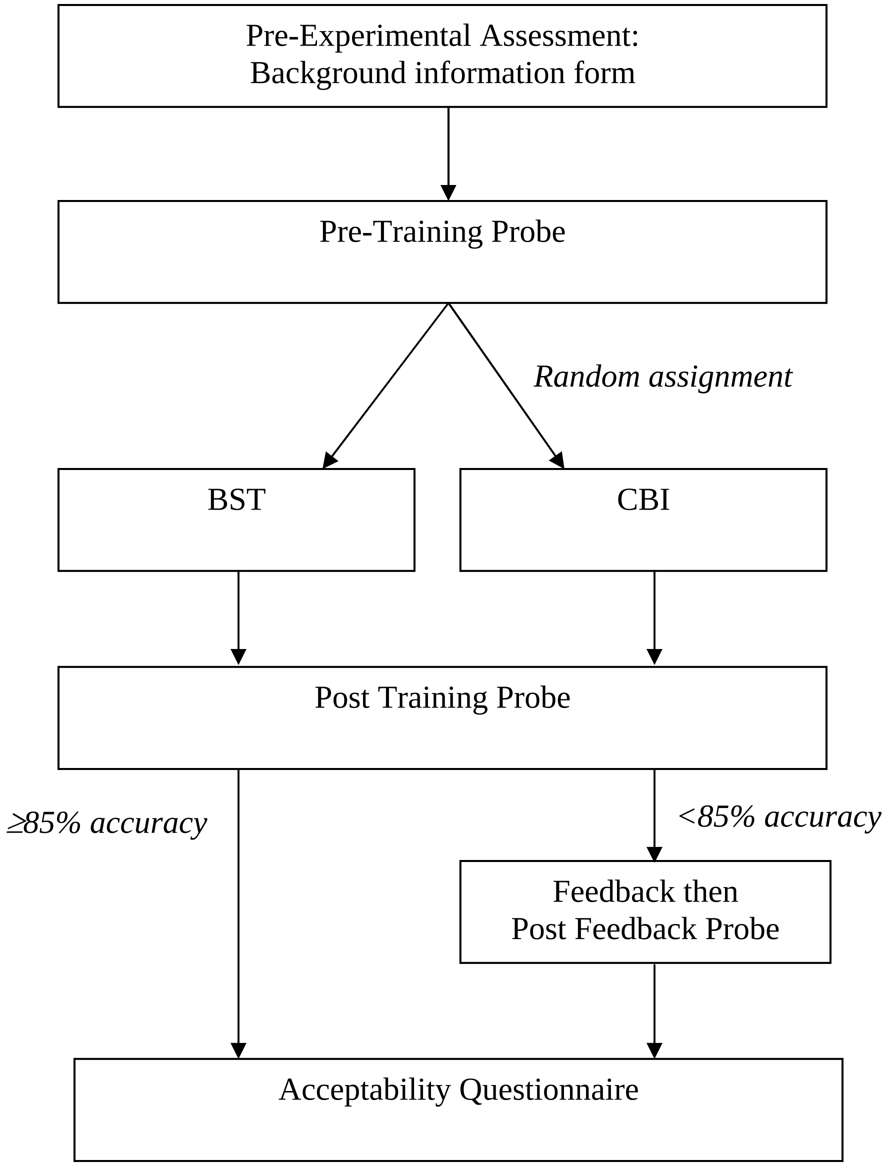
Training Acceptability Questionnaire

Participant #: __________ **Computer-Based Instruction** Date: ____________

Directions: At the end of each statement below, please circle the number (according to the scale) that most accurately describes your reactions to the training you received.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Tutorial Content					
1. This tutorial's learning objectives (teach the learner to be able to implement a Listener Responding program) were successfully achieved.	5	4	3	2	1
2. The tutorial content was at an appropriate difficulty level.	5	4	3	2	1
3. I could apply the concepts presented in the tutorial.	5	4	3	2	1
4. There were enough examples for me to understand the material.	5	4	3	2	1
5. After this training, I feel confident that I could use these procedures.	5	4	3	2	1
6. The length of the tutorial was appropriate.	5	4	3	2	1
Presentation					
7. The author/presenter seemed knowledgeable about the topics covered.	5	4	3	2	1
8. The content was presented well.	5	4	3	2	1
9. The content was well-organized.	5	4	3	2	1
10. The tutorial required active learner participation.	5	4	3	2	1
11. The tutorial covered the material thoroughly.	5	4	3	2	1
12. The media (video, graphics, etc.) were helpful.	5	4	3	2	1
Overall Impression					
13. I learned a lot from this tutorial.	5	4	3	2	1
14. I enjoyed the format of this training program.	5	4	3	2	1
15. I would recommend this training program for others who need to learn to implement a Listener Responding program.	5	4	3	2	1
16. I would have preferred to learn these procedures with a live instructor.	5	4	3	2	1

Appendix F: Flowchart of Experimental Procedures



Appendix G: Participant Accuracy Data Sheet

Probe 1																
								Error Correction:								
	Prep materials	Present stimuli	Get attention	Present instruction	Allow 3 s for response			No response & remove stimuli	Re-present stimuli in same order	Get attention	Re-present instruction	Provide prompt at next level	Provide praise & reinforcer for correct response	Record data	Total correct/Total possible	Total agreement/ Total possible
	C I														/ 1	/ 1
1		C I	C I	C I	C I								C I	C I	/ 6	/ 6
2		C I	C I	C I	C I			C I	C I	C I	C I	C I	C I	C I	/ 21	/ 21
								C I	C I	C I	C I	C I				
								C I	C I	C I	C I	C I				
3		C I	C I	C I	C I			C I	C I	C I	C I	C I	C I	C I	/ 11	/ 11
Teaching 1																
								Error Correction:								
		Present stimuli	Get attention	Present instruction	Allow 3 s for response	Immediately provide prompt	Correct prompt level	No response & remove stimuli	Re-present stimuli in same order	Get attention	Re-present instruction	Provide prompt at next level	Provide praise & reinforcer for correct response	Record data	Total correct/ Total possible	Total agreement/ Total possible
1		C I	C I	C I		C I	C I						C I	C I	/ 7	/ 7
2		C I	C I	C I	C I		C I	C I	C I	C I	C I	C I	C I	C I	/ 16	/ 16
							C I	C I	C I	C I	C I	C I				
3		C I	C I	C I		C I	C I						C I	C I	/ 7	/ 7
4		C I	C I	C I	C I		C I	C I	C I	C I	C I	C I	C I	C I	/ 11	/ 11
5		C I	C I	C I		C I	C I						C I	C I	/ 7	/ 7
6		C I	C I	C I		C I	C I	C I	C I	C I	C I	C I	C I	C I	/ 12	/ 12
7		C I	C I	C I		C I	C I						C I	C I	/ 7	/ 7
8		C I	C I	C I		C I	C I						C I	C I	/ 7	/ 7
9		C I	C I	C I	C I		C I						C I	C I	/ 6	/ 6
Probe 2																
								Error Correction:								
	Prep materials	Present stimuli	Get attention	Present instruction	Allow 3 s for response			No response & remove stimuli	Re-present stimuli in same order	Get attention	Re-present instruction	Provide prompt at next level	Provide praise & reinforcer for correct response	Record data	Total correct/Total possible	Total agreement/ Total possible
	C I														/ 1	/ 1
1		C I	C I	C I	C I								C I	C I	/ 6	/ 6
2		C I	C I	C I	C I			C I	C I	C I	C I	C I	C I	C I	/ 11	/ 11
3		C I	C I	C I	C I			C I	C I	C I	C I	C I	C I	C I	/ 16	/ 16
								C I	C I	C I	C I	C I				
Teaching 2																
								Error Correction:								
		Present stimuli	Get attention	Present instruction	Allow 3 s for response	Immediately provide prompt	Correct prompt level	No response & remove stimuli	Re-present stimuli in same order	Get attention	Re-present instruction	Provide prompt at next level	Provide praise & reinforcer for correct response	Record data	Total correct/ Total possible	Total agreement/ Total possible
1		C I	C I	C I		C I	C I	C I	C I	C I	C I	C I	C I	C I	/ 17	/ 17
							C I	C I	C I	C I	C I	C I				
2		C I	C I	C I	C I		C I	C I	C I	C I	C I	C I	C I	C I	/ 11	/ 11
3		C I	C I	C I		C I	C I	C I	C I	C I	C I	C I	C I	C I	/ 12	/ 12
4		C I	C I	C I		C I	C I						C I	C I	/ 7	/ 7
5		C I	C I	C I	C I		C I	C I	C I	C I	C I	C I	C I	C I	/ 16	/ 16
							C I	C I	C I	C I	C I	C I				
6		C I	C I	C I		C I	C I						C I	C I	/ 7	/ 7
7		C I	C I	C I	C I		C I						C I	C I	/ 6	/ 6
8		C I	C I	C I		C I	C I	C I	C I	C I	C I	C I	C I	C I	/ 12	/ 12
9		C I	C I	C I		C I	C I	C I	C I	C I	C I	C I	C I	C I	/ 12	/ 12
Total:		/ 24	/ 24	/ 24	/ 12	/12	/ 18	/ 19	/ 19	/ 19	/ 19	/ 19	/ 24	/ 24	/ 253	/ 253

Appendix H: Participant Accuracy Operational Definitions

Prep Materials: No materials (data sheet, pen, stimuli, reinforcers) are missing and the participant has their name, date, and session number filled out at the top of the data sheet.

Present Stimuli: All 3 stimuli are presented in a neat row, right side up, in front of the learner, in the correct order from the data sheet.

Get Attention: The actor is either already looking at the materials or the participant get's her attention (e.g., "look" running finger back and forth across the array) before starting the instruction. The actor must NOT still have the reinforcer in her hands from the previous trial.

Present Instruction: The participant says an appropriate brief instruction that is correct for the bold word for the trial. Examples include: Find cow, point to the cow, where's the cow?, cow, can you find the cow?, etc.

Incorrect instructions: How about the cow? The cow is black and white. What's this one?

Allow 3s for a Response: The participant allows the actor to respond and does not immediately provide any prompts.

Immediately Provide Prompt: The participant provides a prompt immediately (within 1-2 sec) after finishing the instruction. If the actor selects a picture before the participant is able to provide the prompt, then this step is considered incorrect.

Correct Prompt Level: The participant provides the correct prompt level according to the data collected in the probe trial.

<u>Error Correction</u>:

No Response and Remove Stimuli: The participant does not say anything *and* removes the stimuli within 1-2 seconds of the actor making an error.

Re-present Stimuli in the Same Order: The participant re-presents the stimuli in the same order as in the original presentation. The array must be neat, presented in front of the learner, and still in the correct order from the data sheet.

Provide Prompt at next Level: The participant provides the next most intrusive/helpful prompt as indicated from the data sheet.

Provide Praise and Reinforcer for Correct Response: The participant provides praise (e.g., "Good job") *and* an edible or toy within 1-2 sec of the actor making a correct response. The participant must make both the praise statement and provide the edible/toy in order for this step to be correct. The participant can offer a choice of edibles or toys and this is still considered correct.

Record data: The participant records data accurately according to the responses that the actor makes.

Appendix I: BST Rehearsal Data Sheet with Procedural Integrity Checklist

Arrange the Stimuli

	Left	*Center*	*Right*	+ / -
1	Cow	**Pig**	Dog	
2	**Dog**	Cow	Pig	
3	Pig	Dog	**Cow**	
4	**Dog**	Pig	Cow	
5	Cow	Dog	**Pig**	
6	Pig	**Cow**	Dog	
7	Dog	**Pig**	Cow	
8	Pig	Cow	**Dog**	
9	**Cow**	Dog	Pig	
10	Dog	Pig	**Cow**	

Procedural Integrity: ***Arranging Stimuli***	
BST Step	**Correct/ Incorrect**
Instructions	C / I
Rehearsal	C / I
Feedback	C / I
Total:	

Get the Learner's Attention

	+ / -
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Procedural Integrity: ***Getting Attention***	
BST Step	**Correct/ Incorrect**
Instructions	C / I
Rehearsal	C / I
Feedback	C / I
Total:	

Present the Instruction

Left	*Center*	*Right*
Cow	Pig	Dog

		+ / -
1	**Pig**	
2	**Dog**	
3	**Cow**	
4	**Dog**	
5	**Pig**	
6	**Cow**	
7	**Pig**	
8	**Dog**	
9	**Cow**	
10	**Cow**	

Procedural Integrity: ***Presenting Instructions***	
BST Step	**Correct/ Incorrect**
Instructions	C / I
Rehearsal	C / I
Feedback	C / I
Total:	

Identify Learner Responses

	+ / -
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Procedural Integrity: ***Learner Responses***	
BST Step	**Correct/ Incorrect**
Instructions	C / I
Rehearsal	C / I
Feedback	C / I
Total:	

Reinforce Correct Responses

	Left	*Center*	*Right*	+ / -
1	Cow	**Pig**	Dog	
2	**Dog**	Cow	Pig	
3	Pig	Dog	**Cow**	
4	**Dog**	Pig	Cow	
5	Cow	Dog	**Pig**	
6	Pig	**Cow**	Dog	
7	Dog	**Pig**	Cow	
8	Pig	Cow	**Dog**	
9	**Cow**	Dog	Pig	
10	Dog	Pig	**Cow**	

Procedural Integrity: ***Reinforcing Correct Responses***	
BST Step	**Correct/ Incorrect**
Instructions	C / I
Rehearsal	C / I
Feedback	C / I
Total:	

Provide Prompts

Left	*Center*	*Right*
Cow	**Pig**	Dog

Gestural	
	+ / -
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Partial Phys.	
	+ / -
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Full Physical	
	+ / -
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Procedural Integrity: ***Prompts***	
BST Step	**C / I**
Instructions	C / I
Rehearsal	C / I
Feedback	C / I
Total:	

Conduct a Probe Trial

Probes					+ / -
	Left	*Center*	*Right*	Prompt Req.	
1	Cow	**Pig**	Dog	I G P F	
2	**Dog**	Cow	Pig	I G P F	
3	Pig	Dog	**Cow**	I G P F	
4	Pig	Dog	**Cow**	I G P F	
5	Cow	**Pig**	Dog	I G P F	
6	**Dog**	Cow	Pig	I G P F	
7	Dog	**Cow**	Pig	I G P F	
8	Cow	Pig	**Dog**	I G P F	
9	**Pig**	Dog	Cow	I G P F	
10	Cow	Pig	**Dog**	I G P F	

Procedural Integrity: ***Probe Trial***	
BST Step	**Correct/ Incorrect**
Instructions	C / I
Rehearsal	C / I
Feedback	C / I
Total:	

Conduct a Teaching Trial

Probes					
	Left	*Center*	*Right*	Prompt Req.	
1	Pig	Dog	**Cow**	(I) G P F	
2	Cow	**Pig**	Dog	I (G) P F	
3	**Dog**	Cow	Pig	I G (P) F	
Teaching					+ / -
	Left	*Center*	*Right*	Correct/Error	
1	Dog	**Pig**	Cow	C E	
2	**Cow**	Dog	Pig	C E	
3	Pig	Cow	**Dog**	C E	
4	**Dog**	Pig	Cow	C E	
5	Pig	**Cow**	Dog	C E	
6	Cow	Dog	**Pig**	C E	
7	Dog	Pig	**Cow**	C E	
8	**Pig**	Cow	Dog	C E	
9	Cow	**Dog**	Pig	C E	

Procedural Integrity: ***Teaching Trial***	
BST Step	**Correct/ Incorrect**
Instructions	C / I
Rehearsal	C / I
Feedback	C / I
Total:	

Teach Listener Responding

Probes				
	Left	*Center*	*Right*	Prompt Req.
1	Pig	Dog	**Cow**	I G P F
2	Cow	**Pig**	Dog	I G P F
3	**Dog**	Cow	Pig	I G P F
Teaching				
	Left	*Center*	*Right*	Correct/Error
1	Dog	**Pig**	Cow	C E
2	**Cow**	Dog	Pig	C E
3	Pig	Cow	**Dog**	C E
4	**Dog**	Pig	Cow	C E
5	Pig	**Cow**	Dog	C E
6	Cow	Dog	**Pig**	C E
7	Dog	Pig	**Cow**	C E
8	**Pig**	Cow	Dog	C E
9	Cow	**Dog**	Pig	C E

Procedural Integrity: ***Teaching Listener Responding***	
BST Step	**Correct/ Incorrect**
Rehearsal	C / I
Feedback	C / I
Total:	

1st Attempt	**Antecedent** (present stim., get attn., present instruction)	**Waited 3s / Provided correct prompt immediately**	**Error Correction** (Remove & re-present, get attn., re-present instruction, immed. provide next prompt level)	**Provide Reinforcer**	**Record Data**	**Total**
1	C I	C I	C I	C I	C I	
2	C I	C I	C I	C I	C I	
3	C I	C I	C I	C I	C I	
1	C I	C I	C I	C I	C I	
2	C I	C I	C I	C I	C I	
3	C I	C I	C I	C I	C I	
4	C I	C I	C I	C I	C I	
5	C I	C I	C I	C I	C I	
6	C I	C I	C I	C I	C I	
7	C I	C I	C I	C I	C I	
8	C I	C I	C I	C I	C I	
9	C I	C I	C I	C I	C I	
Total						

Appendix J: Procedural Integrity Checklist for Post Training and Post Feedback Probes

Data collector: ___________ Date of session: ______________ Participant #: ____________

Post Training Probe

	Actor provided correct # of opportunities for error correction				Instructor	
Probe						
1	0	Y	N	N/A	If 85% or higher did NOT provide feedback	Y N N/A
2	1	Y	N	N/A		
3	2	Y	N	N/A		
Teaching					If lower than 85% provided feedback	Y N N/A
1	1	Y	N	N/A		
2	1	Y	N	N/A	Did NOT provide corrective feedback on steps where no errors occurred	Y N N/A
3	2	Y	N	N/A		
4	0	Y	N	N/A		
5	2	Y	N	N/A		
6	0	Y	N	N/A	Provided feedback on <u>all</u> steps where errors occurred	Y N N/A
7	0	Y	N	N/A		
8	1	Y	N	N/A		
9	1	Y	N	N/A		
Probe						
1	3	Y	N	N/A		
2	1	Y	N	N/A		
3	0	Y	N	N/A		
Teaching						
1	0	Y	N	N/A		
2	2	Y	N	N/A		
3	0	Y	N	N/A		
4	1	Y	N	N/A		
5	0	Y	N	N/A		
6	1	Y	N	N/A		
7	0	Y	N	N/A		
8	0	Y	N	N/A		
9	0	Y	N	N/A		
Total						

Post Feedback Probe

	Actor provided correct # of opportunities for error correction			
Probe				
1	0	Y	N	N/A
2	3	Y	N	N/A
3	1	Y	N	N/A
Teaching				
1	0	Y	N	N/A
2	2	Y	N	N/A
3	0	Y	N	N/A
4	1	Y	N	N/A
5	0	Y	N	N/A
6	1	Y	N	N/A
7	0	Y	N	N/A
8	0	Y	N	N/A
9	0	Y	N	N/A
Probe				
1	0	Y	N	N/A
2	1	Y	N	N/A
3	2	Y	N	N/A
Teaching				
1	2	Y	N	N/A
2	1	Y	N	N/A
3	1	Y	N	N/A
4	0	Y	N	N/A
5	2	Y	N	N/A
6	0	Y	N	N/A
7	0	Y	N	N/A
8	1	Y	N	N/A
9	2	Y	N	N/A
Total				