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Effects of Task Clarification and an Adaptive Computer Software on Implementation of Mand Training using an iPad® as a Speech Generated Device

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Effects of Task Clarification and an Adaptive Computer Software on Implementation of
Mand Training using an iPad® as a Speech Generated Device

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in Curriculum and Instruction

by

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Abstract

Mand training is an evidence-based instructional method and a primary focus in behavioral language training for children with autism. A rapidly growing research base supports manding training using hand-held computing technologies (e.g., iPad®, iPod®) as speech generating devices (SGD) for establishing a manding repertoire in children with autism. To ensure optimal learning efficacy and efficiency, procedures must be implemented with high levels of accuracy, which requires that staff be well-trained. However, research evaluating methods for training staff to implement mand training procedures with the iPad® and application Proloquo2Go™ as an SGD has not yet been conducted. Therefore, this study examined the effectiveness of job aids followed by Train to Code, an interactive observation and behavioral coding software system to teach preschool teachers to implement mand training using the iPad® as an SGD with the application Proloquo2Go™. The TTC training programs used errorless training procedures with performance-based feedback to train expert observation and coding of behavioral events (i.e. mand training sequential components) via video files. As demonstrated in a multi-component within a multiple probe design across participants, all participants' teaching accuracy increased following the initiation of the job aid condition; however, TTC was required to establish high levels of accuracy of mand training procedures during role-play sessions with a confederate. In addition, results indicated improved performance relative to baseline during instructional sessions with a child with autism or a developmental delay, and performance accuracy maintained at one-month follow-up. These results suggest that job aids followed by TTC may be an effective and feasible method for training individuals to implement mand training using an iPad® and the application Proloquo2Go™.

Dedication

To Matt, my best friend and strongest supporter.

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Table of Contents

Introduction.....	1
Literature Review.....	6
Methodology.....	39
Results.....	58
Discussion.....	70
References.....	105
Appendices.....	122

Chapter 1

Introduction

With a current prevalence rate of 1:59 children diagnosed with autism spectrum disorder (ASD), the demand for access to evidence-based interventions across school and community continues to increase (CDC, 2017). The results of large-scale systematic reviews of interventions for children with ASD concur, identifying interventions based on the principles of applied behavior analysis (ABA) as the most empirically supported treatment for individuals with ASD (National Autism Center [NAC], 2015; Wong et. al, 2014). However, behavior analytic teaching procedures must be implemented consistently and accurately to be highly effective (Reed & Codding, 2013).

Mand (request) training is an evidence-based practice and a primary focus in early ABA language training (Sundberg & Michael, 2001). With around 30% of children with autism presenting little to no functional vocal output, use of augmentative and alternative communication (AAC) systems as a conduit for supplementing or acting in place of an individual's vocal speech through aided (i.e., speech generated devices, Picture Exchange Communication System) or unaided approaches (i.e., manual sign, gestures) has become standard educational practice (NPDC, 2014; Wodka, Mathy, & Kalb, 2013). Recently, a rapidly growing research base supports the feasibility and effectiveness of the use of hand-held multipurpose devices (e.g., iPad®, iPod®) with AAC-specific applications (e.g., Prologuo2Go™) as speech generating devices (SGD) in the acquisition of a mand repertoire in children with autism (Lorah, Crouser, Gilroy, Tincani, & Hantula, 2014; King, Takeguchi, Barry, Rehfeldt, Boyer, & Matthews, 2014).

Although the components of mand training are well-established and remain consistent across mand topographies, these components and associated instructional procedures are not always implemented as designed (Carroll, Kodak, & Fisher, 2013; Koegel, Matos-Fredeeen, Lang, & Koegel, 2012; Peter-Scheffer, Didden, Korzilius, & Sturmey, 2011). Preliminary research indicates that procedural fidelity errors are likely to be detrimental to vocal mand acquisition in children who demonstrate limited manding repertoires (Pence & St. Peter, 2015). Considering these results and supplemental research documenting the negative impacts of lower levels of procedural fidelity on skill acquisition along with the increased usage of the iPad® as a SGD, research investigating methods for training staff to implement mand training using an iPad® as a SGD should be conducted (Bibby, Eikseth, Martin, Mudford, & Reeves, 2002; Weinkauff, Zeug, Anderson, & Rosales, 2011).

A lack of well-trained staff exists, with lack of accessible, high quality training being at least partially to blame (DiGennaro Reed, Hirst, & Howard, 2013; Stahmer, Rieth, Reisinger, Mandell, & Connell, 2014). While a robust research base supports the effectiveness of a combination of instruction, modeling, practice, and feedback (i.e., behavioral skills training [BST]) for training staff to implement behavioral teaching procedures including mand training procedures, common barriers such as time and funding constraints, geographic isolation, and/or limited professional involvement or expertise often impede the use traditional behavioral training approaches (Nigro-Bruzzi & Sturmey, 2010; Pollard, Higbee, Akers, & Brodhead, 2014; Wainer & Ingersoll, 2012). Hence, more efficient, viable methods for implementing or embedding behavioral training components are needed.

The combination of job aids followed by interactive computer-based instruction stands to negate many of these training issues while also offering a way of embedding a variety of

evidence-based behavioral training procedures within as accessible, cost-effective, easy to implement, least intrusive training approach. Job aids, simple supplementary written tools, offer an easy-to-apply method for clarifying procedural components and sequences prior to the provision of more comprehensive training (Mager & Pipe, 1997). Train to Code (TTC), an adaptive expert training system, uses errorless training procedures with performance-based feedback to train expert observation and coding of behavioral events via video files (Ray, Ray, Eckerman, Milkosky, & Gillins, 2011; Terrace, 1963). Designers of TTC suggest that TTC training may effectively transfer to performance of those coded procedures, but this potential requires evaluation (Ray & Ray, 2008). Given the potential benefits and paucity of research surrounding both TTC alone and the combination of job aids following TTC, the effects of this training package on empirically-supported behavioral teaching procedures such as mand training warrant investigation.

Given the paucity of highly qualified practitioners in implementation of ABA interventions combined with the sound evidence-base supporting the use of Augmentative Alternative Communication (AAC), research attention should be directed towards increasing efficiency and usability of BST strategies, as well as evaluating these methods across AAC modalities and related procedures. Despite the increasing popularity, accessibility, and research base surrounding modern SGD technologies, such as the iPad® with AAC-specifications such as Proloquo2Go™ (Lorah et al., 2014; King et al., 2014), experiments targeting the evaluation of methods for training staff to implement mand training procedures with the iPad® and application Proloquo2Go™ as a SGD have not yet been conducted. However, a recent study by Lorah (2016) compared SGD and picture-based systems for the purposes of mand training in terms of student acquisition and preference, as well as teacher fidelity of use and preference in relation to

SGD and picture-based systems. Procedural fidelity probes following BST indicated that teachers can be trained to effectively and accurately implement mand training procedures using an iPad® as a SGD. In effect, targeted investigation should be conducted to identify to the most effective and efficient training methods for this purpose. As job aids followed by TTC may provide a means of addressing the afore mentioned training needs and gaps in the related research, investigation of this training package was warranted.

Thus, the objective of this dissertation was to evaluate the effectiveness of job aids followed by TTC on staff implementation of mand training with the iPad® and application Proloquo2Go™ as a SGD.

Research Questions

- 1) What are the effects of job aids followed by TTC on the accuracy of implementation of mand training using an iPad® as a SGD and the application Proloquo2Go™?
- 2) What are the comparative effects of the job aids and TTC in terms of efficacy, efficiency, and usability across behaviors and phases (see below)?
- 3) Will training effects observed within role-plays with a confederate generalize to teaching session with a child with autism or related developmental disability?
- 4) What is the acceptability and perceived effectiveness (social validity) of the training as rated by the trainees?
- 5) Are the teaching procedures (modified and abbreviated from Lorah, 2016) effective for establishing a mand repertoire in children diagnosed with ASD?
- 6) Will training effects maintain over time (see below)?

To answer these questions, three preschool teachers and one director were trained to conduct mand training using an iPad® as a SGD and the application Proloquo2Go™, using job aids followed by TTC. Participants were trained to implement three phases of mand training, broken into two groups of behavioral components which will be trained separately (i.e., Level I

and II). Data were collected on global and component-specific procedural fidelity as measured within both role-plays with an adult confederate and teaching sessions with a child diagnosed with autism or related developmental delay. Maintenance of training effects were measured during one month maintenance probes. Additionally, all participants were asked to complete a social validity questionnaire.

Chapter 2

Literature Review

Autism Spectrum Disorders

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by persistent impairments in social communication accompanied by the presence of restricted, repetitive patterns of behavior, interests, or activities (American Psychological Association [APA], 2013). Deficits in social communication and interaction manifest in problems with social reciprocity, non-vocal communicative behaviors, and acquisition of relationships. Restricted and repetitive behaviors include motor or vocal stereotypy, repetitive patterns of verbal or nonverbal behavior, highly restricted interests, and excessive adherence to rules and routines, and highly restricted interests (APA, 2013).

According to recent Center for Disease Control and Prevention (2017) estimates, one in 59 children have been identified as having ASD, with an average prevalence rate of 1% of the population across countries. Correspondingly, the number of students between the ages of three and 21 identified with ASD and served under the Individuals with Disabilities Education Act (IDEA) has increased from about 93,000 in 2000-2001 to 513,688 in 2015 (U.S. Department of Education, Office of Special Programs, 2015). Marked increases in prevalence combined with corresponding service delivery demands have further fueled efforts towards identifying and adopting evidence-based practices (EBP) for students diagnosed with ASD.

Behavioral Intervention as EBP for ASD

Over the course of the last 15 years, large scale projects and reports have focused on identifying, analyzing, and disseminating empirically supported best practice for children with ASD (NAC, 2009, 2015; Wong et al., 2014; National Research Council [NRC], 2001; Weitlauf

et al., 2014). Behavioral interventions based on applied behavior analysis (ABA), consistently document the strongest evidence-base for children diagnosed with ASD. Children receiving early, intensive behavioral interventions demonstrate more substantial, significant gains across cognitive, language and social domains when compared to children who receive eclectic and no intervention control treatments (Eldevik, Hastings, & Jahr; Howard et al., 2009; NAC, 2009, 2015; Steege, Mace, Perry, & Longnecker, 2007; Peters-Scheffer, Didden, Korzillius, & Sturmey, 2011). More specifically, evidence supports significant gains in language and communication for children receiving Early Intensive Behavioral Intervention (EIBI).

Language acquisition. Impairment in communication skills is a core feature of ASD (American Psychiatric Association, 2013). It is estimated that 30% of persons with ASD fail to develop functional vocal output capabilities (Wodka et al., 2013). With early, functional language established as one of the strongest, most consistent predictors for future social and adaptive outcomes for individuals diagnosed with ASD (Howlin & Moss, 2012; National Research Council [NRC], 2001), increased effort and attention has been directed towards targeting and establishing functional communication prior to age five-years (Tager-Flusberg & Kasari, 2013).

Verbal Behavior Approach: Theory and application. Given the superior efficacy documented by early behavioral intervention, language training procedures within EIBI programs have become common best practice for young children with ASD. Most EIBI programs take a verbal behavior approach to language training (Esch, LaLonde, & Esch, 2010; Sigafos, 1997; Sundberg, 2008). This approach uses B. F. Skinner's functional analysis of verbal behavior (1957), as a basis for assessment and intervention (Sundberg & Michael, 2001).

Skinner (1957) defines *verbal behavior* as operant behavior reinforced through the mediation of a listener or verbal community, directing attention to the behavior of the speaker and the environmental variables that shape and maintain those behaviors (Skinner, 1957). The functional relation between a verbal response and its antecedent and consequential variables (i.e., contingency) serves as the unit of analysis for verbal behavior, as well as the basis of the classification system for different kinds of verbal behavior (Moore, 2008). Skinner refers to each unit of verbal behavior as a verbal operant, describing six types of elementary verbal operants including: mands, tacts, intraverbals, echoics, textuials, and transcription (Skinner, 1957). These verbal operant classes represent different kinds of operant contingencies or verbal relations (Pierce & Cheney, 2008; Johnston, 2014).

In accordance with the Skinner's conceptual framework, a verbal behavior approach to language instruction focuses on the acquisition of these functional and distinct verbal operants (Sautter & Leblanc, 2006). Initially, practitioners assess language deficits in terms of verbal operants, with each verbal operant assessed under the relevant antecedent conditions and corresponding consequences (Rehfeldt & Barnes-Holmes, 2009). Based on assessment data, verbal operant programs are systematically selected, sequenced, and targeted for instruction (Partington, 2006; Sundberg, 2008).

The mand. When conducting behavioral language intervention for early language learners, most practitioners place primary importance on establishing functional communication, or the mand repertoire. In accordance with NRC (2001) recommendations and Skinner's conceptual analysis (1957), most ABA curricular sequences stress spontaneous functional communication, namely the mand repertoire, as the central focus of early language programming (Leblanc, Esch, Sidener, & Firth, 2006; Sundberg, 2001; Partington & Sundberg, 1998;

Sundberg, 2008). The *mand* is a verbal response that directly specifies its reinforcement and is under the functional control of relevant establishing operations (EO; i.e., state of aversive and deprivation stimulation). A mand repertoire, arguably the earliest communication acquired, provides a means of controlling one's environment by increasing the probability of obtaining access to desired items and activities (Bijou & Bear, 1965; Skinner 1957, Sundberg, 2001). Because a verbal response is followed by a powerful consequence, mand training may increase the reinforcing value of communication and, in effect, augment the development of other verbal operants (Leblanc et. al., 2009; Sundberg et. al., 2001). Further benefits of mand acquisition include reduction in problem behavior (Carr & Durand, 1985; Winborn, Wacker, Richman, Asmus, & Geier, 2002; Shafer, 1994; Sigafos & Meikle, 1996) and facilitation of greater independence (Leblanc et al., 2009; Sunderg & Michael, 2001) and vocal output (Carbone, Sweeny-Kerwin, Attanasio, & Kasper, 2010; Tincani, Crozier, & Alazetta, 2006)

Response topographies. Various response topographies can effectively function as a mand (e.g., vocal speech, manual sign, pictures, vocal output devices). Prior to initiating language instruction, special consideration should be given to selecting a modality for responding. (Leblanc, Dillon, & Sautter, 2009). Although vocal speech is arguably the most efficient and accepted modality given the broad verbal community, high rates of individuals diagnosed with ASD fail to acquire functional vocal speech, thus requiring augmentative and alternative communication (AAC) systems to establish or supplement functional communication or mand repertoires (Leblanc et al., 2009; Plavnick & Vitale, 2016). Implementation of augmentative or alternative communication system (AAC) has been established as an evidence-based practice for individuals with ASD by the National Professional Development Center (NPDC, 2014; van der Meer & Rispoli, 2010).

AAC systems include unaided approaches such as manual signing or gestures and aided approach such as graphic icons, communication boards, and speech-generating devices (SGDs). SGDs are portable, electronic devices that rely on the speaker's pressing of a picture symbol or alphabet keys on an electronic screen to evoke digitized or synthesized speech output (Lancioni et al. 2007, NPDC, 2014). With ongoing advances in technology combined with increased availability and portability, increased investigative attention has been directed towards the use of tablet computers and portable media players, as SGDs for establishing a requesting repertoire in children diagnosed with ASD (e.g., Lorah, Tincani, Dodge, Gilroy, Hicky, & Hantula 2013; Kagohara et al. 2013; King et. al., 2014; van der Meer, Sigafos, O'Reilly, & Lancioni, 2011, van der Meer et. al., 2013). Recently, Schlosser and Koul (2015) reviewed 16 studies evaluating the effects of SGDs used within an intervention package on the acquisition of manding skills, eight of which used handheld multi-use electronic devices (i.e., iPad®, iPod®). In 7 out of 8 of these studies, the Proloquo2Go™ application was used. Additionally, 13 studies comparing the differential effects of SGDs with alternative AAC modalities on the acquisition of a mand repertoire, nine of which used handheld multi-use electronic devices. While not a systematic review, researchers identified a substantial amount of high-quality research studies using SGDs to successfully teach manding skills to individuals with ASD, thus concluding a solid research base for a SGD usage for early learners.

Furthermore, in a review of the literature between 2010 and 2014, Lorah, Parnell, Whitby, and Hantula (2014) identified 17 peer-reviewed articles evaluating the use of handheld multi-use devices as SGD in acquisition of verbal behavior for individuals with ASD or a related developmental disability. In 14 of the 17 studies, Proloquo2Go was used as the SGD application. Sixteen of the studies investigated the effect of these devices on acquisition of mand

repertoires. Of the 53 total participants included in the studies, 93% of participants acquired the targeted verbal repertoire indicating a high degree of efficacy.

Mand training procedures. Regardless of response topography, mand training must occur in the presence of a state of deprivation or aversive stimulation, described as either an establishing operation (EO) or a motivating operation (MO). More specifically, an EO (a) alters the momentary effectiveness of a consequence as form of reinforcement, and (b) increases the frequency of any behavior that has been followed by that form of reinforcement in the past; thereby establishing the relevancy of the reinforcer (Keller & Schoenfeld, 1950; Michael, 1982). Thus, mand training entails either capturing natural occurring EO's for mand opportunities or contriving an EO by arranging the environment or creating situations in which the child must mand to ensure access to the preferred item/activity. Once an EO has been verified, the child is required to mand using his/her communication modality (i.e., speech, PECS, SGD, etc.). Immediate access to the item/activity is granted contingent upon the child mand. If the child does not emit the target mand, various prompting and shaping procedures are used to evoke the target response (Leblanc, Dillon, & Sautter, 2009). In terms of prompted mands, effort is made by the trainer to gradually fade prompts to transfer stimulus control from the prompt, to the relevant EO. In summary, mand training requires the manipulation of an EO, use of supplemental antecedent stimuli (i.e., prompts) to evoke a target mand, and listener delivery of a corresponding reinforcer (Hall & Sundberg, 1987). However, specific instructional strategies such as prompting, shaping, and fading procedures may vary, although primarily derived from applied behavior analytic principles and tactics.

Specific to mand training using the iPad® or iPod® touch and application Proloquo2Go™ as a SGD, various teaching methods have been effective in establishing mand

repertoires in young children diagnosed with a developmental disabilities and/or ASD including a five-second time delay with full physical prompt (Lorah et al., 2013), least to most prompting (Waddington et al, 2014), peer-mediated instruction (Strasberger & Ferreri, 2014), and least to most prompting with a 10-second time delay (Couper et al., 2014). Furthermore, the results of studies targeting the acquisition of manding in combination with discrimination between picture symbols, have documented positive results using least to most prompting with prompt fading (King, Takeguchi, Barry, Rehfeldt, Boyer, & Matthews, 2014) and within stimulus prompting (i.e., manipulation of the device screen with no error correction; Lorah et. al, 2014).

More specifically, King et al. (2014) used a multiple probe design to evaluate the effectiveness of using a four-phased protocol, adapted from the picture exchange system (PECS; Bondy & Frost; 1994; 2001) framework in the acquisition of discrimination between picture-symbols on the SGD in three children between the ages of three and five, diagnosed with ASD. During phase 1, the device, displaying one preferred item/activity and three blank or non-referent spaces. All participants met criteria for Phases I through IIIa in an average 13 sessions per phase indicating efficacy of training procedures for Phases 1 through 3a (King et al., 2014).

Using a multiple probe design, Lorah et al. (2013) investigated the effects of a five-phased training protocol and the use of only within stimulus prompts and stimulus fading on the acquisition of manding and discrimination between picture-symbols on the screen of a SGD in four children between the ages of four and six diagnosed with ASD. In Phase I, the screen of the device contained one large picture symbol. Following an in-vivo preference assessment, the chosen item was held in view and out of reach of the participant and the device was placed in front of the participant. If the participant manded independently by selecting the corresponding picture-symbol within five seconds, access to the items was granted. If the participant did not

press the picture-symbol, the trial was scored as incorrect and no error correction occurred.

Phase II was identical to Phase I, except the screen displayed a field of four pictures, one preferred and three blank or non-referent spaces.

Phases III through V were designed to shape discrimination skills. Simple discrimination was targeted in Phase III as the participant was required to mand for a preferred item in a field of one preferred picture, one neutral picture, and two blank spaces. The complexity of discrimination was gradually increased in Phase IV and V, with the screen of the device containing two preferred and two neutrals, and four preferred, respectively. Correspondence checks were performed following all independent mands in Phases III through V. Correspondence checks involved the presentation of two preferred items (one being the item for which the child manded) and the instruction “take it” in order to validate appropriate correspondence. Additionally, pictures were rotated after every trial in Phases II through IV to ensure scanning skills and prevent inadvertent positional prompts. Results of this study indicate that the 5-phase protocol was effective in teaching discrimination between pictures symbols, with participants requiring an average of 14.5 sessions to master all five phases of the protocol (Lorah et al., 2013).

The rapidly emerging research-base for the use of the iPad and application Proloquo2Go™ as a SGD for mand training in combination with the alignment of large-scale systematic reviews documenting behavioral interventions as having the highest degree of empirical support illustrate/are indicative of the considerable progress and continued growth in the identification of evidence-based practices for young children with ASD. However, the translation from identification to implementation proves critical, as higher procedural fidelity is related to improved student outcomes (Durlack & Dupre, 2008).

Procedural Fidelity

DiGennaro and Coddling (2013) define procedural fidelity as the degree to which a trained individual implements a procedure as designed. A significant amount of research documents that lack of child progress relates to or is directly caused by low levels of procedural fidelity (DiGennaro, Hirst, & Howard, 2013). Procedural fidelity can be conceptualized as a mediating variable between practice and outcomes (Baron & Kenny, 1986), meaning that the level of fidelity explains the relationship between practice and learner outcomes (Reed and Coddling, 2013). Empirical evidence backs both a functional (Pence & St. Peter, 2015; Carroll et al, 2013; Northup, Fisher, Kahng, Harrell, & Kurtz; 1997; Wilder, Atwell, & Wine, 2006; St. Peter, Pipkin, Vollmer, & Slomann, 2010; Rhymer, Evans-Hampton, McCurdy, & Watson, 2002; DiGennaro, Reed, Baez, & Maguire, 2011) and correlational relationship (Dib & Sturmeay, 2007; Gresham, Gansle, Noell, Cohen, & Rosenblum, 1983) between integrity and treatment outcomes. Decreased levels of the procedural fidelity negatively affect both skill acquisition and behavior-reduction procedures. Similarly, the higher the level of procedural fidelity, the more effective the treatment.

Research on implementation of EBP for students with ASD parallels these findings (DiGennaro et al., 2013; Tincani, Cucchiarra, Thurman, Snyder & McCarthy, 2013). To ensure efficacy, behavioral interventions must be implemented consistently with a high degree of procedural fidelity (Bibby, Eikesth, Martin, Mudford, & Reeves, 2001; Weinkauff, Zeug, Anderson, & Rosales, 2011). Numerous studies have demonstrated this relationship in connection with skill acquisition in young children with ASD and/or other related disabilities.

DiGennaro, Reed, Baez, and Maguire (2011) examined the relative effectiveness of varying degrees of procedural fidelity on correct responding across various skill areas. They

found that the degree of discrete trial procedural accuracy paralleled the acquisition of skills in a preschool student diagnosed with autism. While without systematic manipulation of fidelity levels, Downs, Downs, & Rau (2008) showed that correct usage of DTI procedures corresponded with greater learner and instructional efficiency in preschool children with developmental disabilities. Further investigations have demonstrated the detrimental effects of low levels of procedural fidelity on acquisition of a variety of skills, including math skills (Noell, Gresham, & Gansle, 2002), sight words (Worsdell, et. al., 2005), and toy manipulation (Groskreutz, Groskreutz, & Higbee, 2011).

In relation to mand training procedures, Pence and St. Peter (2015) used a multi-element arrangement within a multiple baseline design to evaluate the effects of delivery of the incorrect item (Experiment 1) and response-independent item delivery (Experiment 2) across four levels of procedural fidelity (0%, 40%, 70%, and 100%) on mand acquisition with children between the ages of 6 and 10, diagnosed with developmental disabilities. During Experiment 1, two of three participants acquired target mands fastest during the 100% fidelity condition, while one participant did not acquire any mand. During Experiment 2, all three participants acquired the target mand fastest when mand training was implemented with 100% fidelity, while none of the participants acquired the mand trained within the 0% and 40% fidelity conditions. Results suggest that mand training procedures should be implemented with high levels of accuracy to optimal learning efficacy and efficiency.

While only the Pence and St. Peter (2015) study has been the only one to experimentally manipulate levels of procedural fidelity to investigate the functional relationship between fidelity and mand acquisition, further studies support a correlational relation between procedural fidelity and both number and rate of independent and accurate manding in preschool and elementary

ages children diagnosed with ASD. Nigro-Bruzzi and Sturmey (2010) investigated the effectiveness of behavior skills training (i.e., instructions, modelling, rehearsal, and feedback) for training five staff to implement mand training with five preschool children diagnosed with ASD. The training package resulted in increased accuracy in staff implementation of mand training and frequency of unprompted child mands for all staff and three out of five children across post-training sessions (Nigro-Bruzzi & Sturmey, 2010). The number of post-training sessions ranged from four to nine, but information on the frequency of sessions was not provided. Generalization probes indicated that the training effects generalized across setting for three out of five children.

Similarly, McColluch and Noonan (2013) used a multiple baseline design across participants to evaluate the impact of online training videos (OTV) on implementation of mand training procedures in paraprofessionals. Following training, all three participants demonstrated significant increase in the percentage of mand training components performed correctly during teaching sessions with elementary students diagnosed with autism or other developmental delay; however, only two of three participants reached adequate levels of procedural fidelity (i.e., 80%) and this effect was highly variable. Improvements in accuracy of implementation directly correlated with concomitant increases in the rate of spontaneous vocal manding by the students. Five and eight-week maintenance probes were variable for both participants that reached 80% performance accuracy. For one participant, maintenance probes overlapped with baseline data. For the other participant, the level of performance accuracy remained near 80% at the five-week probe, but dropped to around 60% at the 8-week probe.

Lerman, Vondran, Addison, and Kuhn (2004) successfully trained special educators to implement mand training procedures with children ages three to six diagnosed with ASD. Increased accuracy of implementation was associated with increased learning opportunities and

child mands (i.e., signs, vocalizations, or vocal approximations) in 5 out of 8 participants. Maintenance data were not collected. While these studies document the correlational relation between accurate implementation of mand training and rate of child mands and mand opportunities for sign and vocal response forms, researchers have yet to evaluate the influence of procedural fidelity of mand training using a SGD on independent child manding. However, given the collective research base, the clear significance of procedural fidelity in ensuring optimal treatment gains is likely relevant to basic mand training procedures across response forms.

Unfortunately, recognition of the critical impact of procedural fidelity on child outcomes has not easily transferred to wide-spread increases in fidelity of implementation of behavioral interventions (DiGennero et. al, 2013; Tincani et al., 2013). Fidelity errors remain common (Carroll et. al., 2013; Peter-Scheffer, Didden, Korzilius, & Sturmey, 2011) across settings (Stahmer & Ingersoll, 2004). Furthermore, observational reports on the school language environments of children with ASD have reported low frequency of contrived communicative opportunities (Chiang, 2009), below adequate rates of prompting (Young, Simpson, Myles, & Kamp, 1997), and reasonable to low adult response rates to communicative attempts (Keen, Sigafos, & Woodyatt, 2005).

Given the availability of well-established behaviorally-based strategies for enhancing the language and communication of young children with ASD, the critical concern rests upon the translation between identification and accurate implementation, as a significant research base indicates that a lack of child progress relates to or is directly caused by low levels of procedural fidelity of EBP (Digenerro et. al., 2013). To ensure optimal student outcomes, behavioral interventions must be implemented with high levels of fidelity (Durlack & Dupre, 2008).

Stahmer, Rieth, Reisinger, Mandell, & Connell (2015) suggest several reasons that practitioners may not implement EBPs the way they are designed. One barrier to accurate implementation of EBP is practicality of design (Stahmer et al., 2015). Because many EBP were not initially constructed for school implementation, classroom application can be challenging (Stahmer, Suhrheinrich, Reed, Bolduc, & Schreibman, 2011). Additionally, a practitioners' beliefs, training, or pedagogy may conflict with evidence-based programs selected in educational, clinical, and home settings (Dingfelder & Mandell, 2010). Further, resistance to research and/or instructional change manifests because of teachers' and even schools' mistrust of research or concern regarding usability of EBP (Cook & Tankersley, 2012).

Lastly, practitioners often lack effective training on EBP procedures, which precludes quality implementation. While behavioral interventions can be complex, requiring procedural knowledge in combination with an understanding of basic behavior principles and how to apply them, provision of high-quality training heightens the accuracy with which staff implement procedures (Stahmer et al., 2015; Rispoli, Neely, Lang, & Ganz, 2011).

Status of Training

Despite the high demand for well-trained, experienced staff, a paucity of such staff remains (Stahmer, et al., 2015). Lack of effective, evidence-based practitioner training and follow-up appears at least partially to blame (DiGennaro et. al., 2013). Traditional models of training that rely heavily on verbal-skill strategies (e.g., lectures, presentation of written and visual material) may be effective in establishing knowledge on a topic, but are generally ineffective in establishing targeted performance skills (Gardner, 1972). Yet, didactic workshops and provision of manuals continue to prevail as primary methods/modes of practitioner training (Stahmer et al., 2015). As such, the development of both practical and effective tools and

procedures for practitioner training and supervision are critical in bridging the gap between identification of EBP and accurate implementation of EBP (McHugh and Barlow, 2012; Reed & Coddling, 2013).

Recent publications in the AAC intervention literature have called for focus and emphasis on training professionals, arguing that rapid technological development and awareness along with increased availability may result in prescription of devices without provision of training and support for the individual on how to use the AAC to effectively communicate. Barriers such as lack of trained professionals and lack of training and support on SGD implementation have been cited repeatedly (McNaughton & Light, 2013; Crisp, Draucker, & Ellett, 2014). Ensuring effective AAC intervention requires successful implementation and individualization of related instructional procedures to improve communication. Thus, effective, accessible training methods for professionals and communicative partners is required (McNaughton and Light, 2013).

At present, few studies cite methods for training staff to implement procedures for implementing mand training with the iPad® or iPod® Touch and the application Proloquo2Go™ (King et al., 2014; Lorah, 2016; van der Meer et al. 2011). Of those studies, various combinations of behavioral training methods including written instructions, modeling, role-playing, and feedback have been reported used to train training staff or parents to high levels of procedural fidelity. However, researchers have yet to investigate the effectiveness of behavioral training procedures on accuracy of implementation of mand training procedures using the iPad or iPod Touch and application Proloquo2Go™ as a SGD.

Behavioral Skills Training

When the targeted function of training is performance skills, an established evidence base supports a multi-component behavioral skills training (BST) approach, which incorporates both antecedent and consequence based strategies for training staff to teach children with special needs (Sarokoff & Sturmey, 2008; Schepis, Ownbey, Parsons, & Reid, 2000; Rosales, Stone, & Rehfeldt, 2009). Core components of this approach including video and/or written instructions, modeling, rehearsal, and feedback, have been combined in a variety of ways to successfully enhance staff performance of behavioral interventions (Rosales et al., 2011; Bolton & Mayer, 2008; Richman, Riordan, Reiss, Pyles & Bailey, 1988) including mand training (Nigro-Bruzzi & Sturmey, 2010; Laski, Charlop, and Schreibman, 1988; Madzharova, Sturmey, & Jones; 2012).

Instruction and Task Clarification

Instruction, a core component of BST, takes on many forms. Too often instruction is rendered ineffective because of lengthy written documents or vocal instructions rather than succinct, written description of the target skills (Reid, Parsons, & Green, 2012). Task clarification is a behavioral training procedure, which involves the precise specification of behavioral components and sequencing of those components to alter the form and frequency of targeted behavior (Anderson, Crowell, Hantula, & Siroky, 1988; Crowell, Anderson, Abel, & Sergio, 1988). Various forms of task clarification alone and in combination with other behavioral procedures have been used in a variety organizations and industries to improve performance of cleaning behaviors (Amigo, Smith, & Ludwig, 2008; Anderson et al., 1988; Austin, Weatherly, & Gravina, 2005; Rose & Ludwig, 2009), on-time clock in (Palmer & Johnson, 2013), customer service (Squires et al., 2007; Tittelbach, Deangelis, Sturmey & Alvero, 2007), preparation tasks (Gravina, VanWagner & Austin, 2008; Pampino, MacDonald, Mullin &

Wilder, 2004), instructional procedures (McBride & Schwartz, 2003; Severtson & Carr, 2012), and animal training (Durgin, Mahoney, Cox, Weetjens, & Poling, 2014). However, given the high efficacy of task clarification followed by consequence-based interventions in combination with the minimal to moderate effects of task clarification alone on acquisition and maintenance, task clarification as part of a more comprehensive training package is generally recommended (Amigo et al., 2008; Crowell et al., 1988).

Job aids. Written forms of task clarification include checklists, flowcharts, and signs, commonly referred to as *job aids*. Job aids offer a simple, inexpensive strategy for providing a succinct, focused description of target behaviors (Sasson, Alvero, & Austin, 2006). Furthermore, job aids allow for immediate, on-demand performance support prior to, during, or following performance. This accessibility in combination with clarification of performance expectations may serve to increase staff motivation as a lower response effort is required for the targeted performance task (Tilaro & Rossett, 1993). However, despite being identified as critical initial step in evidence-based staff training, many trainers fail to provide clear, concise written descriptions of the target skill (i.e., job aids), relying solely on vocal description and/or lengthier written documents (Parsons et al., 2013).

Furthermore, the effects of job aids are commonly categorized and considered under the umbrella of task clarification interventions, which encompass variant forms ranging from brief, individualized oral instruction (Rice, Austin, & Gravina, 2009) to trainee model of examples and non-examples of target behavior with feedback (Cunningham & Austin, 2007) to job aids such as written lists (Rose & Ludwig, 2009) or procedural checklists.

Investigations of the effects of job aids on staff performance of behavioral teaching procedures for children with autism (i.e., discrete trial instruction, picture exchange

communication system, verbal behavior training) have been limited. While it is common to incorporate job aids such as procedural checklists and summary sheets into lengthier written manuals, training packages, or baseline conditions, these experimental designs do not allow for examination of the isolated effect of job aids.

Specific to performance of mand training procedures, Nigro-Bruzzi and Sturmey (2010) used a multiple baseline design across participants to evaluate the effects of a training package comprised of instruction, modeling, rehearsal, and feedback on staff implementation of mand training procedures with children. The study incorporated a mand training task analysis (i.e., form of job aid) within baseline prior to initiating the behavioral skills training (BST) package. Despite having no previous training in teaching manding, one of six staff gradually increasing trend in procedural fidelity during baseline reaching high levels of fidelity without further intervention (i.e., to above 80% accuracy), while two other staff averaged around 50% accuracy during baseline following the initial baseline session. Conclusions about the effects of the job aid on performance accuracy cannot be drawn as the study lacked a true baseline condition (i.e., no intervention) preventing a comparison between pre-and post-job aid accuracy of mand training implementation, the moderate levels of procedural fidelity demonstrated by half of the staff participants under baseline conditions suggest that job aids alone may have been effective in increasing performance accuracy to some degree.

A recent study conducted by Parnell, Lorah, Karnes, & Whitby (2017) evaluated the effectiveness of leveled job aids followed by feedback on staff implementation of discrete trial instruction (DTI) components using a multi-component design within a multiple baseline design across participants which allowed researchers to evaluate the isolated effects of job aid alone. Job aids alone were effective in establishing basic procedural components (i.e. Level 1

components) of the DTI sequence for both participants who required Level 1; however, all participants required at least one session of performance based feedback to reach mastery criterion (i.e., 90% across three consecutive sessions) for more complex components or chains (i.e., Level 2 components). The results suggest that job aids may offer a simple, cost-effective method for increasing fidelity to some degree prior to more intrusive interventions while potentially reducing the amount of expert involvement required and the latency period between identification of training need and the initiation of training (Parnell et al., 2017). All performance probes were conducted during teaching sessions with children diagnosed with autism. Training effects were maintained at the two-week and one-month maintenance probes.

Considering the relative effectiveness of job aids across other work settings and performance skills, in combination with the ease of accessibility and unobtrusive, cost-effective nature of job aids, future research should investigate the effects of job aids on staff implementation of mand training. Further efforts to disentangle the differential effects of varying forms of task clarification, such as job aids, should be made to create optimal, individualized training packages based on training needs, barriers, and resources (i.e., geographic location, accessibility to experts/trainers, funding, time constraints). It seems plausible that variant forms of task clarification may account, at least in part, for the varied effects of task clarification interventions alone or in combination with other behavioral training procedures.

Modeling and Observational Learning

Modeling is another core components of behavioral skills training. Early studies investigated and confirmed the role of observation (i.e., modeling) as a determinant of behavior change (Bandura, Ross, & Ross, 1963; Bandura & McDonald, 1963). Further research examined the role of verbal behavior in observational learning, finding that verbal coding or, in other

words, having an observer describe or code behaviors, enhanced the modeling process and improved retention (Bandura & Jeffery, 1973; Bandura, Grusec, & Menlove, 1966). While modeling remains an effective training strategy, recent applied behavioral research has documented a related training method for enhancing modeling procedures through the completion of behavioral performance evaluation (i.e., both observing and evaluating the accuracy of target behaviors).

In a preliminary study, Alvero and Austin (2004) directly investigated the effects of conducting observations of eight target safety skills on the subsequent performance of those same skills. Using a multiple baseline across behaviors design, results indicated that using a procedural checklist to observe and evaluate the safety performance of others increased performance of the observer. In contrast, observation alone did not affect performance of the observer. As such, an *observer effect* was documented, defined as the changes in observer behavior following the completion of behavioral observation and evaluation.

A number of other safety-related studies have replicated and extended Alvero and Austin's (2004) initial results, consistently documenting the existence of an observation effect on staff performance (McSween, 2003; Alvero et. al., 2004; Alvero, Rost, & Austin, 2008; Nielsen, Sigurdsson, & Austin, 2009; Sasson & Austin, 2005). Follow-up studies have investigated relationship between safety-related behavior and accuracy of observation. While Sasson and Austin (2005) found a strong-positive correlation between safety performance and accuracy of observation, results of further investigations have shown no relation between observation accuracy and safety-related behavior (Alvero et. al., 2008; Taylor & Austin, 2012). These differential results underscore the need for further research in this area.

Recent investigations have extended research on the observer effect beyond the realm of beyond the domain of occupational safety. Within a neurobehavioral residential setting, Guercio and Dixon (2011) investigated the impact of observing and completing behavioral checklists of video models displaying targeted positive interaction behavior on subsequent interaction behaviors of the observing staff. Results of the multiple baseline across residences, showed that staff increased targeted social interaction behavior from an average 7.2% of intervals in baseline to 73.9% during intervention. Additional increases in positive staff-client interactions were noted. Post-intervention data were not collected. As noted earlier, Williams and Gallinat (2011) demonstrated that video-based evaluations with checklist produced significant and immediate increases in accuracy discrete trial instruction (DTI) implementation, as demonstrated within a multiple baseline across skills design. Thomas (2013) used classroom-based peer observations to increase the percentage of DTI component performed correctly. Following low levels of correct usage in baseline, all participants demonstrated large, rapid improvements in accurate performance of components during DTI sessions with a child with autism and related developmental disorder upon initiation of the observation phase. Maintenance data were not collected.

The results of additional applied studies examined the impact of collecting data on staff performance of behavior-specific praise on supervisor's treatment integrity (i.e., rate of behavior-specific praise; Howard, Allen, & Burke, 2013; Burke, Howard, Peterson, Peterson, & Allen, 2012). Results showed that data collection may be an effective method for enhancing treatment integrity. However, these data should be interpreted with caution, as one study included only two participants and neither study conducted a component analysis, making it impossible to

determine whether increases in treatment integrity were the result of evaluating performance of others or the pre-intervention meeting, which involved goal setting and task clarification.

Most recently, Hine (2014) used a multiple baseline design across behaviors to evaluate the impact of video modeling followed by directed data collection and discussion on child care worker performance of seven behavioral practices. Workers met 80% criterion for four skills with video modeling with alone (i.e., 20 minute videos for 14 training sessions) and public posting of performance scores. Following introduction of monthly directed data collection and discussion in combination with previous video modelling, staffs' use of the other 3 behaviors increased to 80% of intervals or higher. Performance assessments were conducted in the natural classroom setting. Data were not collected on child performance. Maintenance data were not collected.

In summary, research to date suggests that the process of conducting behavioral observations may be a simple and efficient method for increasing target behavior(s) of the person who conducted the observation. In all the above experiments, trainees demonstrated significant increases in targeted performance skills after conducting behavior observations of those same behaviors, although some trainees required further intervention to reach high levels of procedural fidelity. Further replication and expansion of current research across behavior analytic procedures is required to determine whether adequate levels of procedural fidelity can be achieved through observing and evaluating performance models alone. Additionally, additional research should evaluate the impact of variables such as observation accuracy, training modality (in-vivo or video-based), and feedback on observation accuracy on relative effectiveness and generalization (i.e., performance transfer) of conducting behavioral observation. This may aid in establishing a more standardized, best practice for utilizing performance observation and

evaluation as a training tool. Particularly, further research should evaluate the effects of incorporating behavioral coding/observation into computer-based instruction (CBI) given the potential benefits discussed in the subsequent section.

Computer-based instruction. While data-backed treatment efficacy is arguably the most critical point of consideration when selecting training methods, other practical considerations such as efficiency and cost effectiveness impact success and continuation of training programs (Daniels & Bailey, 2014; Parsons & Reid, 1999). Implementation of the steps involved in a multi-component BST model typically require a significant time commitment from both participants and a qualified behavioral consultant, in turn amounting to high training costs (Ahearn & Tiger, 2012). In effect, increased investigative attention has been directed to the use of visual media (i.e., computer-based instruction and video modeling training procedures) for accomplishing one or more core components of the multi-component behavioral training model (e.g. video modeling, feedback) with many studies reporting high levels of success (Catania, Almeida, Liu-Constant, & DiGennaro, 2009; DiGennaro-Reed, Coddington, Catania, & Macquire, 2010; Moore & Fisher, 2007; Pollard et al., 2014; Vladescu, Carroll, Paden, & Kodak, 2012).

Computer-based instruction (CBI) may reduce instructional time by as much as 66% (Kulik & Kulik, 1991). Additionally, integrating BST and CBI may increase training efficiency by reducing delays in staff training, ensuring demonstration of identical and accurate procedural models, and enabling flexible training schedules and locations (Parsons et. al., 2012). Ingvarsson and Hanley (2006) argue that computer-based staff instruction may in fact be preferable to supervisor mediated training (trainer-based) training. Specifically, CBI allows for flexible training schedules and access without specialist involvement while also providing enhanced

teaching precision, performance-based prompting procedures, and automatic, accurate data collection.

However, concerns regarding full reliance on computer or video-based training remain as many of these training programs fail to incorporate critical behavioral strategies for training, most frequently the practice with feedback component of training (Reid, O'Kane, & Macurik, 2011). While supplementing computer-based training with on-the-job supervision and feedback may resolve the issue, this once again requires frequent involvement of a behavioral consultant and further financial expenditures (Macurik, O'Kane, Malanga, & Reid, 2008). Consequently, recent research has examined the into the possibility *interactive* computer based instruction may offer the opportunity to simulate a more comprehensive kind of training utilizing a full range of behavioral techniques enabling increasingly consistent and effective transfer of skills (Bass, 1987; Davis, Chryssafidou, Zamora, Davies, Khan, & Coomarasamy, 2007; Kritch & Bostow, 1998; Ray et. al., 2008).

Computer-based systems that embed active response systems and incorporate direct feedback within dynamic multimedia computer-based training have been termed computer-based interactive response systems. Common components of interactive CBI include quizzes, self-practice opportunities, content coverage, response-based feedback, and enhanced video models (Pollard, Higbee, Brodhead, & Akers, 2014). The only two studies that have conducted experimental comparisons of interactive vs. non-interactive CBI found little difference between the two methods, relative effectiveness was determined through measurement of post-training *verbal skills* (i.e., knowledge of policy and procedural information demonstrated by answering questions about target skills) as opposed *performance skills* (Jamison, Kelley, Schmidt, Harvey,

Harvey, and Meyer, 2014; Rohlman, Eckerman, Ammerman, Fercho, Lundeen, Blomquist, & Anger, 2005).

In effect, further research is required before conclusions can be drawn regarding comparative efficacy in performance outcomes. Albeit new and limited, preliminary research supports the potential benefits of interactive computer-based training models on *performance* (i.e., interactive and non-interactive) in training staff to implement behavioral teaching procedures exists. As reviewed earlier in this chapter, McColluch and Noonan (2013) demonstrated that interactive online training was an effective tool for training paraprofessionals to implement mand training procedures. The online training video (OTV) course combined instruction, quizzes, video modelling, and a self-monitoring checklist specifying mand training procedures. Results indicated significant increases in the percentage of mand training components performed correctly for all participants; however, only two of three participants reached adequate levels of procedural fidelity (i.e., 80%) and this effect was highly variable.

Wainer and Ingersoll (2012) investigated the effectiveness of an internet based, self-directed online training program on parent and therapist-in-training (i.e., student) knowledge and performance of reciprocal imitation training (RIT) with a child. Two experiments were conducted, both utilizing a multiple baseline design. Training entailed a PDF of a written training manual, audio lecture, short quizzes each module, and short interactive learning tasks in which trainees identified accurate implementation of RIT techniques within video clips of adult-child interactions. The program provided immediate feedback on performance on quizzes and interactive learning tasks, but accurate performance was not required to progress to subsequent modules. Following the training program, five out of six therapists demonstrated at least average accuracy of RIT techniques, defined as a score of 4 (or 80%) on a five-point rating scale.

Training effects maintained across three post-training sessions for four out of five participants. Two therapists required post-coaching to reach or maintain 80% performance accuracy. Following three sessions at 80% performance accuracy during post-training sessions, no further data was collected. In the second experiment, two out of three parents demonstrated at least average accuracy of RIT techniques for two post-performance sessions. One-third of participants requiring additional coaching to reach average or above average levels of fidelity for one session. Across both studies, child imitation rates increased following RIT training, although magnitude of change varied and some variability existed. Moreover, increase in knowledge and use of RIT procedures increased across procedures. Finally, parents rated training procedures as both useable and acceptable, as measured by the Behavioral Intervention Rating Scale (BIRS).

Studies conducted by Nosik and Williams (2011) and Nosik, Williams, Garrido, and Lee (2013) delivered mixed results regarding the efficacy of *interactive* computer-based instruction (ICT) in training staff to implement DTI procedures. The IBT training package incorporated instruction, quizzes, and modelling enhanced by directed data collection, and feedback. While the training package resulted in significant improvements (i.e., 90% and above) across all participants as well as maintenance (6-week post training) and generalization to the natural environment of those improvements (2011), the follow-up comparative study (2013) found ICT to be less effective than in-vivo BST. However, it should be noted that although participants receiving ICT did not reach the mastery criterion of 80% accuracy in role-play sessions with a research assistant, increases in from baseline were significant with baseline levels of below 40% immediately increasing to between 60 to 75% with the lowest of these being an increase from a 15% baseline to 60% immediately following training. During generalization performance

sessions with a client in the natural environment, all participants demonstrated an initial reduction in accuracy followed by gradual improvements to accuracy levels similar to those observed in role-play sessions was observed. Six-week maintenance probes showed that skills maintained at a similar level for one participant, but failed to maintain for the other two participants albeit at levels higher than baseline (Nosik, Williams, Garrido, & Lee, 2013). Additionally, participants in IBT group had lower baseline levels than those in the BST group, while being exposed to fewer baseline practice sessions. Lastly, BST training took three times as long as IBT.

Pollard, Higbee, Akers, and Brodhead (2014) used a concurrent multiple baseline to investigate the effectiveness of ICT to train four undergraduate students to implement discrete trial instruction (DTI) procedures with children with autism. The ICT consisted of four online modules, which incorporated audio narration with supporting graphics and text, video models that demonstrated the teaching skill, and interactive questions and self-guided practice opportunities. Following each module, participants were required to answer at least 80% of posttest questions correctly prior to beginning the subsequent module. Following an average of 115 minutes total training time, all participants DTI procedural fidelity increased from an average of 25% in baseline to an average of 93%, with performance assessed within adult role-plays. During teaching sessions with a child with autism, high levels of procedural fidelity maintained for two participants, a slight decrease was observed for one participant, and a decrease in performance accuracy was observed for one participant although a high level of DTI fidelity demonstrated after only one performance feedback session was required to obtain high level of procedural fidelity. Maintenance data were not collected.

To date, only four published studies have evaluated ICT to training teachers to implement behavior-analytic teaching interventions. Collective results provide limited support for the use of ICT to train teachers to implement behavior-analytic procedures in the natural setting with children diagnosed with ASD. Further research is required before any definitive conclusion regarding efficacy can be drawn. Additionally, future research should investigate variables that may impact the success of the ICT including format (i.e., comprised components), pacing, and trainee response type, and quantity and quality of learning opportunities.

Train to Code. Train to Code (TTC), an interactive computer-based instruction training program, developed by Ray and Ray (2008) uses an advanced adaptive expert system for training systematic observation and coding with the ultimate goal of transfer of skills to the applied setting (Ray, 1995). TTC was founded and developed based upon behavioral learning principles, fundamental to the effectiveness of instructional technology (Kritch & Bostow, 1998; Holland, 1967). TTC uses an operant response-shaping instructional model to train expert coding skills, which underscores the differential reinforcement of successive approximations to a goal response class (Catania, 1998; Ray, 1995). The use of response prompting and discriminative response feedback based upon individual coding accuracy allows for the gradual shaping of coding skills with minimal errors (Ray & Ray, 2008).

This model is illustrated through an exploration of TTC's two alternative modes of use including an instructor and student mode (Ray, 1995). The instructor mode allows instructors to develop *expert reference files* by uploading their own digital video exemplars of correct and incorrect performance of target procedural components, as well as corresponding behavioral taxonomies (i.e., coding schemes) based upon operationally defined steps or components of the targeted training procedures. Next, each video file is then coded according to this taxonomy and

saved as an expert reference file. Further customization of expert files is possible using adjustable play rates, within event discriminations prompting, coding response feedback, and error correction procedures, with these features being gradually faded as coding accuracy increases (Appendix. TTC's student mode is thus able to guide trainees through a unique and individualized errorless training procedure for recognizing and identifying (i.e., coding) almost any desired behavioral circumstance with accuracy, fluency, and stability (Ray & Ray, 2008).

While this software has been effectively employed to train participants to accurately code/identify behavioral components, TTC was primarily created as a training tool for staff in applied settings (Ray & Ray, 2008). As noted earlier, research on observational learning (Bandura, 1969) as well as more recent research of the observer effect (Alvero et. al., 2008; Taylor & Alvero, 2012) would suggest that training individuals to recognize and label behaviors of models (i.e., performance evaluation) would generalize to the application of or engagement in those discriminated behaviors within an actual training setting. As such, TTC may provide a mechanism for extending both the research on the observer effect and ICT. TTC creates and facilitates the process of observational learning through explicit programming of video models and multiple exemplar training.

Moreover, TTC organizes behavioral components into a pattern (i.e., behavioral taxonomy) for the learner then explicitly trains participants to identify and code components and patterns of models. In addition, TTC collects precise data on the quantity of learning opportunities and accuracy of behavioral evaluations facilitating a reduction in professional involvement as well as a means for evaluating the influences of such variables. Furthermore, TTC incorporates immediate performance-based feedback on trainee coding accuracy while adaptively adjusting training supports according to this accuracy. The potential benefits of such

as computer-based instruction warrant investigation. Currently, research investigating the effects of TTC on performance skills remains limited to one recently published study and several unpublished Masters theses.

TTC evidence base. Rosales, Eckerman, & Martocchio (2018) used a multiple baseline design across participants to investigate the impact of Train to Code on implementation accuracy of Phase 3A of the Picture Exchange Communication System to four undergraduate students. During TTC training, participants viewed and identified multiple video exemplars of accurate and inaccurate performance of each step in the Phase 3A procedure. Following completion (i.e., certification) of the Preferred and Non-Preferred TTC Training programs, all participants reached a mastery criterion of 80% accuracy of implementation during role-play sessions with a confederate. Performance accuracy improved to 88% during 2-4-week post-training maintenance probes. Researchers did not conduct generalization probes with actual learners.

Causin (2009) compared the effectiveness of TTC training and Board Certified Behavior Analyst™ (BCBA) instructor training in establishing accurate staff performance of errorless learning procedures. Using a matched multiple baseline design, six undergraduate students (teacher-trainees) were randomly assigned to one of the two alternative training conditions. BCBA™ instructor training sessions included a combination of lectures, PowerPoints, demonstration videos, modeling, role-playing, feedback, and discussion conducted in under an hour. While average percentage of perfect trials across the last 40 trials of evaluation indicated that staff receiving TTC training implemented procedures with higher degree of accuracy and stability than those receiving BCBA™ instructor training (TTC range 76 to 95; BCBA™ range 18 to 58) several significant limitations exist. First, a large degree of variability between participants during post-orientation baseline rendering a true comparison of previously matched

pairs difficult. Specifically, participants in the TTC training condition averaged 72% perfect teaching trials during baseline, while participants in the BCBA™ training group average 45% perfect teaching trials in baseline. Further, a near “ceiling” effect existed for one participant in the TTC group, and the minimal training effects observed were not maintained. Lastly, the only participant in the BCBA™ training group that demonstrated significant changes in performance post-training dropped out of the study, completing only one of three post-training teaching evaluations. Limited information regarding training duration for the TTC was provided, making comparison of training duration impossible.

Bourdon (2011) used a multiple baseline design across participants to evaluate the effects of TTC training on staff performance of discrete trial instruction (DTI) procedures (i.e., material presentation, prompting procedures, and consequence delivery) during teaching sessions with students. Results of this study are difficult to interpret as two of the four participants terminated employment before completing the post-training skill transfer phase, thus this study does not meet the minimal number of participant requirement of a multiple baseline design. Additionally, researchers noted that training required significantly longer than expected, but did not provide specific information on training duration apart from the number of coding required for TTC certification. However, both participants completing the post-training skill transfer phase performed DTI procedures with high levels of accuracy. Following an average baseline of 12% accuracy, participant one averaged 98% accuracy of DTI performance following TTC certification across seven performance evaluations. Following an average baseline of 42% accuracy, participant two performed an average of 95% of DTI components accurately following TTC certification across three teaching sessions. However, the study did not provide information on how often sessions were conducted (Bourdon, 2011).

Frizzell and Ray (2010) utilized TTC to train novice observers to identify and code gesture-based communication (i.e., American sign language), with subsequent evaluation of TTC as a transfer of training tool. Researchers found that learning to code gestures transferred to the performance of those same gestures, with participants demonstrating high level of accuracy (80%-100%). One-week maintenance measures indicated that high levels of performance accuracy had maintained (Frizzell & Ray, 2010).

Stratton (2014) investigated the impact of TTC training on staff identification and subsequent performance of the behavioral sequence required for accurate implementation of Picture Exchange Communication System (PECS) phase 3B in two ABA therapists. While TTC proved to be both a highly effective and efficient method for teaching staff to identify correct versus incorrect examples of target behaviors within the sequence, subsequent performance of those behaviors during PECS teaching sessions with students was inconsistent across participants. Following TTC training (i.e., one week post training sessions), one participant demonstrated a significant decrease in the proportion of errors for one target behavior, a moderate decrease in the proportion of errors for one target behavior, and little to no decrease in the proportion of error for the other two target behaviors. The other participant demonstrated a significant decrease in errors for one target behavior, but errors remained high (above 80%) for the other three target behaviors, thus indicated limited transfer to performance skills. Of note, this experiment was designed to be a multiple probe design across participants and behaviors; however, due to time constraints introduction of the intervention was not staggered across participants thus limiting experimental control. Another limitation of consisted of the unequal distribution of videos displaying errors as compared to no-error sequences (47 error and 17 no-

error sequences). This may have hindered transfer between coding accuracy and performance accuracy (Stratton, 2014).

Design limitations and inconclusive results of the current TTC literature base, evidence the need for additional rigorous, high-quality research designed to evaluate the effectiveness and generality of TTC as a transfer of training tool. Moreover, conflicting social validity ratings have been documented across studies; thus, indicating the need for further evaluation.

Conclusion

Unprecedented rises in autism prevalence and resultant demand for highly qualified staff skilled in behavior analytic techniques underscores the need for high-quality training programs (CDC, 2012). The success of a multi-faceted behavioral training approach, combining core components such as instruction, modeling, rehearsal, and feedback, has been well-documented in the literature; yet, identifying a means for providing this comprehensive training in a less labor intensive, but more time and cost efficient manner has yet to be established.

While TTC posits an efficient, flexible, cost-effective vehicle for embedding core components of BST (i.e., modelling, performance based feedback, and instruction), evidence-based staff training protocols suggest task clarification as a least-intrusive initial step in performance management (Parsons et. al., 2012; Mager & Pipe, 1997). Given the research citing the critical importance of clear and concise task clarification within the training process, incorporation of job aids is arguably a simple, straightforward, and productive first step in performance support.

However, given the documented limitations of job aids in terms of magnitude and maintenance of behavior change, the addition of a program such as TTC may be necessary for reaching highly accurate performance of complex skill sequences. Recent research evaluating

TTC as a tool for accomplishing this aim, has cited promising results that should be further tested across varying critical skills domains and empirically-based interventions.

Given the growing evidence-base supporting the use of SGD's as a medium for establishing communication skills, identifying instructional methods for training practitioners to implement corresponding mand training procedures with fidelity would appear a necessary next step in ensuring optimal mand acquisition in early learners with ASD. The benefits of a personalized, adaptive interactive computer-based instruction program that incorporates empirically based training techniques, may offer far reaching benefits for both children diagnosed with ASD and the teachers and other professionals that teach and support them. Thus, the purposed dissertation seeks to evaluate the relative effectiveness of jobs aids followed by TTC on the implementation of mand training using the iPad® and the application Proloquo2Go™.

Chapter 3

Methods

Research Questions

The primary purpose of the proposed experiment is to evaluate the effectiveness of job aids followed by TTC on the accuracy of preschool teacher implementation of mand training using an iPad® as an SGD and the application Proloquo2Go™ with children with autism or developmental delays. Secondary objectives of the experiment will be: (a) investigate the effects of job aids and TTC on implementation of mand training procedures during role-plays with an adult, (b) to compare the effects of job aids and TTC across mand training behavioral components and phases, (c) evaluate the social validity of the training procedures, and (d) measure maintenance of training effects over time.

Participants

Three female preschool teachers from an international nursery school in Egypt participated in this study. The nursery school serves children between the ages of eighteen months and five years. Demographic information on teacher participants is presented in Appendix A. Layla and Lucy participants held varying levels of high school diplomas, and Nour held a bachelor's degree in commerce and business administration from a local, private university. Layla was 51; Lucy was 54; and Nour was 33. English was a second language for all participants; however, all participants learned English around the age of five. Participation was voluntary; however, participants were given a gift card equal to 25 United States Dollars upon completion of the study.

The inclusion criteria for teacher participants included the following: (a) agrees to attend all training sessions, (b) agrees to participate in school-based sessions with a confederate or child

three times per week, and (c) provides permission for video recording of all teaching and training sessions. Additionally, teacher participants did not have any prior experience with, or training in, applied behavior analysis or mand training procedures for mand. Additionally, they did not have any special education or autism related training or professional development aside from regular feedback from the director, who held a master's degree in an education-related field.

As depicted in Appendix B, three children diagnosed with autism or related developmental delay participated in the study. Lara was a 5-year-old girl diagnosed with autism. Neil was a 4-year-old male diagnosed with autism and Heddy was a 2-year-old diagnosed with a developmental delay. All children attended preschool five days a week for four to seven hours per day. Lara and Heddy participated in both baseline and post-training teaching sessions with a teacher participant; Neil participated in baseline teaching sessions only as he withdrew from the preschool. Lara demonstrated emerging vocal behavior (5-10 words) and a highly limited mand repertoire (3-5 intelligible vocal mands). Heddy demonstrated emerging vocal behavior and communicated through gestures only.

The inclusion criteria for child participants included the following: a) ability to attend to a speaker, sit in a chair, and attend to a task for 60 seconds as measured by the *Verbal Behavior-Milestones Assessment and Placement Program* (VB-MAPP; Sundberg, 2008) and b) VB-MAPP barriers assessment scores ranging from absent to limited for both manding and echoic repertoires (Sundberg, 2008). Criteria (a) was selected based on VB-MAPP 0-18 month skills development, which corresponds with the time frame that typically-developing children acquire basic manding repertoires. Criteria (b) was selected as learners with limited mand and echoic repertoires are good candidates for the use of AAC. Further, the use of a SGD as an AAC has been identified by the National Professional Development Center (NPDC) as an evidence-based

practice for targeting communication skills for children with autism (Wong et al., 2014). Child participants did not have any history of formal mand training using an iPad® as a SGD. Each teacher was assigned to work with one from her classroom during the probes.

Materials

Job Aids. As depicted in Appendices B and C, laminated, color-coded job aids, specific to the Levels I and II of implementation, were provided for use before, during, and after mand training sessions. For both levels of training, participants received a job aid displaying a clear and concise task analysis of target components as well as a flow chart mapping the sequencing of target components based on child responding. The Level I job aids displayed mand training primary components (i.e., contriving motivation, device presentation, prompting and error correction, reinforcement, and data collection) necessary for accurate implementation of Phase 1 of mand training procedures with the iPad® as a SGD (Lorah, 2016). Level II job aids were presented supplemental components, including field rotation and correspondence checks, required for accurate implementation of Phase 2 and 3 of mand training with the iPad® as a SGD (Lorah, 2016).

Train to Code. Within the training phase, the TTC 2.0 software was used as the training apparatus. To generate TTC training programs, video exemplars of mand training procedures were collected during natural occurring therapy sessions or role-play sessions at the university autism clinic, using a Flip Ultra Camcorder. Supplemental video exemplars were collected using confederate in role-play situations. A total of around 350 video clips (i.e., mand training trials) were edited using Apple iMovie® software, coded according to behavioral definitions and taxonomy (see Appendix E), and uploaded to the TTC software. As depicted in Appendix E, TTC Level I and II included three training programs customized to gradually introduce and

target the behavioral components required for accurate implementation of mand training with the iPad® as a SGD and the application Proloquo2Go™ across three phases of implementation.

TTC Level I included two training programs targeting primary behavioral components necessary for Phase 1 of the mand training protocol. The first TTC program targeted contriving motivation, device presentation, and child response (i.e., independent, accurate mand or error), while the second TTC program targeted additional primary components included error correction, reinforcement, and data collection. This program also required participants to identify any errors in the behavioral components previously trained in the first training program of TTC Level I.

The TTC Level II targeted supplemental components required for implementation of Phase 2 and 3 of mand training, which included field rotation, correspondence checks, and reinforcement/error correction following those correspondence checks. These expert coding reference files included variations of accurate and inaccurate implementation of these code-able events/components with the viewing of each clip or trial separated by three seconds of black screen and the phrase “Next Trial”. Specific to the first program of TTC Level I, the black screen displayed a sentence emphasizing the critical value of motivation to mand training following demonstration of an error in contriving motivation within a video trial (e.g., “If an error in contriving motivation occurs, the trial is over. Ensuring and verifying motivation is a vital step in mand training.”). Specific to the second program of TTC Level I as well as the program for TTC Level II, the black screen between all video trials displayed a sentence prompting and allowing time for participants to code the absence data collection following the end of the trial (e.g., “If further coding is required, do so now.”).

The software was installed on a MacBook® laptop with participants. Participants used the computer keyboard to code behaviors as part of TTC training.

Performance materials. During baseline and post-intervention performance sessions, an iPad® and the application Proloquo2Go™ (AssistiveWare, Amsterdam, the Netherlands) was used as the SGD. Preferred stimuli were identified through free operant (Roane, Vollmer, Ringdahl, & Marcus, 1998) and multiple stimulus without replacement preference assessments (DeLeon & Iwata, 1996; MSWO) were used during training sessions. Generic mand targets were selected for role-play with adult sessions. The researcher preloaded and organized mand targets on the iPad according to the phase of implementation. Performance sessions were recorded using a Digital Flip video camera.

Setting

TTC training and job aid introduction sessions were conducted in a large office adjacent to the preschool classrooms. The room (12x15 ft.) contained four child-sized tables of various shapes, chairs, book/toy shelves, two rugs, toy storage containers, and an administrator's desk. Role-play performance sessions were also conducted in the office at a small child sized table and chairs. Originally, teaching sessions with a child (i.e., generality probes) were supposed to be conducted in the child's regular classroom on the floor in an area designated for free-play. However, physical limitations of all three teachers made sitting on a carpet difficult; thus, teachers sat next to child at a small child-sized table next to the free play area in the child's classroom. While teacher participants encouraged children to remain at the table, children could move from the table to other areas in the classroom. Items corresponding with individual mand targets (i.e., those items/activities identified in the preference assessments for teaching sessions)

were placed on the table. Performance sessions were recorded using a Digital Flip video camera to score inter-observer agreement and procedural fidelity at a later time.

Experimental Design

A multi-component within multiple probe design across participants design was used to analyze the effects of job aids followed by TTC training software on participant accuracy of implementation of mand training using the iPad® as a SGD (Gast, 2014). Following baseline probes for both basic components (Level I) and complex/supplemental components (Level II), participants were provided with corresponding job aids to clarify behavioral components necessary for accurate implementation of mand training procedures. If mastery criterion was not obtained in the job aid only condition, TTC training were introduced. Specifically, the TTC training condition was designed to evaluate the degree to which training participants to accurately discriminate behaviors will transfer to performance of those same discriminated behaviors.

A multiple baseline across participants was selected because it allows for the demonstration of a functional relation between baseline and intervention through a replication of effect across participants (Gast, 2014). A multiple baseline is useful when evaluating functionally non-reversible behaviors as the design does not require withdrawal of the intervention. Further, a multiple baseline design offers a practical, straightforward method of evaluating efficacy of new training methods across a number of participants demonstrating similar behavior deficits (Gast, 2014).

Dependent Measures and TTC Data Collection

Mand training procedures. Targeted behavioral components and instructional sequence were derived from the phases of the mand training protocol used in a study conducted by Lorah

(2016), evaluating a discrimination training procedure to teach manding using an iPad® as a SGD. While the current study trained an abbreviated version of the protocol, which included three of the four original phases, all behavioral components integral to both protocols were trained (e.g., correspondence checks, field rotation, contriving motivation, error correction). In accordance with the aforementioned studies, training procedures combined various evidence-based ABA-based teaching strategies including time delay, prompting, reinforcement, and shaping (NAC, 2015; Wong et al., 2014). In the current study, Phase 1 of the mand training procedure involved shaping the topography of the response (i.e., teaching the child to press a picture symbol to request a preferred item), while Phase 2 and 3 introduced and refined discrimination between picture-symbols on the screen of the iPad® SGD. In accordance with this aim, the iPad® screen contained one picture symbol of a preferred item in Phase 1, two picture symbols of preferred items and two blank or non-referent symbols in Phase 2, and four picture symbols of preferred items in Phase 3.

Based on these phases, Level I training required accurate performance of the Phase 1 mand training components, which included 1) contriving motivation; 2) device/material presentation; 3) prompting and error correction procedures; 4) delivering the reinforcer, and 5) collecting data. While these primary components are intrinsic to all three phases of the mand training protocol, accurate implementation of Phase 2 and 3 of mand training required performance of supplemental behavioral components, which included 1) correspondence checks; 2) prompting and error correction following trials without correspondence; 3) delivery of reinforcer following trials with correspondence; and 4) field rotation. These supplemental components targeted within Level II training. Appendix F depicts a list of phase-specific components.

Teacher/trainee measures. Data collection and video analysis accomplished through viewing of video footage of all performance sessions (i.e., role-play with an adult and training sessions with a child). All mand training trials occurred during performance sessions were scored. The dependent measure was the percentage of mand training components performed accurately and sequentially, based on student participants' performance of mand training procedures using an iPad® as a SGD. During all phases of this study, as depicted in Appendix I, component checklists were used to assess accuracy of participants' implementation of relevant phase-specific mand training components.

Each component within the mand trial was scored as correct or incorrect, according to operational definitions. An overall percentage of components performed accurately and sequentially in each trial was calculated by dividing the total number of mand training components performed accurately/sequentially by the total number of components performed accurately and inaccurately and multiplying by 100. The percentages for each trial were added together and divided by the total number of trials evaluated/performed.

Only relevant and necessary components were scored for each trial. For instance, if the child/confederate manded independently, error correction procedures were not scored for that trial. Each trial required performance of four components for Level I, and between five and six components for Level II. A mastery criterion of 90% accuracy across three consecutive sessions was used across training phases to ensure consistent, high levels of procedural fidelity before terminating training. Because research results suggest that procedural drift commonly occurs after training, a relatively stringent (i.e., 90%) was selected (Lerman, Leblanc, & Valentino, 2015). Further, requiring consistent, high-level performance may support maintenance and generalization of that performance (Homlitas, Rosales, & Candel, 2014). Two performance

sessions were conducted per day, two to three times per week. Sessions lasted 10-15 minutes. During performance generality probes (training sessions with a child), trial by trial data was collected for all mand training trials by the both the trainer (Appendix G) and the observing researcher (Appendix H).

As depicted in Appendix I, the checklist for Level I assessed the accuracy of the behavioral components required for accurate implementation of Phase 1 of mand training procedures (i.e., primary components), while the checklist for Level II (depicted in Appendix I) was used to assess the accuracy of supplemental components specific to implementation of Phase 2 and 3 mand training procedures. Each component was individually and operationally defined, and accurate sequencing of behaviors was determined based upon phase of implementation and child/confederate responding as displayed in the flowcharts displayed in Appendix C and D.

More specifically, as depicted in the flowcharts and outlined below, the sequencing of components following an independent, accurate child/confederate mand differed from those following an error. This sequencing also varied across phases, as noted when comparing the Level I (Phase 1) and Level II (Phase 2 and 3) flowcharts, depicted in Appendix C and D.

Child measures. During teaching sessions with a child, as depicted in Appendix H, the primary researcher recorded the mand target, prompt level (i.e., independent or full physical prompt), and, if relevant, accuracy of correspondence check for each trial. This data served as a basis for determining the appropriate sequence per trial.

An independent child/confederate response for all phases was operationally defined as pressing an icon on the screen of the iPad® with enough force to evoke the synthesized voice output, within 5 seconds of indicating motivation. An indication of motivation was defined as pre-linguistic behavior directed towards an item, including grabbing, reaching, or pointing. In

terms of accuracy, a mand was considered accurate in Phase 1 (i.e., Level I training) if the response criteria for independence has been met, as touch responding rather than discrimination will be the goal for this phase. The child response was considered an error if the icon on the screen is not selected with enough force/accuracy to evoke the synthesized output, or if five seconds elapsed (following an indication of motivation) without the child/confederate pressing the icon on the screen with enough force to evoke the synthesized output following the contriving of motivation. Following an accurate, independent response in Phase 1, participants were required to deliver immediate reinforcement. Following an error in Phase 1, participants were required to perform error correction procedures.

During Phases 2 and 3 (Level II), correspondence checks (Bondy & Frost, 1994) were used to assess the accuracy of every independent mand. Following an independent mand, the child/confederate was presented with two preferred items represented on the screen of the iPad®. If the picture symbol selected on the screen of the iPad corresponded with the preferred item selected, the independent mand was scored as accurate and immediate reinforcement should follow. If the preferred item selected did not demonstrate 1:1 correspondence with the picture symbol selected, the response was considered inaccurate and the error correction procedure should follow. An error following an initial indication of motivation was scored if 1) a picture symbol on the screen was not selected with enough force/accuracy to evoke the synthesized output, 2) a blank or non-referent symbol was selected, or 3) five seconds elapsed (following an indication of motivation) without the child pressing the icon on the screen with enough force to evoke the synthesized output following the contriving of motivation. An error response should be followed by the error correction procedure.

TTC data collection. The TTC 5.0 software collects data on various aspects of trainee performance. Specifically, TTC uses participants coding accuracy to adaptively present six levels of coding, with parameters for moving up and down levels set at 90 and 80 percent, respectively, across a running average of 5 codes for Level I training programs and 8 codes for the Level II training program. For the purposes of this study, the global coding accuracy measure per training and full certification phase(s) was used. To evaluate generative transfer of performance skills, behavioral components targeted for coding and discrimination within the TTC training programs were identical to those evaluated by performance measures, as depicted in Appendix E.

Social validity. As a measure of social validity, depicted in Appendix J participants were asked to fill out a modified version of the Treatment Acceptability Rating Form-Revised (Reimers, Wacker, Cooper, & DeRaad, 1992) regarding the training procedures utilized within the current experiment following their training experience. The scales were eleven statement Likert-type instruments, with an item score of five indicating “strongly agree” and a one indicating “strongly disagree”. The rating scale was anonymous and the researcher was not present during participant completion.

General Procedures

General procedures. Two-to-three sessions were conducted per week for approximately ten weeks. Forty-five minute sessions involved either one training (TTC or job aid introduction) or two performance assessments (role-play with adult and/or child teaching sessions). For all four participants, Level I behavioral components were trained first and Level II behavioral components were trained second. For all four participants, job aids were introduced first, followed by TTC if required.

All baseline and post-training performance assessments, including both role-play with a confederate and teaching sessions with a child, were conducted during 15-minute natural environment teaching (NET) sessions. NET is a behaviorally based instructional procedure that uses natural occurring contexts, settings, or activities. A child's immediate interests and activities serve as a guide for language instruction, thus creating a more natural and less structured teaching environment than that of more formal teaching approaches (Partington, 2006).

Before all performance assessments, participants were instructed to "Conduct mand training with the confederate/with the child to the best of your ability. Dependent upon motivation, try to teach all mand targets." While the number of trials per target were not standardized, teacher conducted an average of two trials per target. Likewise, the number of trials per session varied, with an average of 10 trials being performed per session.

Corresponding baseline and post-training performance assessments for Level I and II mand-training components will be conducted in an identical format. For Level I, participants were provided an iPad® mini containing the Proloquo2Go™ software, pre-programmed with four folders each presenting an icon depicting one of the four mand targets selected. These mand targets remained consistent across all role-play sessions. All items were located on a make-shift shelf created out of two child-sized chairs (in sight, but out of reach to begin) directly adjacent to the table at which participant and confederate were seated. The primary researcher acted as the confederate in all role-play sessions. A secondary researcher watched and assessed procedural fidelity for at least 30% recorded role-play performance sessions via video-recorded sessions. Level II performance assessments were conducted in a similar fashion, although the iPad® was preprogrammed with three folders, two folders arranged for implementation of Phase 2 of mand

training and one folder arranged for Phase 3 of mand training. As depicted in Appendix E, components and sequencing remained the same across Phases 2 and 3 of the mand training procedures, with the number of picture symbols vs. the number of blank picture symbols in the field of four being the only difference.

As depicted in Appendix K, five different scripts per Level were developed for the confederate adult to follow during role-plays. For Level I components (i.e., Phase 1 of mand training with the iPad as an SGD), the scripts specified if/how to indicate motivation (16 of 20 trials), how to respond following an indication of motivation (e.g., accurately and independently in 6, no touch responding in 4, error in touch responding in 4). For Level II components (i.e., Phase 2 and 3 of mand training), the script specified if/how to indicate motivation (i.e., 18 out of 20 trials), how to respond following an indication of motivation, and how to respond following a correspondence check (error in initial responding in 4 trials, independent and accurate in 16 trials with correspondence demonstrated in 8 trials and lack of correspondence demonstrated in 8 trials). The order of confederate responses varied across scripts, but the quantity of manding trials comprising each response types remained constant for all sequences. Scripts will be assigned in a random order. Scripts were not assigned multiple times in a row.

Stimulus preference assessment. To identify preferred, target stimuli for mand training, both a free operant (Roane et. al., 1998) and MSWO preference assessment (DeLeon & Iwata, 1996) was conducted for each child participant prior to collecting baseline conditions for Level I. During the 30-minute free operant preference assessment, an assortment of 20 toys and activities was freely accessible to the child. The primary researcher collected duration data on the mean length of child engagement with each activity/item. Next, items/activities that corresponded with the longest duration of engagement in the free operant assessment were assessed within a

MSWO preference assessment. Based on the MSWO assessment, all assessed items received a rank and the top four items were selected as mand training targets for generalization probes. A second round of preference assessments were conducted prior to beginning the baseline condition for Level II training for both child participants as child motivation appeared low for either child participants, as indicated by a failure to reach for or point to any of the previously identified preferred items/activities.

Baseline (A). Prior to collecting baseline data, participants were given a data sheet with instructions to record the responses of the confederate and a one-page general description of and rationale for the use mand training with the iPad® as a SGD and the application Proloquo2Go™, both depicted in Appendix L. The one-page description detailed all phases of mand training and were used for Level I baseline and Level II baseline sessions (i.e., Phases 1-3 of the mand training protocol), although the participant was asked to perform only the Level I components (i.e., Phase 1) or Level II components (i.e., Phase 2-3) during baseline sessions dependent on targeted level. Participants had up to 10 minutes to review this document before the first baseline session, and five minutes to review prior to subsequent baseline sessions. When the participant indicates that he/she is ready, or after the designated time limit has elapsed, the participant was asked to “conduct mand training (target phase(s) specified) with the confederate to the best of your ability”. Following stability is baseline (i.e., at least three consecutive data points as indicated by a 20% stability envelope; Gast, 2014), one baseline probe was conducted with a child with autism without a script. Baseline sessions was staggered for each participant and continued until data indicated stable responding. During baseline, three performance sessions a week were conducted, with two performance assessments per session.

Job aids (B). Following baseline probes, training was introduced in a staggered manner across participants. Following a stable counter-therapeutic or zero-celerating baseline trend across at least three consecutive data points as indicated by a 20% stability envelope (Gast, 2014), participants were given the Level I job aids, which will be explained using a brief script. Job aids became possessions of participants; hence, the job aids could be studied further or used during teaching or reviewed prior to sessions. Job aids were introduced 48-72 prior to the first post-training performance assessment. Sessions continued three times a week, with two performance assessments per session until either mastery criterion of 90% accuracy or stable performance below mastery criterion across three sessions was observed for level-specific behavioral components. If mastery criterion was reached with the job aid alone condition for Level I components negating the need for TTC training, baseline condition for Level II mand training procedures followed mastery of Level I mand training components. If stable, but below mastery criterion levels of performance were observed across three sessions, as indicated by a counter-therapeutic or zero-celerating trend with three consecutive with a 20% stability envelope, TTC training was introduced. Following a stable baseline for Level II behavioral components (same stability criteria as Level I), Level II job aids and TTC training progressed in the same sequence based on the same criterion as those described for Level I training conditions.

Train to Code (C). For all phases of Level I and II TTC training, participants were provided a MacBook laptop and headphones. Because participant TTC training sessions did not overlap, the same room was used for all TTC sessions. For both TTC Level I and II of TTC, participants were required to complete three phases of training including 1) a foundations section provides basic information the terms, codes, and definitions of the behavioral components included in the taxonomy; 2) a training section that entails six levels of adaptive training

targeting behavioral coding skills; and 3) a certification section for assessment of performance evaluation (Ray & Ray, 2008). Participants that failed to meet mastery criterion for either or both Level I or II within the job aid only condition, completed TTC immediately following stable, below criterion levels of procedural fidelity. In effect, participants could have been required to complete TTC for both, either, or neither Level I and Level II based on performance following job aid provision.

Foundations. The foundations section is designed to provide a general overview of the terms/codes and definitions of the behaviors incorporated into the taxonomy. Computer-based textual definitions and video examples of the behaviors will be provided. Participants will also view a 5-minute “Welcome to TTC” video that includes basic information on TTC and how to use the TTC program.

Training. The training section consisted of a progression of six levels of training, with Level I TTC Program 1 containing 52 units (sequences of video exemplars) comprised of 101 randomized exemplars (coding opportunities); Level I TTC Program 2 containing 170 units comprised of comprised of 350 randomized exemplars; and the Level II TTC Program containing 130 units (sequences of exemplars) comprised of 315 randomized exemplars. TTC version 2.0 were used for the current study, which adaptively moves up or down between levels of difficulty, with the criteria for changing levels based on the parameters of 90% accuracy and 70% respectively, across running averages of 20 codes (level 1 and 2) and 10 codes (levels 3-6). A 90% mastery criterion (across 10 or 20 blocks of video exemplars) was selected as this criterion allows for no more than 1 error across 10 video exemplars, which ensured highly accurate and fluent coding, while also allowing for a limited amount of errors given the pace of “in vivo” coding required in later stages of the TTC program. Throughout the training section,

participant coding was compared with the expert reference files. Error-correcting feedback and visual timing prompts was faded as the participants progress through the six levels. These instructional services could also be reinstated based on performance.

Certification. The certification section simulated in vivo coding without prompting, assistance, or feedback for correct or incorrect responses. An 80% mastery criterion across 20 blocks of video exemplars) was selected as this criterion allows for no more than 1 errors across 10 video exemplars.

If TTC was required, performance assessments (both confederate role-play and child teaching) were conducted following full certification through self-termination of both Level I TTC or Level II TTC, depending on the target Level of training.

Generality probes. Participants' implementation of both Level I and II mand training was assessed with a child with autism. Fifteen-minute NET teaching sessions were conducted after the participant met the 90% accuracy criterion for both Levels I and II within role-play performance assessments. A 90% mastery criterion was selected, as this required student participants to consistently perform mand training procedures within role play situations with high levels of accuracy, prior to allowing them to conduct mand training in real time with real child participants. Procedures were identical to those used in the role-play assessment, except participants were asked to conduct mand training with a child with autism or a developmental delay. Additionally, mand targets consisted of four preferred items identified through free operant and MSWO preference assessments. Data was collected on all mand opportunities occurring during the timed session. Mand opportunities were defined as any trial in which the child indicates motivation and/or the participant prompts a response following failure to accurately contrive motivation). For each mand opportunity, data was only collected on relevant

behavioral components. Supplemental, novel targets as identified by the MSWO rankings were introduced as needed to provide opportunities for error-correction procedures to be used during teaching sessions.

Maintenance probes. Maintenance probes for Level I and II behavioral components were conducted in a manner identical to corresponding Level I and II baselines, one month after final generality probes.

Interobserver Agreement & Procedural Fidelity

Interobserver agreement (IOA) for participant implementation was assessed for 30% of performance assessments, including both role-play and teaching sessions. IOA data were collected by the secondary researcher through video review. For participant implementation, IOA was calculated by taking the total number of agreements for each behavioral component (on the procedural fidelity checklist) and dividing the number of disagreements plus the number of agreements, multiplied by 100. The overall agreement across all sessions and participants was 83% for mand training components performed correctly (range, 60-100%). IOA for child responding was calculated by taking the number of agreements and dividing that by the number of agreements plus disagreements and multiplying by 100. IOA data was assessed for 38% of teaching sessions with a child. The overall agreement across sessions and participants was 95% for frequency of mands and 99.5% for percentage of independent mands. All components on the procedural fidelity forms were also operationally defined and researchers practiced scoring mand training trials prior to the initiation of the study to ensure clarity of operational definitions.

Additionally, procedural fidelity checklists were completed by both observing researcher (i.e., for IOA purposes) and roleplaying/present researcher to assess whether the researcher leading role-play and teaching sessions followed the designated procedures. Appendix H depicts

the procedural fidelity checklist for the researcher running the teaching sessions. Appendix M depicts procedural fidelity checklists for both types of sessions (for observing researcher) as well as the procedural fidelity checklist for the role-play session (for the role-playing researcher).

Experimenters

Two experimenters were involved in this research project. The primary researcher was a doctorate level student in curriculum and instruction, and a Board Certified Behavior Analyst (BCBA™). The secondary researcher was a doctorate level student and a Board Certified Behavior Analyst. Additionally, an assistant professor and BCBA™ at the doctorate level (BCBA-D™) served as an expert coder to evaluate IOA for TTC video exemplars. The primary investigator trained the secondary researcher to evaluate fidelity to a mastery criterion of 100%.

Data Analysis Procedures

Line-graphed data was inspected and interpreted using visual analysis. Within single-subject research, visual analysis of graphic data is the most common data analysis strategy used (Gast, 2010). Visual analysis was conducted to determine whether a meaningful change in a behavior occurred, and, if it so, to what extent can the change be attributed to the independent variable. Data patterns were inspected in relation to (a) number of data points within a condition, (b) variability (the extent to which the values of the data differ across conditions), (c) level (the magnitude of data as indicated by the value on the vertical axis; per each phase), (d) trend (the path of the data, either increasing, decreasing, or zero trend), and (e) percentage of overlapping data points (number of data points that overlap between conditions; Cooper, Heron, & Heward, 2007; Gast, 2014). Data were analyzed within and across conditions.

Chapter 4

Results

Performance Accuracy

Appendix N depicts the percentage of Level I and II mand training components implemented accurately by teachers with a confederate and during probes with a child. The results indicate that jobs aids followed by Train to Code produced clear and significant increases in mand training accuracy during role-play sessions with a confederate as compared to baseline. In comparing Level I baseline measures to post-training role-play sessions, no overlapping data existed for any of the three participants. In comparing Level II baseline measures to post-training role play sessions, only one of the three participants' data showed any overlap in data points between baseline and training.

Additionally, the collection of maintenance data indicate that performance maintained for all participants across Level I and Level II components. However, a moderate decrease in mand training accuracy, as compared to post-training role-play sessions, was observed for Layla and Nour across initial generality probes conducted with a child with autism for Level I and II mand training components. Follow-up generality probe sessions were not conducted for Lucy, as the child participant with whom she was paired withdrew from the preschool following the Level I baseline.

Participants required an average of 323 minutes of training time to reach mastery criterion levels in the training setting (range, 212-428 minutes).

Layla. As depicted in Appendix N, Layla performed an average of 6% of Level I mand training components (range, 2-12 %) accurately during baseline. Following the introduction of the Level I job aid, Layla reached the stability criteria (i.e., three consecutive data points

indicating a zero-celerating or counter-therapeutic trend below mastery criterion) for introducing TTC training within three sessions, with her mand training accuracy averaging 29% (range, 22-33%) for Level I components. Upon completion of the Level I TTC training, Layla met mastery criterion within 3 sessions, averaging 91% (range, 90-92%). Layla achieved certification for Level I TTC (program 1) in 122 minutes, requiring 333 codings. An exact duration of Level I TTC training time (program 2) was not possible, as Layla forgot to log-out of TTC upon completion of one of her coding sessions. In effect, the single session (29 codings) duration registered as 5 hours and 25 minutes. Layla estimated that active coding during this session lasted about 15 minutes, which appears reasonable calculations indicate that the average rate per coding was 22 seconds across the other coding sessions for Level I, Program 2 (i.e., calculations based on this rate suggest an 11-minute training session). Using the estimated 15-minute training duration for session, Layla completed Level I TTC certification (program 2) in 90 minutes, requiring 244 codings. Total training duration was 428 minutes.

During baseline for Level II, Layla performed an average of 68% of Level II mand training components (range 63-74%) accurately during baseline. Layla's performance accuracy increased to an average of 95% (range 94-96%) across three consecutive sessions following completion of Level II Train to Code training. Following the introduction of the Level II job aid, performance accuracy remained almost unchanged at 65% accuracy for the first two sessions, then deteriorated to 25% accuracy in the third session (range, 25-65%). Following Level II TTC certification, Layla met mastery criterion within three sessions, averaging 95% accuracy (range 95-96%). Level II Train to Code certification was completed in 196 minutes. The number of codings required cannot be determined as an internet/server connection issue resulted in the loss of coding data.

Performance accuracy declined to 79% during the Level I generalization probe session with a child with autism. Layla performed the error correction procedure incorrectly in 4 out of 5 opportunities (20% accuracy in trials requiring error correction). Prior to the second Level I generalization probe, Layla was directed to the Error Correction section of the Level I job aid and instructed to “read the section closely and make sure to perform all components as specified”. Subsequently, performance accuracy remained stable at 78% for Level I mand training components. While Layla performed the error correction procedure correctly 60% of the time, she failed to collect data in 4 out of 10 trials. During the Level II generalization probe session with a child, Layla performed Level II components with 88% accuracy. It should be noted that Layla received in-vivo feedback on performance of Level I mand training components between Level I generalization probes and Level II generalization probes with a child, as the Level II generalization probe was not conducted until Lara (i.e., the child paired with Layla) reached mastery criterion for Phase 1 of mand training.

High levels of accuracy during role-play sessions maintained at 90% and 94% at the one-month maintenance probe for both Level I and Level II mand training components, respectively.

Following low, relatively stable baseline levels for Level I components, Layla’s graph illustrates an immediate, moderate yet temporary increase in level following Level I job aid introduction. Upon certification of Level I TTC training, the data pattern indicates an abrupt, immediate increase in level, stabilizing at a high-level of accuracy. No overlap of data points between intervention and baseline was noted. Thus, it can be concluded that the behavior change was observed and that training was responsible for improvements in performance of Level I mand training components. The data path for Level II mand training accuracy illustrates relatively high, stable baseline levels. Despite the introduction of the Level II job aid, accuracy

percentage remained stable across the first two training sessions, deteriorating to 25% accuracy in the third training session. Following Level II TTC certification, an abrupt level change in level was observed. Percentage of non-overlapping data was 33% for the Level II Job Aid training phase indicating a low degree of experimental effect; however, the percentage of non-overlapping data was 100% for the job aid plus Train to Code Level II training phase indicating high degree of experimental effect only when Train to Code training was added to the training package. High level of performance accuracy maintained across one-month maintenance probes for both Level I and II mand training components.

The data path indicates a moderate decrease in level during the generality probe session with a child. A slight decrease in level of performance accuracy was also observed between post-training role-play sessions and the Level II generality probe session with a child with autism.

Lucy. As depicted in Appendix N, Lucy performed an average of 16% of Level I mand training components (range, 10-25%) accurately during baseline. Following the introduction of Level I job aid, Lucy required only three sessions to reach mastery criterion, averaging 92% performance accuracy for Level I mand training components (range, 80-100%), negating the need for Level I TTC training. Lucy demonstrated moderate levels of Level II mand training accuracy during baseline role-play sessions (average 60%; range 57-65). Her mand training accuracy increased to an average of 83% post Level II job aid, meeting criterion for introducing Level II TTC (range 81-85%). Level II Train to Code certification was completed in 192 minutes, requiring 382 codings. Following Level II TTC certification, Lucy required three sessions to reach mastery criterion, averaging 97% performance accuracy of Level II mand training components (range 96-98%). High levels of accuracy maintained at 94% and 90%

across one-month maintenance probes for both Level I and II mand training components, respectively.

Following the first baseline generalization probe, the child participant paired with Lucy withdrew from the nursery school. Thus, post-training generalization probe sessions with a child could not be conducted.

Following low, relatively stable baseline accuracy for Level I components, Lucy's graph illustrates an abrupt increase in level followed by a therapeutic trend, which stabilized at mastery criterion levels. Percentage of non-overlapping data was 100% for the job aid training condition, indicating that the job aid alone was sufficient for establishing high level of performance fidelity for Level I mand training components. The data path for Level II performance accuracy displays moderate, stable baseline levels followed by an immediate increase in to levels slightly below mastery criterion, with no change in trend. Thus, TTC Level II training commenced. Upon certification, the level of performance accuracy immediately increased to mastery levels across three consecutive sessions. Level II Train to Code certification was completed in 192 minutes, requiring 382 codings. Percentage of non-overlapping data was 100% for both Level II training phases indicating a high degree of experimental effect. High levels of performance accuracy maintained across one-month maintenance probes for both Level I and II mand training components. Total training duration was 212 minutes.

Nour. As depicted in Appendix N, Nour performed an average of 32 % of Level I mand training components (range, 23-40 %) accurately during baseline. Following the introduction of the Level I job aid, Nour's accuracy increased to an average of 73% (range, 67-77%) meeting the criterion for the initiation of TTC Level I training. After certifying in Level I TTC, Nour required four sessions to reach Level I mastery criterion, averaging of 91 % (range, 70-98%).

Level I TTC certification (Program 1) was completed in 122 minutes, requiring 353 codings, while certification (Program 2) was completed in 70 minutes, requiring 308 codings. Total training duration was 328 minutes.

Across Level II baseline, Nour averaged 47% performance accuracy (range, 20-57%). Her Level II performance accuracy increased significantly with the introduction of the Level II job aid, averaging 94% accuracy and reaching mastery criterion with four training sessions (range, 80-98%). High levels of fidelity were maintained at an average of 98% and 92% at the one-month maintenance probe for Level I and II, respectively.

Following a deteriorating trend in baseline, Nour's graph illustrates an abrupt increase in level followed by a gradually deteriorating trend with the introduction of the Level I job aid. Following certification in TTC Level I, aside from an initial data point indicating no change, implementation accuracy increased to mastery levels for the remaining three sessions. This suggests that the Level I job aid alone was not sufficient for establishing high levels of performance accuracy for Level I components. The data path for Level II performance accuracy illustrates a moderate, stable baseline level. Upon the introduction of the Level II job aid, the data depict a moderate increase in level, which immediately increased to mastery criterion levels across the subsequent three sessions, negating the need for TTC Level II training.

During the Level I follow-up probes, performance declined to 55% accuracy during the generality probe session with a child with autism. Nour failed to collect data during the session, which significantly impacted her accuracy percentage. Prior to the second Level I generality probe, Nour was directed to the Reinforcement section of the Level I job aid and instructed to "read the section closely and make sure to perform all components as specified". This section of the job aid was selected primarily because it included data collection, but also because it

specified delivering reinforcement with one-second following an independent mand, which Nour had performed incorrectly in 7 out of 9 opportunities (i.e., 78% of trials that required reinforcement). Performance accuracy increased to 81% in the second generality probe session. Nour stopped conducting mand training before Heddy (i.e., child paired with Nour) began Phase 2 of mand training, identifying child sickness and distraction caused by the iPad® as the basis for this decision. In effect, a generality probe session for Level II mand training components could not be conducted.

Independent and Prompted Child Mand

Table N displays the percentage and frequencies of independent and prompted mands using the iPad® completed by Lara (paired with Layla) and Heddy (paired with Nour) during Level I and II baseline and post-training generality probe sessions (see Appendix O). During baseline generality probe sessions for Level I and II, Lara displayed no independent or prompted mands using the iPad®. In the first and second Level I post-training generality probe session, the number of mand trials using the iPad increased to seven and ten, respectively. Lara independently manded using the iPad® 14% and 50% of trials, respectively. During the Level II generality probe session, the number of mand opportunities remained stable at ten. Lara independently manded using the iPad® 40% of opportunities.

During baseline generality probe sessions for Level I and II, Heddy displayed no independent or prompted mands using the iPad®. For the first Level I post-training generality probe session, the frequency of mand trials increased to eleven. Heddy independently manded using the iPad® 91% of trials. During the second Level I generality probe session, the frequency of mand opportunities increased to thirteen. Heddy independently manded using the iPad® 92% of opportunities. A post-training Level II generality probe session was not conducted as Nour

(i.e., teacher paired with Heddy) stopped conducting mand training before Heddy began Phase 2 (i.e., Level II).

Train to Code

Both participants who required Level I TTC training met the mastery criterion for independent coding (18 or more correct for 20 successive coding opportunities in certification Level 7). Likewise, the two participants who require Level II TTC training reached mastery criterion for independent coding (same mastery criterion as Level I). The duration of TTC Level I training was 98 to 122 minutes for Program 1, and 70 to 90 minutes for Program 2. The duration of TTC Level II training ranged from 192 to 196 minutes. The number of codings required to certify for Level I ranged from 333 to 353 (program 1) and 244 to 308 (program 2). The number of codings required for participants to certify for TTC Level II can only be reported for Lucy as internet connection/server issues resulted in a loss of segments of Layla's coding data, rendering a total coding count impossible. Lucy required 382 trials to achieve certification level.

A coding error analysis for TTC Level I (Program 1) indicated that participants demonstrated the lowest coding accuracy for the following two codes: 1) ErrDP at 86% and 2) INCR at 84% (range of accuracy for all codes, 84% to 96%; definitions of codes are provided in Appendix E). For TTC Level I (Program 2), participants demonstrated the lowest coding accuracy for the following three codes: IR+ErrEC (M=68%), M+ErrR (M=80%), and ErrPC (M=82%), while the average coding accuracy across participants for the other six codes ranged from 68% to 97%. For TTC Level II, Lucy demonstrated the lowest coding accuracy for NoCo+EC at 65% and NoCo+ErrEC at 78%. Accuracy percentages are based on only the initial coding entered by a participant for each coding opportunity in the training; thus, an indication of

relative difficulty of coding the behavioral included in the taxonomy. Because early levels within each TTC program provide a highly supportive training environment in terms of prompting and feedback, coding data on the last 10 errors per participant for each training program, identify coding errors that persisted after supports were removed. For TTC Level I, errors of omission accounted for 5 of the final 20 errors for Program 1, and 3 of the 20 final errors for Program 2. All other errors were documented as errors of commission, meaning the participant entered a code that did not match the expert coding record. Of the final 20 errors (10 per participant) during Level I TTC Program 1, inaccurate/missed codings of either INCRS and ErrDP accounted for 40% (8/20) and 30% of errors (4/20), respectively. Most of the ErrDP coding errors appeared to errors of omission, while INCRS coding errors seemed to result from difficulty discriminated between INCRS and other codings (i.e., ErrMO, ErrDP, MAND). Of the final 20 errors (10 per participant) during the Level I TTC Program 2, errors in coding IR+ErrEC accounted for 60% of coding errors. Specifically, participants appeared to have the most difficulty discriminating between IR+ErrEC and IR+EC. For Level II TTC, Lucy's final 10 errors were identified as errors of commission. Of the errors, 8 out of 10 error appeared to result from discrimination errors between NoCo+ErrEC and NoCo+EC, or between M+ErrCoC and M+CoC. In other words, judging the accuracy of: 1) error correction procedures following no correspondence and 2) correspondence check presentation proved particularly difficult, even towards the end of training.

An analysis of the number of participant coding opportunities for each behavioral component varied within the three TTC training programs. In other words, participants viewed/coded fewer video exemplars of INCRS in Program 1, and M+ErrR and IR+ErrEC in Program 2. Within TTC Level II, participants had fewer opportunities to code Co+ErrR,

NoCorr+EC, and NoCorr+ErrEC. The codes were identified if the average number of code-specific opportunities was ten or more opportunities less than the overall average of coding opportunities across all codes in the taxonomy.

Based on an analysis of errors occurring during Level I performance probes (i.e., post-TTC training Programs 1 and 2), participant errors were most consistently recorded on the performance checklist step that involved performing error correction procedures, the step most closely associated with INCRS, IR+ErrEC, and IR+EC on the TTC taxonomy. Results of the performance error analysis also documented errors in contriving motivation, the performance checklist associated with ErrMO on the TTC taxonomy. The analysis of performance errors for Level II post-TTC performance probes documented a low frequency and inconsistency of trainee errors. In other words, following the completion of Level II TTC training, none of the steps appeared particularly difficult for participants to perform.

Social Validity

Appendix P shows the mean and range of the responses made by participants for each item in the modified TARF-R. Three classroom teachers completed the survey. The survey consisted of 11 items, evaluating time, disruption, effectiveness, acceptability, and willingness. Each item was rated on 5-point Likert scale, with low 1 equaling strongly disagree and 5 equaling strongly agree. In response to Item 1 and 8, all participants found the training procedures acceptable (i.e., rating of 4 or 5; Item 1, M=4, range, 4; Item 8; M=4.7, range 4-5). In response to item 11, all participants reported having an overall positive reaction to the training procedures (M= 4, range, 4). In response to Item 9, two of three participants indicated that the training procedures were not disruptive (i.e., rating of 1 or 2), while one participant indicated neutrality (M=2, range, 1-3). In response to Item 5 and 7, all participants reported the training to

effective in establishing and maintaining accurate performance of request-training procedures (Item 5, $M=4$, range 4; Item 7, $M=4.7$, range 4-5). In response to Item 6, one participant agreed that there were disadvantages and/or undesirable side effects associated with the training procedures, while two participants indicated neutrality. In response to Item 9, two out of three participants identified the training procedures as non-disruptive, while one participant remained neutral ($M= 2$, range 1-3). While the data suggest that the training procedures may be associated with or result in minor disruptions, disadvantages, and/or undesirable side effects, all participants felt that other staff members would be willing to participate in this type of training. Overall, these scores suggest that all participants found the job aids followed by Train to Code software an effective and acceptable for training staff to implement mand training procedures using the iPad® as a SGD.

Chapter 5

Discussion

The purpose of this study was to evaluate the effectiveness of job aids followed by performance-based feedback on staff implementation of mand training with the iPad® and application Proloquo2Go™ as a Speech Generated Device (SGD). The results provide direct evidence that the training procedures can increase participants' mand training procedural accuracy in role-play sessions and teaching sessions with a child with autism or a developmental delay. To establish high levels of procedural accuracy, the addition of Train to Code training proved necessary for establishing high levels of accuracy (i.e., 90%) in two out of three participants for both Level I and II mand training procedures. Despite reductions in accuracy following the transition from the training environment (i.e., with a confederate) to the natural environment (i.e., with a child) across teachers, a brief performance-based feedback session effectively established adequate levels of accuracy (i.e., above 78%) for participants and Levels assessed. Performance maintained at one-month probes across all participants. In accordance with the training research, job aids provided an unobtrusive and cost-efficient method for improving performance to varying degrees, but generally required the addition of TTC (i.e. comprehensive intervention) to establish high levels of mand training procedural accuracy (Amigo et al., 2008; Crowell et al., 1988). Furthermore, these findings support the preliminary results reported by Rosales, Eckerman, & Martocchino (2018), and further demonstrate the successful transfer of coding skills to performance accuracy of mand training procedures using AAC systems.

Research Questions

Question 1

What are the effects of job aids followed by TTC on the accuracy of implementation of mand training using an iPad® as a SGD and the application Proloquo2Go™?

The primary objective of this dissertation is to evaluate the effectiveness of job aids followed by TTC on staff implementation of mand training with the iPad® and application Proloquo2Go™ as a SGD. As evidenced by visual analysis of the training data, the training procedures were effective in establishing high levels of mand training procedural fidelity for all participants. One of the three participants met criterion for mastery for Level I with the provision of job aid only, requiring four performance sessions to reach mastery criterion. The other two participants reached mastery criterion following job aid provision and TTC training, each requiring a total of six and seven performance sessions total.

Similarly, the provision of the job aid only was sufficient for establishing mastery criterion for Level II mand training procedures for one of three participants in the three performance sessions (i.e., minimum number required for mastery). The other two participants reached mastery criterion following job aid provision and TTC training, requiring between 6 and 7 performance sessions.

Mand training performance accuracy increased from a baseline average of 19% to an average of 91% following job aid and TTC training conditions for Level I components. Likewise, mand training performance accuracy increased from a baseline average of 64% to an average of 96% following JA and TTC training conditions for Level II components.

Layla. Across three baseline sessions for both Level I and II mand training procedures, Layla demonstrated low mand training performance accuracy. Although the Level I job aid

training condition documented only minor improvement in performance, completion of the Level I TTC training programs resulted in immediate mastery level performance. She averaged 91% performance accuracy following Level I TTC training. Similarly, Layla's Level II performance accuracy remained unaffected by the job aid provision; however, following the completion of Level II TTC training, Layla's performance accuracy increased to an average of 95% across the three consecutive sessions.

Lucy. Across four Level I baseline sessions, Lucy demonstrated low levels of performance accuracy. Following Level I job aid provision, Lucy reached mastery criterion within four sessions, average 92% accuracy. Lucy demonstrated moderate levels of performance accuracy across three Level II baseline sessions. While her performance accuracy increased slightly during the Level II job aid condition, she required Level II TTC training before reaching mastery criterion. Following TTC Level II training, she reached mastery criterion within three performance sessions, averaging 94% accuracy across the final three sessions.

Nour. Across four Level I baseline sessions, Nour demonstrated a low level of performance accuracy. Following both Level I job aid provision and TTC training, Nour met mastery criterion for Level I mand training components, averaging 91% across the four sessions following TTC training. Nour demonstrated moderate to low levels of performance accuracy across three Level II baseline sessions. Following Level II job aid provision, Nour reached mastery criterion within four performance sessions, averaging 94% across sessions.

Results align with previous research indicating that various forms of task clarification alone and in combination with other behavioral procedures can be used to improve performance across work settings and performance skills. In accordance with the literature, clarifying performance steps through the provision of job aids, appeared a productive, cost-effective, and

unobtrusive method for improving teacher implementation of Level I and II mand training procedures for most participants (Parsons et al., 2013; Sasson et al. 2006). However, as consistent with the literature on antecedent-based interventions alone, provision of a job aid often produced only minimal to moderate effects on acquisition and maintenance, and thus required the addition of TTC training, a more comprehensive training package, to establish high levels of accuracy in most cases (Amigo et al., 2008; Crowell et al., 1988). Further discussion of the relative effects of these training procedures will be included in the discussion as it relates to the second research question.

While research documents the positive effects of TTC training on participant coding accuracy, research evaluating the effects and generality of TTC as a transfer of training tool remains highly limited (Ray, 2008; Causin, 2009; Bourdin, 2011). The results of the current study provide preliminary evidence that training staff to accurately code behavioral components using TTC do generalize to improved application or performance of those discriminated behaviors in a training setting.

The effectiveness of TTC as a transfer to training tool stands theoretically and experimentally consistent with research on the observer effect, which suggests that conducting behavioral observations (i.e., directed data collection on behavioral components) results in significant increases in performance of those same target skills (Alvero et. al., 2008; Taylor & Alvero, 2012, Hine, 2015). The current study extends previous research by successfully incorporating a completely online or computer-based training platform for conducting behavioral observations, reducing professional involvement and offering flexibility of training schedules and locations as compared to fully or partially in-vivo training. Discussion of the comparative

efficiency of this training modality in comparison to other training modalities will be discussed in association with research question three.

Currently, the four published studies evaluating the use interactive computer training (ICT) to train teachers to implement behavior-analytic teaching interventions have had mixed results (Nosik, Williams, Garrido, and Lee, 2013; McColluch & Noonan, 2013; Wainer & Ingersoll, 2012). While all four studies documented some degree of improvement in performance accuracy following ICT, only two out of the four documented adequate levels of performance accuracy (i.e., above 80%) across participants. Of the studies evaluating performance in the natural setting (i.e., teaching sessions with a student diagnosed with autism or a developmental disability), participants either demonstrated below adequate levels of accuracy without further intervention and/or reductions in accuracy compared to the training setting (Nosik et al., 2013; McColluch & Noonan; Wainer & Ingersoll, 2012).

The results of the current study add to the current literature base, providing evidence that ICT can significantly improve performance accuracy of behavior analytic teaching procedures in a training setting. However, consistent with the current research base, participants demonstrated reductions in performance accuracy when transitioning to implementing mand training with a child diagnosed with autism. Both Layla and Nour required performance-based feedback in the form of a one-sentence reminder and job aid prompt to reach 78% and 81% performance accuracy on Level I components. Layla, the only participant for which a Level II generalization probe could be conducted, demonstrated 88% accuracy of Level II mand training components. However, this result should be interpreted with caution, as Layla did receive two sessions of coaching on Level I components before the Level II generality probe was conducted, which may have resulted in carryover effects as several of the core components remain consistent across the

Level II mand training procedure. Generalization data will be discussed in depth in association with the third research question (see pp. 83-84).

Despite the increasing popularity, accessibility, and research base surrounding the use of the iPad® as a SGD with applications such as Proloquo2Go™, targeted investigation of methods for training staff to implement associated mand training procedures have not yet been conducted (Lorah, Parnell, & Tincani, 2017; Lorah, 2016; Lorah et al., 2014; King et al., 2014). Thus, the current study extends the existing research base by evaluating the effects of methods for training staff to implement mand training procedures using an iPad as a SGD® with the application Proloquo2Go™.

Overall, results of this study are promising, suggesting that job aids followed by TTC may be a viable, effective training package for teaching staff to implement mand training with an iPad® as a SGD, particularly when financial or location constraints render in-vivo training impractical. Furthermore, the results demonstrated that this training package was effective in teaching a population with no professional ABA or mand training experience or professional development to implement mand training in a training environment. However, a minimal amount of performance-based feedback will likely be required for participants to reach high levels of performance accuracy in the natural environment with a child diagnosed with autism or a developmental delay.

Analysis and Potential Impact/Considerations

TTC Performance Error Analysis. While all trainees demonstrated high levels of fidelity post-job aid and TTC training, an error analysis of persistent TTC coding errors and performance session errors, reveal possible relationships that may: 1) inform individualization of

TTC training to enhance future effectiveness; and 2) suggest reasons/functions for the current effectiveness of TTC training.

Participants demonstrated lower performance accuracy of behavioral components that were less well trained during TTC training. In other words, if participants exhibited difficulty identifying the behavioral component towards the end of the training, they oftentimes performed these behaviors/steps less accurately during the role-play performance probes. These results align with preliminary finding reported by Rosales, et al. (2018) suggesting that the individual accuracy of a trainee's observation skills may control the transfer of those same behavioral components to accurate performance. More specifically, for TTC Level I Program 1, participants demonstrated persistent, consistent errors in identifying an "Incorrect Response" within TTC Level I Program 1, and discriminating between Incorrect Response+Error in Error Correction and Incorrect Response+Error Correction. Interestingly, during Level I performance probes, participants made more errors on the performance checklist step that involved performing error correction procedures, the step corresponding with INCRS, IR+ErrEC, and IR+EC than any other step in the TTC taxonomy. Of note, both INCRS and IR+ErrEC were these least trained meaning that trainees were presented fewer opportunities to codes these behavioral components across Level I TTC training. The analysis of performance errors for Level II post-TTC performance probes documented a low frequency and inconsistency of trainee errors. In other words, following the completion of Level II TTC training, none of the steps appeared particularly difficult for participants to perform.

Overall, these findings add support to the conclusions drawn by Rosales et al. (2018). Rosales et al. (2018) evaluated the effects of TTC on staff implementation of the Picture Exchange Communication System (PECS) protocol and identified TTC behavioral coding

accuracy as a potential predictor of performance accuracy of those coded procedures in role-play sessions. As noted, Level I data appear to align with this hypothesis which warrants consideration of associated implications for both formative evaluation and individualization of TTC training. Given that TTC collects precise data on the quantity of learning opportunities and accuracy of behavioral evaluations, allowing trainers to identify individual trainees' strengths and weaknesses and adapt TTC training accordingly, additional or modified training for specific behavioral components could be provided based on individual TTC trainee data (Rosales et al., 2018). Adjusting the alternative parametric setting options inherent to TTC would allow trainers to easily manipulate the number/rate/percentage of accurate codings required for changing prompting levels or feedback per training level.

TTC and Atomic Repertoires. As we consider the implications of the TTC error analysis and the associated relationships and implications, potential behavioral interpretations of the underlying mechanisms and/or training features responsible for the overall effectiveness of TTC training format offer a context/framework to the discussion. As discussed earlier, TTC uses errorless training procedures with performance-based feedback to train expert observation and coding of behavioral events via video files with a goal of skill transfer to performance in the applied setting (Ray, Ray, Eckerman, Milkosky, & Gillins, 2011; Terrace, 1963; Ray, 1995).

As mentioned, results of the current study align with previous research on observational learning (Bandura & Jeffery, 1973; Bandura, Grusec, & Menlove, 1966) as well as more recent research of the observer effect (Alvero et al., 2008; Taylor & Alvero, 2012), suggesting that training individuals to recognize and tact behaviors of models (i.e., performance evaluation), particularly complex actions, enhances generalization to the application of or engagement in those discriminated behaviors within an actual training setting. While Eckerman, Hall, Vreeland,

and Ray (2017) identify the say-do correspondence facilitated by TTC as a type of observational learning, they rely on a behavioral account of this phenomenon to analyze the underlying mechanisms. Specifically, Eckerman et al. (2017) submit Skinner's notion of minimal repertoires (1957) and Palmer's (2012) related behavioral interpretation of atomic repertoires as framework for interpreting observational learning and thus the effects of TTC training on performance transfer. These theoretical accounts highlight a strengthening of precise elementary behavioral unit responses that can be evoked in any combination by the arrangement of corresponding stimuli that can be rearranged to produce new behavior; thus, allowing for the induction of an immediate or almost immediate criterion-level variation in behavior (Palmer, 2012).

Palmer (2012) suggests that during observation, the observer engages covertly or overtly in tacting, echoic behavior, textual behavior, or imitative behavior (i.e., types of atomic repertoires) that are under the control of corresponding features of the model. This immediate response is atomic, independent of shaping, but dependent on basic atomic repertoires. Within this interpretation, the supposed first performance of the target behavior is not actually the first as the behavior has occurred in some form albeit covertly or overtly at the time of observation (Palmer, 2012). This view assumes reinforcement of the behavior, which Palmer deems plausible, noting that accurate replication of a behavioral model regardless of the practical benefit, is likely reinforcing while failing to replicate a model is likely mildly aversive, given the past consequences associates with successful and unsuccessful replication (Palmer, 2012). Furthermore, Palmer (2012) points out that differential outcomes of observational learning can be explained by the nature (i.e., essential qualities or characteristics), range, and grain (i.e., precision vs. coarse) of the atomic repertoires. Depending on the individual differences in

atomic repertoires as well as the modeled behavior, alternative atomic repertoires take on an active role. As it relates to TTC, the relevant atomic repertoires consisting of atomic tacts and atomic rule-governed behavior may control the behavioral components within a procedure that can be replicated when the individual's imitation repertoire stands insufficient (i.e., verbal behavior comes to control the response vs. the visual stimuli). Along the same lines, Skinner recognized that as we strengthen one operant (or rather the elements of the response), we often produce an increase in the strength of another, resulting in response generalization/transfer or response induction; therein, stands the potential benefit of viewing behavior in terms of atomic repertoires rather than individual responses (Skinner, 1953; Palmer, 2012; Eckerman, et al., 2017).

Using Palmer's analysis (2012), TTC training appears to establish atomic tact units that are under the control of corresponding features of the model and environment at the time of observation. When a corresponding context is present at a later time, and the imitative repertoire inadequate, the trained atomic tact repertoire is evoked in conjunction with other relevant repertoires (i.e., rule-governed behavior), exert control over performance of the behavior as needed (Palmer, 2012). TTC appears to "fine-tune" (i.e., grain) the tact repertoire specific to the request training procedures (i.e., several elements within the domain of request training) and then, later, when a similar context is represented during the performance probe, allows for the rearrangement elements of a combination of relevant atomic repertoires to come into play, resulting in engagement in a sequence of behavior components that make up the request training procedures (Palmer, 2012). In this way, TTC may train or enhance the grain and nature of atomic repertoires resulting in effective and efficient performance transfer. The suggested relationship between coding accuracy and performance transfer appears to stand in accordance with Palmer's

behavioral interpretation of observational learning and together offer a tentative explanation of the underlying mechanisms of TTC training (Rosales et al., 2018; Eckerman et al., 2017).

Furthermore, this account of atomic repertoires stresses the importance of individual requisite atomic repertoires in combination with atomic repertoires trained by TTC, as these differences may result in differential outcomes (i.e., success and limitations) of observational learning (Palmer, 2013). As such, trainers should consider the importance of assessing incoming atomic repertoires required to facilitate successful transfer to performance (Eckerman et al., 2017; Rosales et al., 2018) in addition to the accuracy of trained repertoires.

Overall findings of the current study align with the purposed theoretical account of and preliminary research on TTC, further iterating the need for pre-assessment and/or formative assessment for the purposes of: 1) identifying prerequisite atomic repertoires that may enhance the efficiency and effectiveness of performance transfer; 2) modifying/individualizing training to ensure criterion coding (i.e., tacting) accuracy across behavioral components to optimize potential transfer of performance and; 3) adapting training to support fine-tuning of a range of relevant atomic repertoires to support performance transfer (i.e., echoic, imitative, intraverbal, etc.).

In relation, identifying current instructional features and format of TTC that appear to positively influence the effectiveness stands to inform future training design and research. First, TTC uses an operant response-shaping instructional model to train expert coding skills, which emphasizes the differential reinforcement of successive approximations to a target response class (Catania, 1998; Ray, 1995). The use of response prompting and discriminative response feedback based upon individual coding accuracy allows for the gradual shaping of coding skills with minimal errors (Ray & Ray, 2008). Additionally, the use of multiple exemplar training may

contribute to the effectiveness of TTC in terms of coding accuracy and performance transfer. Research supports the use of video modeling for teaching staff and teachers' various behavioral procedures such as discrete trial (Catania, Almeida, Liu-Constant, & DiGenarro Reed, 2009; Nosik, et al., 2013), functional analysis (Moore & Fisher, 2007), and stimulus preference assessment (Lavie & Sturmey, 2002). In relation, research findings support the use of multiple exemplar training within video modeling procedures, documenting a positive relationship between the number and range (i.e., complete sequence of behavior) exemplars depicted in the video models and the degree of performance skill acquisition (Moore & Fisher, 2007; Nosik & Williams, 2011). Given these findings, the inclusion of a range of complete video exemplars and non-exemplar likely factor into the overall effectiveness of TTC training.

Question 2

What are the comparative effects of job aids and TTC in terms of efficacy, efficiency, and usability across behaviors and phases?

Relative Effectiveness

While it is common to incorporate job aids such as procedural checklists and summary sheets into lengthier written manuals, training packages, or baseline conditions, these experimental designs do not allow for examination of the isolated effect of job aids (Palmer & Johnson, 2013; Nigro-Bruzzi & Sturmey, 2010; Severtson & Carr, 2012; Reetz, Whiting, & Dixon, 2016; McBride & Schwartz, 2003). This study extends training research through the inclusion of a job aid only condition, thereby isolating the effects of jobs aids on mand training performance accuracy as well as providing further information on the relative effectiveness of job aids and TTC training as it relates to efficacy, efficiency, and usability across behaviors and phases.

For both Level I and II, one of the three participants reached mastery criterion within the job aid only condition. Specifically, Lucy reached mastery criterion for Level I mand training components following job aid provision within four training sessions, while Nour reached mastery criterion for Level II mand training components following job aid provision within four training sessions.

An analysis of the independent effects of the job aid alone revealed that an equal number of participants required the addition of TTC training to reach high levels of performance accuracy for both Level I and II components, despite the increased complexity and length of the sequence required for accurate performance of the Level II mand training sequence as compared to Level I. Data presented by Parnell, Lorah, Karnes, & Whitby (2017) suggested a positive relationship between the need for more intrusive intervention (i.e., performance-based feedback) and the level of complexity and length of the targeted training sequence. At first glance, this study appears to conflict with this conclusion. On the other hand, looking more closely at these data, the magnitude of effect of the job aid only condition across participants and levels did vary significantly. Following the provision of the Level I job aid, Nour and Lucy's performance accuracy increased from an average baseline of 32% and 16% to 77% and 80%, respectively, immediately following job aid provision. While Layla's performance accuracy increased from an average 6% to 32%, the magnitude of effect was less significant but only slightly so. Following the introduction of the Level II job aid, Nour and Lucy's performance accuracy increased from an average baseline of 47% and 60% to 80% and 83% post job aid introduction, while Layla's accuracy remained almost unchanged (i.e., average of 68% in baseline to 65% post-job aid). Given the increased complexity and length of the Level II mand training sequence in conjunction with the decreased magnitude of change following the Level II job aid provision

as compared to the Level I job aid, results suggest that job aids may be less effective when targeting complex, lengthier behavioral sequences. These results do appear to align with the results presented by Parnell et al. (2017). However, comparative effects of job aids across levels should be interpreted with caution given higher Level II baseline averages and, in effect, the potential for ceiling effects.

While the multi-components design does not allow for evaluation of the independent effects of TTC apart from job aid provision, it enables a comparison of the effects of job aid only versus job aid plus TTC training. All participants requiring Level I and/or II TTC training after failing to reach mastery criterion within the job aid only training condition, performed corresponding mand training procedures with high levels of accuracy immediately following the TTC training. The only exception was Nour who demonstrated 70% performance accuracy in the initial session following Level I TTC training before her percentage accuracy increased to 97% and remained above mastery criterion levels for the remainder of the study. Low initial accuracy was due to placement of stimuli. In the initial session following TTC, Nour moved the preferred items from the shelf and placed them on the table, putting them within reach of the confederate. Therefore, 72% of errors were errors of contriving motivation, as the items were not out of reach of the participant. During subsequent sessions, Nour left the items on the shelf (i.e., out of reach of participant). Overall, when job aid provision alone did not suffice, supplementing job aid provision with TTC training resulted in immediate improvement of performance accuracy to high levels across participants in role-play performance sessions regardless of post job aid accuracy levels (i.e., pre-TTC training).

Efficiency and Usability

Given the practical variables that influence training selection, comparative efficiency and usability of the two training methods warrants consideration. Participants required an average of 323 minutes (i.e., about 5 hours, 20 minutes) training time to reach high levels of fidelity in the role-play sessions (range, 212-428 minutes). Specifically, job aid provision took only 10 minutes and provided participants with brief written and oral instructions. Job aid introduction did not require any active participation from the trainee. Certification for Level I TTC training required an average of 2 hours and 20 minutes and certification for Level II TTC training required an average of 2 hours and 10 minutes to complete. However, TTC training combined written/oral instruction, explicit programming of video models, multiple exemplars and non-exemplars, immediate feedback, adaptive response prompts, and precise data collection. TTC training required participants to use basic computer skills such as using the keyboard and logging in and out of the TTC program.

As research evaluating method for training staff to conduct mand training using the iPad® as a SGD with the application Proloquo2go™ has not yet been conducted, we cannot compare training duration across studies. However, research on training staff to implement behavioral communication training procedures such as incidental teaching, vocal mand training, or Picture Exchange Communication System (PECS) report a range of total training times and vary in terms of professional involvement. For example, Mcolluch and Noonan (2013) trained staff to implement vocal mand training with high levels of fidelity using interactive computer training in fewer than three 60-minute trainings sessions, while research documenting successful use of behavioral skills training (BST) for train staff to implement PECS procedures report training times ranging from 30 to 208 minutes per trainee (Rosales, Stone, & Rehfeldt, 2009;

Homilitas, Rosales, and Candel, 2014). Furthermore, Madzharova and Sturmey (2012, 2015) reduced the number of BST training components, using only video modeling and feedback, to successfully train caregivers to implement mand training with total training durations of less than 100 minutes. Finally, Robinson (2011) trained four paraprofessionals to implement Pivotal Response Training (PRT) using an in-vivo modeling and video feedback training program in an average of 91 minutes per participant (range = 50–115 min). Exact amount of professional involvement during training was rarely specified for these studies; however, Robinson (2011) did report that professional involvement was required for entirety of the training sessions. As discussed earlier, implementation of BST strategies including feedback, in-vivo modeling, instruction, and rehearsal typically require a greater time commitment from a qualified behavioral consultant than using computer or video-based instruction to accomplish BST strategies (Ahearn & Tiger, 2012).

While provision of job aids followed by TTC required lengthier training times than more recent studies evaluating methods for training staff to perform behavioral communication training procedures, the current training sequence required little to no professional involvement once the TTC programs are created. Job aid provision and TTC program introduction would not require the involvement of a Board Certified Behavior Analyst™ (BCBA) or related professional, which stands to lower training costs, reduce delays in staff training, ensure demonstration of identical and accurate procedural models, and enable flexible training schedules and locations (Parsons et. al., 2012). However, it should be noted that TTC training program creation was time intensive as it involved: 1) collection of hundreds of video examples and non-examples of each behavioral components, 2) initial editing each video sequence using video editing software, 3) coding, sequencing, and further editing of selected video exemplars

using the TTC software, and 4) design of behavioral taxonomy and associated definitions. Time will vary depending on the skill level of the developer and technological resources available. A cost/benefit analysis that considers the number of staff requiring training and development/design costs should be conducted per individual school or training setting.

Performance Analysis

A range of factors and functions influence the effectiveness and efficiency of training methods. Based on these data, the effects of TTC appears rather consistent across participants, while the effects of job aids varied across participants. Although not specifically evaluated, staff characteristics such as English language proficiency and computer competency may have contributed to the variance in efficacy and efficiency of interventions. Specifically, Nour and Lucy demonstrated significant improvements following Level I and II job aid provision (increase of 45% and 65% from baseline to post-job aid for Level I, respectively; increase of 33% and 23% from baseline to post-job aid for Level II, respectively), Layla's performance accuracy increased by only 26% following Level I job aid provision and remained unchanged as compared to her Level II baseline average, following Level II job aid provision. Although English was the second language of all the participants, as noted in Appendix B, Layla's English language proficiency appeared more limited than the other two participants as evidenced by the frequency of questions regarding vocabulary and required repetition of instructions. The purpose of a job aid, a written form of task clarification, is to clarify expectations and provide precise specification of behavioral components to alter the form and frequency of targeted behavior (Anderson, Crowell, Hantula, & Siroky, 1988). However, if terminology and directions contained within the job aids proved difficult, the effects of the job aid would presumably be limited even if the performance deficit was a function of unclear expectations, which may have

contributed to the lesser effect of the effects of job aids for Layla. English language proficiency may have influenced the efficiency of training for all participants, specifically TTC training. Although an attempt to simplify language and utilize clear, concise definitions, the TTC behavioral taxonomy did include terms such as correspondence check, error correction, and contrive motivation, which may have been challenging for participants depending on their actual level of English Language proficiency. As English was a second or third language for all participants and a formal language assessment was not administered, it is not possible to draw any clear conclusions based on the current data.

In addition, computer competency may have impacted the efficiency of the TTC training. Although differences between total time across participants was not greater than 20 minutes, Nour, the participant that appeared most comfortable with computer usage (i.e., could complete log-in and TTC requirements without questions), required the least amount of time to complete TTC training. However, given the limited number of participants completing both TTC training programs (i.e., two participants), interpretations of the data are limited, but warrant future consideration.

The varying levels in efficacy across interventions and participants may have resulted from differing or combined functions of performance discrepancies. Although an informal analysis of performance, completed prior to designing intervention, suggested that lack of clear expectations and/or information regarding quality of individual performance may be responsible for performance problems, this study did not formally evaluate the function of the performance discrepancy for each individual (Mager & Pipe, 1997). Operant models for conducting performance analysis involves the identification of controlling antecedent and consequence variables to hypothesize the function of the performance discrepancy. Linking function to

treatment should be helpful in designing effective and efficient interventions and may require individualized analysis (Austin, 2000; Mager & Pipe, 1997). Discussing plausible functions of procedures in relation to hypothesized functions of performance problems serves to inform current findings as well as advise future areas of research.

While job aids are often comprised of rules that clarify operating contingencies which may control accurate performance (e.g., “once the student is attending, provide the instruction”), their effectiveness is contingent upon the individual’s rule-following repertoire as well as the assumption that the performance discrepancy exists because of unclear expectations (Schlinger & Blakely, 1987; Daniels & Bailey, 2014). Task clarification resulted in significant and immediate improvements in Lucy and Nour’s performance accuracy, but was insufficient for establishing high levels of accuracy (i.e., 90%) for Level I components (for Nour) and Level II components (for Lucy) without the addition of TTC training. This indicates that lack of clear expectations contributed significantly to these performance discrepancies; thus, job aid provision was a fast-fix strategy that provided clear instructions as to what trainees should be doing (Mager & Pipe, 1997).

For Layla, job aid provision did little to improve performance without the addition of TTC training. Earlier analysis of the TTC program suggests that Layla’s performance discrepancy may have resulted from a lack of accurate discrimination between accurate and inaccurate sequential performance of components inherent to Level I and II mand training procedures. TTC training may have effectively shaped atomic tact and intraverbal units that relations and those such that acquired skills can be transformed to corresponding listener relations during performance assessment skills related to various atomic repertoires such that acquired skills transferred effectively to listener which may have been remedied by the

completion of TTC training as suggested by significant increase in performance accuracy post-TTC training programs. A combination of performance-based feedback and sufficient video exemplars may have contributed to this skill acquisition.

Ultimately, regardless of function, provision of job aids to ensure clear expectations provides a valuable first step for jump starting performance improvement, although more comprehensive interventions that include consequence-based strategies remain critical to maintaining acquisition (Mager & Pipe, 1997). Job aids offer an unobtrusive, inexpensive, and easy to produce/introduce intervention with multiple benefits, including: 1) improving performance accuracy to some degree, possibly reducing the extent of professional involvement required; 2) reducing training delays by serving as an interim intervention prior to more comprehensive training and/or commencement of supervisor/consultant involvement, and 3) providing a tool that may allow for self-monitoring of behaviors targeted within feedback sessions or self-review following the termination of training (Daniels & Daniels, 2006; Mager & Pipe, 1997). Using a least to most intrusive approach to training, introducing TTC computer-based training on an as needed basis following job aid provision as needed appears an effective method for establishing and maintaining high levels of mand training accuracy across trainees while minimizing the involvement of a behavior specialist and the time commitment of trainees.

Question 3

Will training effects observed within role-plays with a confederate generalize to teaching sessions with a child with autism or related developmental disability?

While job aids followed by TTC proved effective for establishing high levels of performance accuracy in role play sessions, accuracy levels deteriorated during generalization probes requiring the addition of brief performance-based feedback to establish adequate levels of

accuracy in teaching sessions with a child (i.e., 78% for Layla and 81% for Nour). Errors in role-play sessions differed in type and consistency as compared to errors made during generality probes (i.e., teaching sessions with a child with autism), which likely resulted from increased distraction, faster pace, and less predictability. Errors during generalization probes appeared to be significantly influenced by in vivo conditions (i.e., child behavior, pace of session, organization of classroom). For example, both Nour and Layla appeared more likely to omit data collection when the child exhibited high rates of child manding, touching the device, and grabbing target items. Furthermore, participants reported that the high frequency of device touching made it difficult for trainees to identify a motivating operation for a target item versus the iPad®, and thus the accurate mand training sequence, which increased errors in delivering reinforcement and error correction. Also, Heddy (i.e., the child paired with Nour) almost immediately began independently/accurately selecting the picture icon on the device and unexpectedly navigating folders on the iPad®, which appeared to lead to errors in device presentation.

Training research suggests that a decrease in performance accuracy following the transition from a training environment to the natural environment is common at least initially; however, the magnitude of reduction varies considerably across studies and participants (Nosik, Williams, Garrido, & Lee 2012; Pollard, Higbee, Akers, & Brodhead, 2014). Characteristics associated with the natural environment (i.e., behaviors and factors that trainees had not observed/practiced before) likely attributed to errors on procedural steps that rarely occurred during role-play sessions.

Although a clear pattern did not exist across participants in the types of generality probe errors and TTC coding accuracy as observed in the role-play performance probes potentially due

to the variability of the natural environment and diverse child participants, Layla's performance errors during the first Level I post-training teaching session with a child (i.e., generality probe) revealed a similar pattern to the one observed in her role-play sessions with a confederate. As discussed earlier, participants demonstrated persistent, consistent errors in identifying an "Incorrect Response" within TTC Level I Program 1, and discriminating between Incorrect Response+Error in Error Correction and Incorrect Response+Error Correction in Program 2. During the initial Level I teaching session (post-TTC, but prior to feedback), Layla demonstrated more errors on the performance checklist step that involved performing error correction procedures, the step corresponding with INCRS, IR+ErrEC, and IR+EC than any other step in the TTC taxonomy just as she did in the role-play sessions with a confederate. These results align with results of the current study presented earlier and the preliminary findings of Rosales, et al. (2018) suggesting that the individual accuracy of a trainee's observation skills may control the transfer of those same behavioral components to accurate performance.

While a similar pattern was noted in Nour's performance error analysis for Level I role-play sessions, Nour only had to perform error correction procedures in one mand training trial during her initial Level 1 teaching session (i.e., generality probe) and twice in her second teaching session as Heddy immediately and consistently selected the icon on the screen with enough force to activate the speech synthesized output. Interestingly though, her errors may still support a relationship between accurate identification of behavioral components (i.e., TTC coding accuracy) and performance accuracy of those same behavioral components. Although Nour demonstrated the highest percentage of performance errors on the data collection step, she also performed the contriving motivation and the device preparation step with only 70% accuracy. Interestingly, participants demonstrated the second lowest coding accuracy on the

device preparation step on the TTC taxonomy for Level I TTC (Program 1) when analyzing the final 10 errors per participants. Furthermore, Nour's coding data for Level I TTC (Program 2) revealed an overall coding accuracy of 74% for all initial coding opportunities during training, the lowest accuracy percentage relative to the other six TTC codings. While Nour did not demonstrate errors on these steps as frequently during role-play sessions, a relative weakness in the performance of these behavioral components may still have existed, becoming more evident during teaching session with a child (i.e., generality probes) as a function of additional variables associated with the natural environment.

On the other hand, despite high coding accuracy of the data collection step in the TTC taxonomy, Layla failed to collect data in the second Level I generality probe resulting in significantly low performance accuracy of the data collection step of the performance checklist. Similarly, Nour consistently coded data collection, yet failed to collect data for all mand training trials the first Level I teaching sessions. Low performance accuracy of this step may have resulted from the increased pace of mand training trials, as discussed above. As soon as one trial ended, the child participants consistently reached for another item; whereas, the time for data collection was provided before the confederate motivation for a new item during role-play sessions.

Ultimately, the natural environment is not as controlled and consistent as the training environment and, in effect, relationships and data appear less clean as the results of the increased number of variables at play. In other words, performance errors in generality probes may have been a function of both coding accuracy and supplemental variables associated with naturalistic teaching conditions. The differences in error patterns between role-play and teaching sessions as they relate to TTC coding accuracy may help trainers identify examples of stimulus conditions

and child/teacher responses that should be included or better trained to optimize successful programmed generalization, as performance transfer to the natural teaching environment is the ultimate goal. Research supports actively programming for generalization through strategies such as multiple exemplar training (i.e., providing sufficient exemplars; Stokes & Baer, 1977; Baer, Wolf, & Risley, 1966; Moore & Fisher, 2007). TTC holds the capacity to provide trainees with wide variety of video exemplars, but ultimately it is the person recording and selecting the footage that controls the nature of the selected video exemplars used within the TTC program. While common staff errors informed the selection of video exemplars used in the current study (i.e., inclusion of child participants attempting to touch preferred items, demonstrated lack of motivation), current data and existing research base suggest that further diversification of child behaviors and settings (i.e., enhanced multiple exemplar training) of video exemplars may maximize generalization to the natural environment (Ducharme & Feldman, 1992; Stokes & Baer, 1977; Moore & Fisher, 2007; Horner & Sturmey, 2008; Burns, Egan, Kunkel, McComas, Peterson, et. al, 2013).

Overall, training effects did generalize to the natural environment although a brief session of performance-based feedback was required to establish adequate accuracy of mand training components. While accuracy levels during generality probes failed to reach post-training criterion (i.e., 90%) most performance errors resulted from failure to collect data rather than other core components such as contriving motivation, error correction, and reinforcement. Still, given the research indicating that: 1) skill-acquisition programming should be implemented with complete accuracy to optimize outcomes and 2) errors in implementation of mand training procedural components negatively impact mand acquisition in early learners, attention should be given to eliminating or at least minimizing all performance errors (Carroll, Kodak, & Fisher,

2013; DiGenarro, Martens, & Kleinmann, 2007; Pence and St. Peter, 2015). Based on closer analysis of Level I generality probe data in conjunction with TTC video exemplars, role-play scripts, and characteristics of the natural environment as it relates to mand training with a child with autism or a developmental disability offered potential steps for actively addressing reductions in accuracy observed following the transition to the natural environment. It should be noted that the results should be interpreted with caution as only two teacher-child dyads participated in post-training Level I generality probes. Furthermore, Level II generality probes could only be conducted for one teacher-child dyad, prohibiting clear conclusions regarding generalization.

Question 4

What is the acceptability and perceived effectiveness (i.e., social validity) of the training as rated by the trainees?

A survey was distributed to the three teacher participants to measure the social validity of the training procedures. Overall, teachers had a positive reaction to the training approach, reporting that they liked the training procedures and would be willing to use job aid and TTC again to learn to perform/code new procedures. Participants believed the training procedures were effective in establishing/maintaining personal performance of request training procedures. As a group, the teachers agreed that the training procedures were an acceptable way of training staff to implement request training procedures, all participants agreed that staff would be willing to participate in this type of training, but felt that trainee consent should be obtained before implementing training procedures. While most participants identified the training procedures as non-disruptive, one participant remained neutral. Similarly, most participants remained neutral when asked if the training procedures were associated with undesirable side effects, while one

participant agreed that associated undesirable side effects did exist. There are a couple of implications to these responses.

First, direct observation and survey results suggested that the training approach was likely associated with some degree of negative side effects. While these responses are not surprising given the added demands and time commitment of any training conducting during the regular school day, they are important to consider when designing the training environment and schedule. Completion of TTC training sessions required that participants be absent from their classroom for a 30 to 45-minute block 2 to 3 times per week; hence, finding an acceptable slot of time when schedules are already very busy was sometimes difficult. Furthermore, TTC required sustained focus and attention, which was reportedly difficult at times due to/ influence environment distractions (i.e., classroom noise, people in an out of training room, etc.) or motivating operations (lack of sleep, excess of work demands/responsibilities). However, all trainees did report a willingness to participate in this type of training again, which suggests that trainees felt that the long-term benefits outweighed the short-term inconveniences associated with the training.

Question 5

Are the teaching procedures (modified and abbreviated from Lorah, 2016) effective for establishing a mand repertoire in children diagnosed with ASD?

Due to the limited number of generality probes conducted (i.e., teaching sessions with a child), results should be interpreted with caution. Two Level I teaching session probes were conducted for Lara (paired with Layla) and Heddy (paired with Nour). Teaching session data (i.e., generality performance probes) indicate that the teaching procedure, which used a constant time delay with full physical prompting, documented significant increases in level of: 1) number

of mand trials per session; and 2) the percentage of independent mands using the iPad® as a SGD with the application Proloquo2Go™. Neither participant independently manded for using the iPad® during Level I baseline and zero mand training trials occurred. Across two Level I teaching sessions, the number of mand training trials using the iPad® increased to an average of 8.5 and 12 for Layla and Nour, respectively. By the second Level I teaching session, Lara and Heddy demonstrated 50% and 92% independence, respectively. Due to the termination of mand training using the iPad® prior to mastery of Level I mand training for Heddy, only one Level II teaching session was conducted for Lara. Lara did not independently mand using the iPad® during Level II baseline probe. During the Level II teaching session probe, Lara demonstrated 40% independence and mand training trials increased from zero to ten.

The current study adds to the literature base suggesting that a constant time delay procedure, with full physical prompts is an effective instructional method for increasing the percentage of independent child mands and the number of mand opportunities using an iPad® as as a SGD with the application Proloquo2Go™ (Lorah et. al., 2014; Lorah, 2016). While clear limitations in child data collected exist (i.e., number of participant and number of data points), the results provide preliminary data that suggest the potential efficacy for use of this instructional method in establishing manding skills for English Language Learners (ELL) students diagnosed with autism or a developmental delay.

This study attempted to evaluate the effectiveness of the instructional sequence will be derived from the phases of the mand training protocol used in a study conducted by Lorah (2016), evaluating a discrimination training procedure to teach manding using an iPad® as a SGD. However, given that only one teaching session probe was conducted for Level II data, it is

not possible to draw conclusions regarding the effectiveness of this instructional sequence based on the data.

Additionally, results align with the current albeit small research base indicating that improvements in accuracy of implementation of mand training procedures correlate with concomitant increases in the rate and frequency of independent manding by students (McColluch & Noonan, 2013; Nigro-Bruzzi & Sturmey, 2010; Pence & St. Peter, 2015).

Question 6

Will training effects maintain over time (i.e., one-month probes)?

One-month maintenance probes indicate that the training effects for both Level I and II mand training procedures maintained across all participants. These results indicate that training procedures were successful for establishing and maintaining high levels of fidelity in a training setting even after training procedures had been terminated.

None of the studies investigating the observing and evaluating (i.e., directed data collection) of video or in-vivo exemplars reported maintenance data (Hine, 2014; Thomas, 2013; Guercio & Dixon, 2011). In related ICT studies, McColluch and Noonan (2013) reported variable results across five and eight-week maintenance probes for both participants that reached 80% performance accuracy. For one participant, maintenance probes overlapped with baseline data. For the other participant, the level of performance accuracy remained near 80% at the five-week probe, but dropped to around 60% at the 8-week probe. Nosik and Williams' initial study (2011) evaluating the efficacy of ICT to train staff to implement DTI procedures reported that significant improvements in performance accuracy (i.e., 90% and above) maintained (i.e., 6-week post training) across all participants. However, the follow-up comparative study (Nosik, Williams, Garrido, & Lee, 2013) found ICT to be less effective than in-vivo BST study and

performance improvements maintained at a similar level for one participant, but failed to maintain for the other two participants albeit at levels higher than baseline (Nosik et al., 2013). The current study adds to the mixed results reported by the current research base evaluating the maintenance of training effects of both: 1) interactive computer-based training (ICT) and 2) observing and evaluating video and in-vivo models, suggesting that improvements in performance accuracy following ICT incorporating video modeling and performance assessment do maintain over time (i.e., one-month probes).

Considerations, Limitations, and Recommendations

TTC Evaluation

In relation to TTC evaluation, trainer selected parametric settings, video content, and taxonomy vocabulary highly influence the training environment and results should be interpreted with attention and consideration of these variables. While the underlying adaptive system and core components remains the same, the TTC training format and content varies significantly based on the number of codings required for changes in prompting and feedback, the number and scope of video exemplars depicting target components, and the complexity of language and length of description used within the taxonomy selected and programmed by the person creating the TTC program. Thus, the design of the current study evaluated the combined effect of the TTC adaptive training system in combination and selected mand training video content, language, and parametric settings, but did not allow evaluation of comparative effect of alternative selections aside from the results reported in the TTC error analysis. Future TTC research should investigate the impact of content and parametric variations in terms of frequency, scope, and vocabulary. More broadly, Pollard et al. (2014) noted that computer-based training designed to teach behavioral analytic teaching procedures varies widely in terms

behavior analytic theory, format, and behavioral training components (i.e., modeling, feedback, self-instruction), necessitating the evaluation and identification of critical ICT components and effective formats to establish standards for ICT design (Pollard et al., 2014).

Although overall findings are encouraging, some limitations of the current study as they relate to TTC evaluation warrant consideration. Comparative efficiency and associated variables that may influence efficiency limit the positive results of this study. Even though TTC requires little professional involvement during TTC training implementation, total training duration was longer than some related studies as discussed in detail beginning on page 83 (Madzharova & Sturmey, 2015; McColluch & Noonan, 2013; Homilitas, Rosales, and Candel, 2014).

While TTC appears conceptually sound, practical and technological characteristics of the software may impede accessibility resulting in decreased efficiency of training, especially as it relates to certain populations and locations. For example, the TTC video viewer screen is significantly smaller than the full computer screen, which made viewing the iPad® screen display difficult for Lucy due to issues with eye sight. Secondly, TTC is a computer-based program that requires consistent internet connection. Unreliable internet connection or internet signal fluctuation result in loss of data as occurred in Level II training for Layla. Specifically, when a connection/server problem occurred (as documented by TTC error reports), TTC failed to store participant coding data and level progression during that training session, which occurred on several occasions. Lastly, the description of mand training procedures often involve some degree of technical language and, without a live instructor, trainees could not ask additional questions to clarify understanding of the terminology used within the TTC program. That said, in the current study, the trainer was present and available for questions during the job aid review, and the job aid and TTC taxonomies incorporated similar terminology. Although the current

study did not specifically evaluate the impact of these variables, anecdotal data highlight the importance of examining and addressing aspects of TTC that may inhibit efficiency and effectiveness of TTC training. For example, future research could examine how training in an individual's native language affects the effectiveness and efficiency of TTC especially given the need for and importance of dissemination and growth of ABA-based intervention around the world (BACB, 2018; WHO, 2017).

Additionally, future researchers should formally assess English language proficiency as well as computer skills to determine what level of proficiency (i.e., type or range) is needed to effectively and efficiently progress through TTC training programs. While this study provides information on practical and technological issues that may impede performance, future studies should continue to identify aspects of TTC that can be modified to optimize efficiency and effectiveness as it relates to diverse populations and training locations. Furthermore, further evaluation and identification of individual characteristics and/or associated pre-requisite skills (computer skills, language proficiency, etc.) that support or limit effectiveness of various training approaches such as TTC training will allow trainers to select and design more efficient and effective training packages.

Also in relation to TTC evaluation, the current study did not evaluate entry-level skills that may facilitate effective and efficient transfer of coding skills to performance skills. Eckerman et al. (2017) suggests that future TTC research begin to assess and identify pre-requisite abstract verbal relations such as bi-directional tacting, listener relations, and/or delayed self-echoic behavior) that may be crucial in successfully transforming the skills taught by TTC to performance. Using Palmer's theory of atomic repertoires as a framework, future researchers should investigate ways to examine the covert behavior of trainees during TTC training and post-

training performance probes to identify the mediating behaviors and mechanisms underlying observational learning and performance transfer (Eckerman et al., 2017).

Maintenance Assessment

Limitations related to the evaluation of job aids followed by TTC training should also be considered. Although one-month maintenance probes rendered an adequate measurement of short-term maintenance, future research should evaluate long-term maintenance probes. It would be interesting to investigate participant use of the job aids post-training, and if so, did that usage correlate with maintenance of mand training performance accuracy. Future research could also evaluate the use of TTC for periodic review of mand training procedures to ensure performance maintenance, especially considering that professional involvement would be unnecessary.

Generalization Training and Assessment

Additionally, a limited number of generalization probes were conducted. While one to two generalization probes were conducted for Level I and II for two out of three participants, further investigation of the generalized training effect are warranted. Furthermore, future research should evaluate the impact of scope and selection of included video exemplars as they relate to the natural training environment and common child behaviors on generalization of training effects.

Child Performance Assessment

While data evidence teacher performance change, limited child performance data were collected due to time constraints (i.e., teacher schedules; teacher-student ratio) and child-related variables (i.e., sickness, absence). Future research should evaluate the relationship between child mand acquisition and mand training performance accuracy as it related to mand training using the iPad® as a SGD. Child performance data would also allow for: 1) further evaluation of the

effectiveness of the mand training procedures using the iPad® as a SGD with Proloquo2go™ and 2) extension of the research to child participants for whom English is a second language as well as child participants from countries other than the United States.

Practical Implications

The practical consequences of the current study as it relates to the the current situation in and context of Egypt and other developing countries should be considered given the essential value of feasible application, social and culatural validity, and potential applied impact.

The prevalence of ASD is increasing, with recent estimates suggesting that 1 in every 59 individuals are diagnosed with the disorder (Center for Disease Control [CDC], 2017). ASD affects approximately 1% of the global population regardless of geographic region, socioeconomic status, or cultural factors (Elsabbagh, 2012; Wallace, 2012). While large epidemiological prevalence studies from Egypt have not been conducted, preliminary reports in conjunction with global prevalence statistics suggest that anywhere between 300,000 and 500,000 of Egyptian school-age children have autism (Seif eldin et. al, 2008; CDC, 2017, World Health Organization, 2017).

Despite the high number of Egyptian youth affected by autism, access to effective, evidence-based treatment remains highly limited in terms of quantity, quality, and accessibility (Mendoza, 2010; Samadi & McConkey; Taha & Hussein, 2014). Results of large-scale systematic reviews of interventions for children with ASD clearly identify ABA-based interventions as the most empirically supported treatment for individuals with ASD (National Autism Center, 2015; Wong et. al, 2014); however, a severe deficit in local professionals trained to implement and supervise ABA exists, highly restricting the provision of quality ABA services and intervention in Egypt. Moreover, the Behavior Analyst Certification (BACB) identifies only

three Board Certified Behavior Analysts™ (BCBA) and three Assistant Behavior Analysts™ (BCaBA) located in Egypt, a country with a population of around 100 million people.

While various factors such lack of autism awareness and accurate information, cultural stigma, and limited financial and community resources contribute to the paucity of ABA-based interventions in Egypt, a scarcity of well-trained, knowledgeable teachers, staff, and therapists stands fundamental to this issue (Taha & Hussein, 2014; Samadi & McConkey, 2011). Ensuring high-quality, affordable, and accessible training in ASD and ABA-based intervention in a country where BACB certificants qualified to implement and supervise ABA treatment are few is undoubtedly challenging. However, recent methods (i.e., computer-based training and video modelling) for embedding and implementing traditional behavioral skills training approaches (i.e., instruction, performance-based feedback, modelling, and role-play) hold promise for countries facing personnel, financial, and geographical constraints.

Specifically, job aids followed by TTC negates many of these training issues while also offering a way of embedding a variety of evidence-based behavioral training procedures within an accessible, cost-effective, easy to implement, least intrusive training approach. While limitations including duration of training, technical issues, and TTC program creation time should be considered, potential and practical benefits of the training approach in countries facing barriers like those of Egypt appear to outweigh those limitations. Aside from initial TTC creation by a BCBA, job aids followed by TTC holds potential as an accessible and affordable way to train a large population of professionals and family members with limited professional (i.e., BCBA, BCaBA) involvement.

Furthermore, the translation of job aids and TTC programs to Arabic and other local languages could extend training access to an even larger portion of the population. Job aids

followed by Train to Code could be used to train a variety of skills in appropriate sequences based on the need of the local population. For example, doctors lack specialized training on diagnostic procedures (Johnson, 2014; Taha & Hussein, 2014). Moreover, the training sequence could be modified/individualized in terms of technical vocabulary, prompt levels, and video exemplars to align with culture, education level, and technological skills of the targeted population (i.e., parents, teachers, doctors).

The BACB and the Association of Behavior Analysis International (ABAI) prioritizes the dissemination and growth of behavior analysis around the world. While all children should have access to services and intervention proven to be effective in diagnosing and treating autism, provision of effective ABA-intervention is contingent upon access to effective, feasible training methods (Johnson, 2014). Moving forward, researchers should prioritize further research on practical training methods such as job aids followed by TTC with recognition of country-specific cultural and social values and sensitivities, as well as associated financial, geographic, and personnel barriers.

Summary

Despite these limitations, the current investigation demonstrated that job aids followed by Train to Code training was effective in establishing high levels of mand training accuracy in the training environment. Although participants demonstrated an initial reduction in accuracy when transitioning to performance in the natural environment, a minimal amount of feedback was needed to establish adequate levels of performance accuracy (i.e., above 80%) which suggests that this combination of procedures has potential for training staff to implement mand training procedures using the iPad® as a SGD with high levels of accuracy, especially when common

barriers such as time and funding constraints, geographic isolation, and/or limited professional involvement or expertise inhibit the use traditional behavioral training approaches.

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Appendix A

TTC Screen Shots

TTC EL Training

Training Level 1
Current Accuracy Score is 100 % for Your Most Recent 1 Codings

Feedback
Correct Coding!
Press Spacebar to Continue Play

Behavior Frequency Count	
Video Length = 13 min 58 sec	
Number of Occurrences	
EPNE (1)	
PNE (2)	1
PFNE (3)	
PwE (4)	
PPwE (5)	
NPNE (6)	
NPwE (7)	

3:35 / 6:12

Training Level 1
Current Accuracy Score is 100 % for Your Most Recent 4 Codings

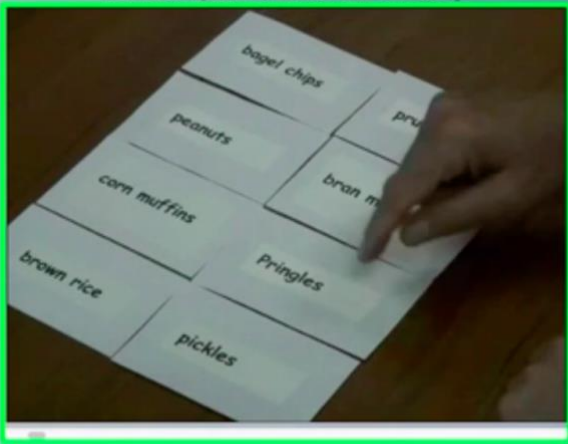
Behavior Frequency Count	
Video Length = 13 min 59 sec	
Number of Occurrences	
EPNE (1)	
PNE (2)	3
PFNE (3)	
PwE (4)	
PPwE (5)	
NPNE (6)	1
NPwE (7)	

NPwE (7) = No Prompt with Error

54:07

Figure A1. Screen shots depicting trainee view of Train to Code software.

Training Level 1
Current Accuracy Score is 0 % for Your Most Recent 0 Codings



Behavior Frequency Count
Video Length = 13 min 59 sec
Number of Occurrences

EPNE	[1]	
PNE	[2]	
PFNE	[3]	
PwE	[4]	
PFwE	[5]	
NPNE	[6]	
NPwE	[7]	


Replays Behavior

Hit Spacebar to Pause!

38:00

TTC EL Training

Training Level 1
Current Accuracy Score is 100 % for Your Most Recent 2 Codings



Feedback
You failed to Pause and Code!
Press Spacebar to Learn to Pause...

Behavior Frequency Count
Video Length = 13 min 59 sec
Number of Occurrences

EPNE	[1]	
PNE	[2]	1
PFNE	[3]	
PwE	[4]	
PFwE	[5]	
NPNE	[6]	
NPwE	[7]	

Replays Behavior

Hit Spacebar to Pause!

3:57 / 6:12

Figure A2. Screen shots depicting trainee view of Train to Code software.

Appendix B

Participant Demographic Information

Table B1

Teacher Demographic Information

Teacher	Age	Education	First Language	Duration Employed
Layla	51	A- Levels		5 years, 3 months
Lucy	54	B-Tech National Diploma in business studies and finance	Welsh	1 year, 10 months
Nour	33	BS in commerce and business administration	Arabic	3 months

Table B2

Child Demographic Information

Name	Age	First Language	Diagnosis	Communication Modality
Lara	5.0	Arabic	Autism	One word (often unintelligible) and Sign Language (5-10 signs)
Heddy	2.5	Arabic	Developmental delay	Gestures

Appendix C

Level I Job Aid and Flowchart

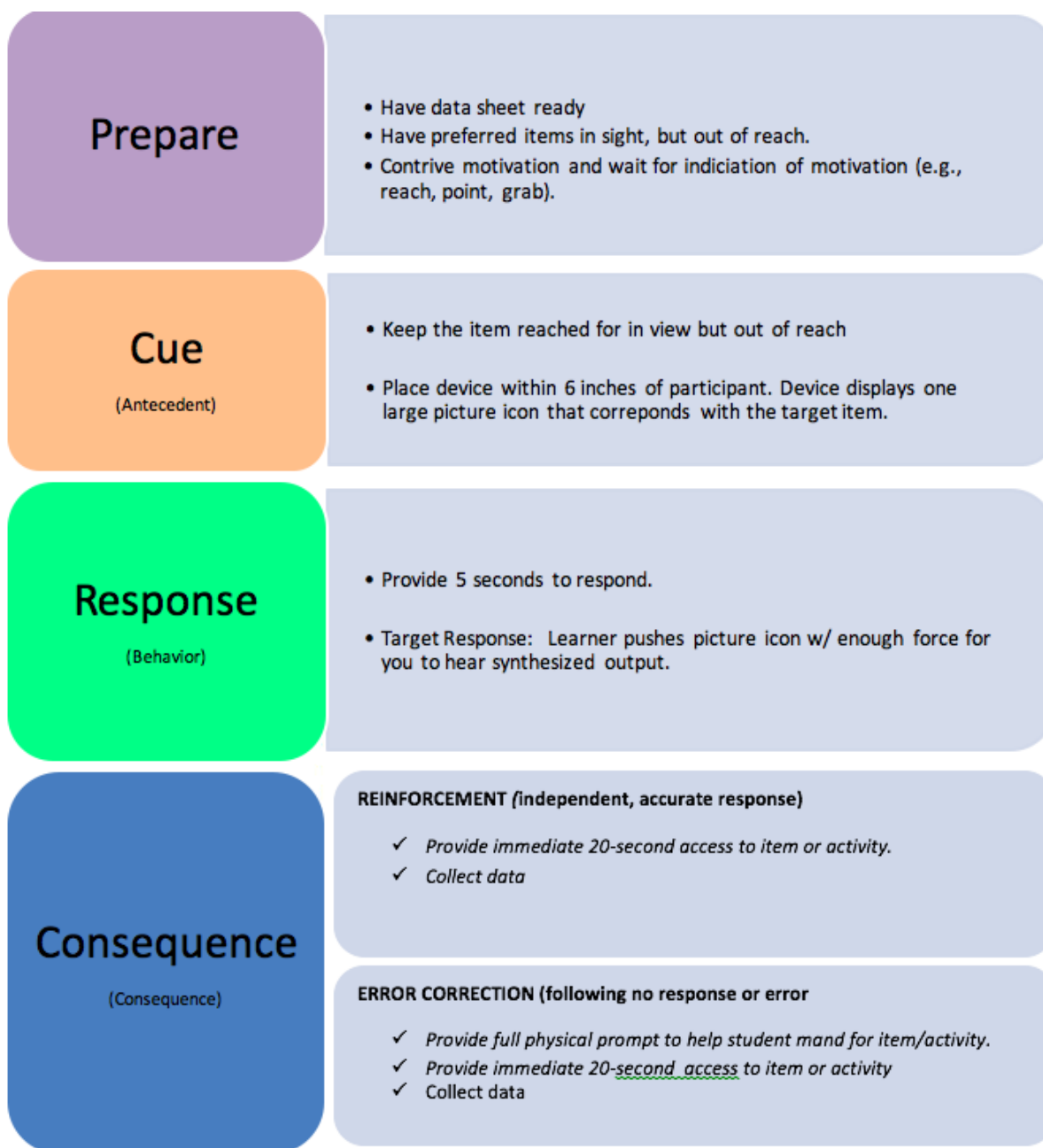


Figure C1. Level I Job Aid.

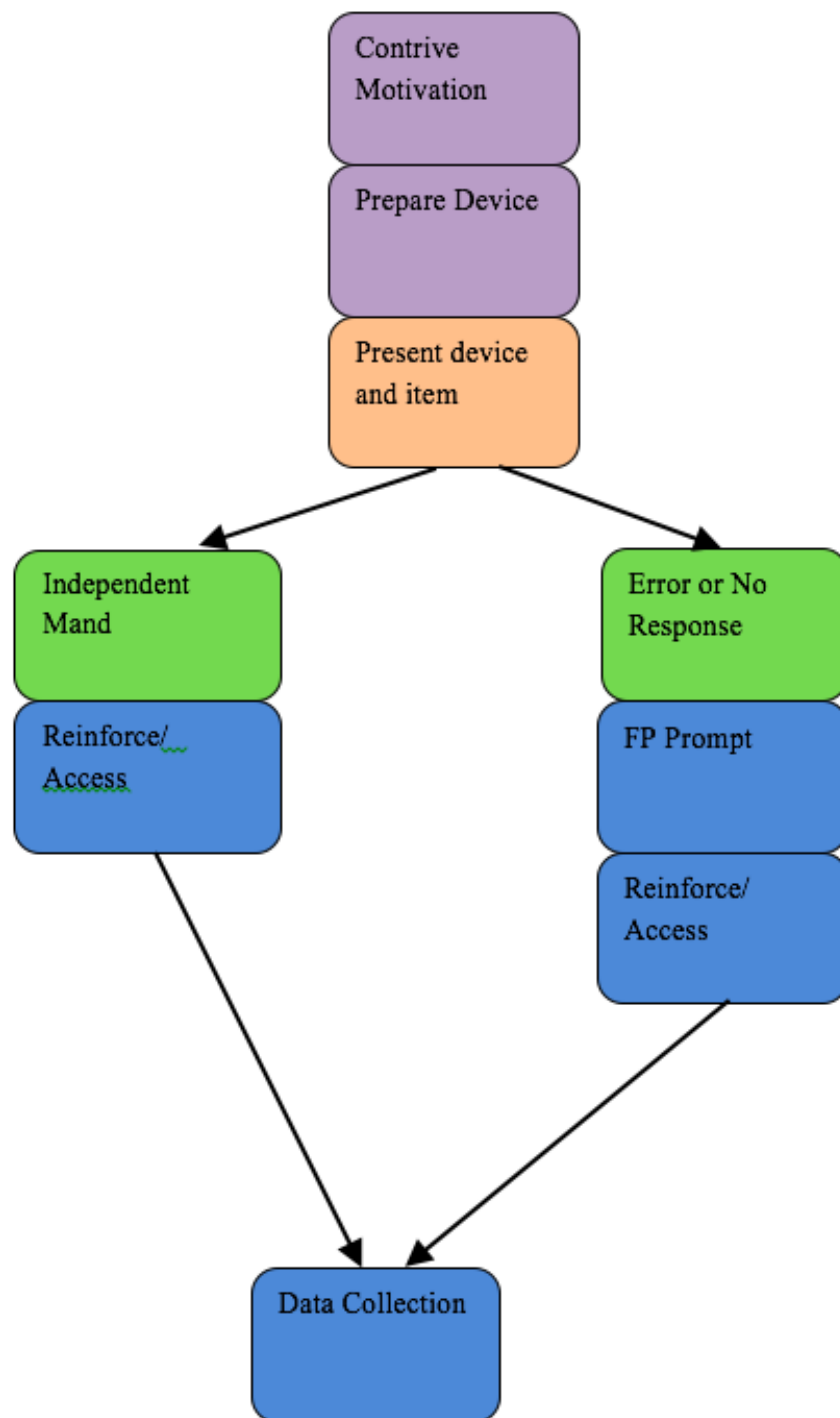


Figure C2. Level I Flowchart.

Appendix D

Level II Job Aid and Flowchart

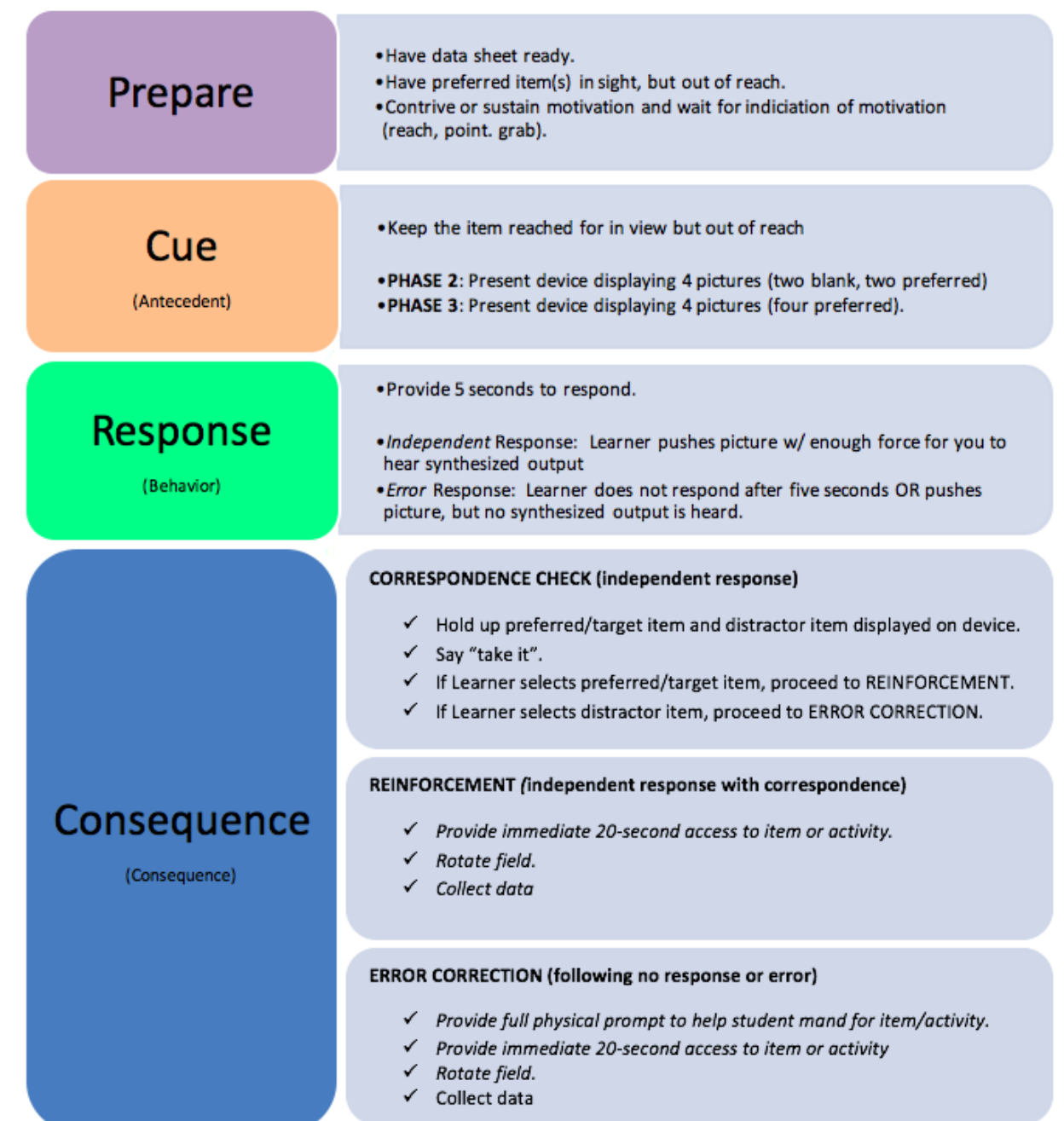


Figure D1. Level II Job Aid.

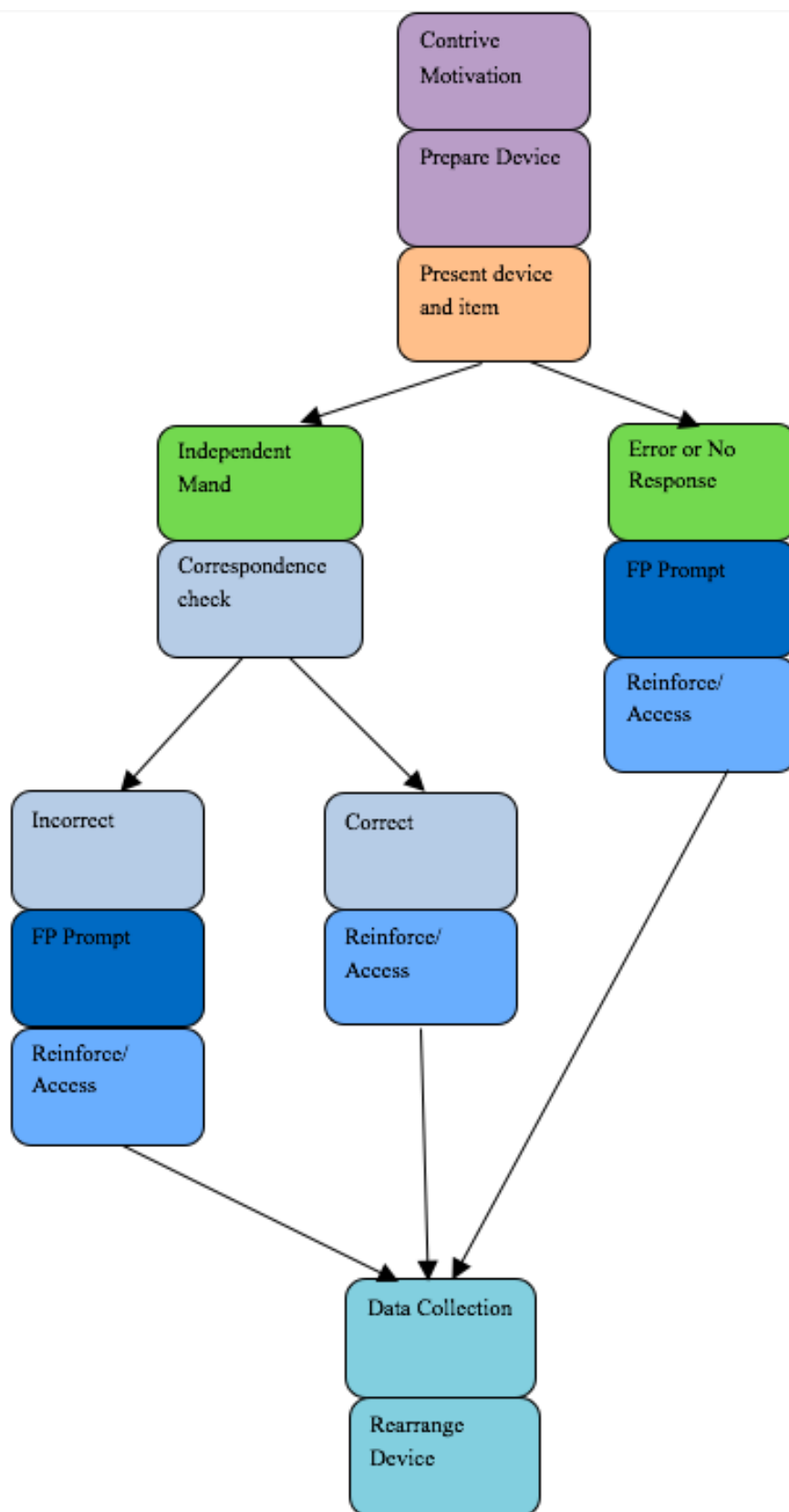


Figure D2. Level II Flowchart.

Appendix E

TTC Components, Codes, and Definitions

Table E1. TTC Level I (Program 1) components, codes, and definitions.

Behavioral Components	Codes	Operational Definitions
Error in Device Presentation	ErrDP	iPad not placed within 6 inches of the learner. AND/OR iPad screen did not contain one picture-symbol, which filled the entire screen of the device.
Contrive Motivation	MO	Therapist holds target item held in sight, but out of reach of the learner AND Learner demonstrates some form of pre-linguistic behavior (i.e., reach, point) indicating motivation is in place. **If Learner selects icon accurately and immediately, motivation is assumed if child takes the item when delivered.
Error in Contriving Motivation	ErrMO	Therapist provides prompt when the learner did NOT demonstrate pre-linguistic behavior (i.e., reach, point) indicating motivation was in place. AND/OR Therapist allows learner to touch target item prior to manding. **If Learner selects icon accurately and immediately, motivation is assumed if child takes the item when delivered.
Accurate, Independent Mand	MAND	Learner presses the picture on the screen of the device with enough force to evoke the synthesized speech output (without any prompt) within 5 seconds of indicating motivation (i.e., prelinguistic behavior in the form of a reach or point).
Incorrect Response	INCRS	Learner fails to press the picture-symbol within 5 seconds of indicating motivation. OR Learner fails to press the picture symbol with enough force to evoke the synthesized output.

Table E2. TTC Level I (Program 2) components, codings, and definitions.

Behavioral Components	Codes	Operational Definition
Error in Program 1 Components	ErrPC	iPad not within than 6 inches the learner (iPad presentation). OR iPad screen did not one picture-symbol, which filled the entire screen of the device (iPad presentation). OR Therapist provides prompt prior to an indication of motivation (contrive motivation). OR Learner touches/grabs target item prior to mand (contrive motivation).
Independent, accurate mand + Reinforcement	M+R	Learner presses the picture-symbol on the screen of the device with enough force to evoke the synthesized speech output (without any prompt) within 5 seconds of indicating motivation (i.e., prelinguistic behavior in the form of a reach or point). AND Therapist delivers the target item within 1 second of the learner mand.
Independent, accurate mand + ERROR in Reinforcement	M+ErrR	Learner presses the picture-symbol on the screen of the device with enough force to evoke the synthesized speech output (without any physical, gestural, or vocal prompts) within 5 seconds of indicating motivation (i.e., prelinguistic behavior in the form of a reach or point) (INDEPENDENT, ACCURATE MAND). AND Therapist fails to deliver the target item within 1 second of the learner mand (ERROR IN REINFORCEMENT).
Incorrect Response+ Error correction	IR+EC	Learner fails to press the picture-symbol within 5 seconds of indicating motivation (INCORRECT RESPONSE) OR Learner fails to press the picture symbol with enough force to evoke the synthesized output (INCORRECT RESPONSE) AND Therapist uses a full physical prompt to evoke the learner mand and delivers item within one second of learner mand (ERROR CORRECTION).
Incorrect Response+ ERROR in Error correction	IR+ErrEC	Learner fails to press the picture-symbol within 5 seconds of indicating motivation (INCORRECT RESPONSE) OR Learner fails to press the picture symbol with enough force to evoke the synthesized output (INCORRECT RESPONSE) AND Therapist uses LATE (greater than 5 second latency) or EARLY (shorter than 5 seconds latency) to evoke the learner mand following indication of motivation. OR Therapist provides prompts other types of prompts (vocal or gestural).
Data Collection	DC	Therapist collects data on data sheet following the end of the trial.
Data Collection Missing	NoDC	Therapist fails to collect data following the end of the trial.

Table E3. TTC Level I (Program 2) components, codes, and definitions.

Behavioral Components	Codes	Operational Definition
Error in Program ½ Components	ErrPC	iPad not within than 6 inches the learner (iPad presentation). OR iPad screen did not one picture-symbol, which filled the entire screen of the device (iPad presentation). OR Therapist provides prompt prior to an indication of motivation (contrive motivation). OR Learner touches/grabs target item prior to mand (contrive motivation). OR Therapist uses LATE (greater than 5 second latency) or EARLY (shorter than 5 seconds latency) to evoke the learner mand following indication of motivation (error correction). OR Therapist provides prompts other types of prompts (vocal or gestural) (error correction). OR Therapist fails to collect data following the end of the trial (data collection).
Independent, accurate mand + Correspondence Check	M+CC	Learner presses the picture-symbol on the screen of the device with enough force to evoke the synthesized speech output (without any prompt) within 5 seconds of indicating motivation (i.e., prelinguistic behavior in the form of a reach or point). AND Therapist holds out (at equal distance from the learner) two preferred items (one being the item just selected) represented on the screen of the iPad®. Therapist can, but does not have to say “take one”.
Independent, accurate mand + ERROR in Correspondence Check	M+ErrCC	Learner presses the picture-symbol on the screen of the device with enough force to evoke the synthesized speech output (without any physical, gestural, or vocal prompts) within 5 seconds of indicating motivation (i.e., prelinguistic behavior in the form of a reach or point) (INDEPENDENT, ACCURATE MAND). AND Therapist fails to conduct a correspondence check (ERROR IN CC) OR Therapist presents items at unequal distance from learner (ERROR IN CC) OR Therapist presents item not respresented on the iPad (ERROR IN CC)
Correspondence + Reinforcement	C+R	Learner reaches for the preferred item that corresponds with the picture symbol selected on the screen of the iPad (CORRESPONDENCE) AND Therapist delivers the target item within 1 second of the learner mand (REINFORCEMENT)
Correspondence + ERROR in Reinforcement	C+ErrR	Learner reaches for the item that corresponds with the picture symbol selected on the screen of the iPad (CORRESPONDENCE) AND Therapist fails to deliver the target item within 1 second of the learner mand (ERROR IN REINFORCEMENT). OR Therapist delivers the other item rather than the item for which the learner reached (ERROR IN REINFORCEMENT)
No Correspondence + Error Correction	NoC+EC	Learner reaches for the item that DOES NOT correspond with the picture symbol selected on the screen of the Ipad. (NO CORRESPONDENCE) AND Therapist uses a full physical prompt to evoke the learner mand (ERROR CORRECTION) and delivers item within one second of learner mand.
No Correspondence + ERROR in Error Correction	NoC+ErrEC	Learner reaches for the item that DOES NOT correspond with the picture symbol selected on the screen of the Ipad. (NO CORRESPONDENCE) AND Therapist delivers the item that does not correspond with picture symbol selected on the iPad. OR Therapist provides prompts other types of prompts (vocal or gestural).
Missing Field Rotation	NoFR	Therapist fails to rotate the pictures on the screen of the device.

Appendix F

Phase-specific Components

Table F. Mand Training Phase-specific Components

Phase	Steps
Phase 1	<ol style="list-style-type: none"> 1. Device presentation and preparation (<i>Field size= 1 item</i>) 2. Contrive/sustain motivation 3. Reinforcement or Error Correction
Phase 2	<ol style="list-style-type: none"> 4. Collect Data 1. Device presentation and preparation (<i>Field size= 4 pictures (two preferred, two blanks)</i>) 2. Contrive/sustain motivation 3. Learner Mand + Correspondence Check (CC) <ol style="list-style-type: none"> a. CC accurate + Reinforcement b. CC inaccurate + Error Correction 4. Learner Error + Error Correction 5. Data collection 6. Field Rotation
Phase 3	<ol style="list-style-type: none"> 1. Device presentation and preparation (<i>Field size= 4 pictures (four preferred)</i>) 2. Contrive/sustain motivation 3. Learner Mand + Correspondence Check (CC) <ol style="list-style-type: none"> a. CC accurate + Reinforcement b. CC inaccurate + Error Correction 4. Learner Error + Error Correction 5. Data collection 6. Field Rotation

Appendix G

Mand Data Form (Trainee)

Mand Training Data Sheet

Trainee Name: _____ Child Name: _____ Date: _____

Trial #	Item Name	Prompt Level	Trial #	Item Name	Prompt Level
1		I FPP	11		I FPP
2		I FPP	12		I FPP
3		I FPP	13		I FPP
4		I FPP	14		I FPP
5		I FPP	15		I FPP
6		I FPP	16		I FPP
7		I FPP	17		I FPP
8		I FPP	18		I FPP
9		I FPP	19		I FPP
10		I FPP	20		I FPP

Figure F. Mand training data form used by teacher participants during mand training sessions including performance sessions and generality probes.

Appendix H

Generality Probe Data Form and Procedural Fidelity Checklist (Researcher)

Mand Training Data Sheet

Trainee Name: _____ Date: _____ Training Start Time: _____ Training End Time: _____

Session Type and Number: Baseline _____ Training _____ Maintenance _____ IOA: Yes No

Target Level: I or II

Trial #	Item Name	Prompt Level	Correspondence Check	Trial #	Item Name	Prompt Level	Correspondence Check
1		I FPP	+ -	11		I FPP	+ -
2		I FPP	+ -	12		I FPP	+ -
3		I FPP	+ -	13		I FPP	+ -
4		I FPP	+ -	14		I FPP	+ -
5		I FPP	+ -	15		I FPP	+ -
6		I FPP	+ -	16		I FPP	+ -
7		I FPP	+ -	17		I FPP	+ -
8		I FPP	+ -	18		I FPP	+ -
9		I FPP	+ -	19		I FPP	+ -
10		I FPP	+ -	20		I FPP	+ -

General Procedures for Teaching Sessions:

1. Ensure target toys/activities are on shelf located next to trainee.
2. Ensure iPad displays Target Level folders.
 - a. During Level I, four Phase 1 folders
 - b. During Level II, two Phase 2 folders and one Phase 3 folder
3. Present the following instructions to the trainee
 - a. Level I: Locate folder with item picture
 - b. Level II:
4. Set timer for 15 minutes.
5. Collect Data.
6. Stop session when time elapses.

Procedural Fidelity:

- | | | |
|--|-----|----|
| 1. Did I follow the procedures as outlined above? | Yes | No |
| 2. Did I provide instructions other than those outlined above? | Yes | No |
| 3. Did I provide any feedback to the trainee? | Yes | No |
| 4. Did I collect the data as outlined above? | Yes | No |

Figure H. Mand training data sheet and procedural fidelity checklist used by researcher during generality probes.

Appendix I

Component Checklist- Level I

LEVEL I Mand Training Data Sheet

Student Name: _____ Date: _____ Training Start Time: _____ Training End Time: _____

Level/Session Type and Number: _____ Baseline Training Maintenance IOA: Yes No

<i>LEVEL I Trainee Responses</i>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DEVICE PREPARATION -Phase-specific field size -Device within 6 inches of learner															
CONTRIVE MOTIVATION -Item in sight, but out of reach. -Learner indicates of motivation OR selects picture on iPad independently															
REINFORCE Following independent, accurate response, trainee delivers items w/i one second															
ERROR CORRECTION -Following error, Trainee uses immediate physical prompt to evoke correct response															
DATA COLLECTION -Written documentation on data sheet															

Learner responses /

ACCURATE, INDEPENDENT = Learner presses the picture-symbol on the screen of the device with enough force to evoke the synthesized speech output (without any prompt) within 5 seconds of indicating motivation (i.e., prelinguistic behavior in the form of a reach or point).

ERROR: Learner fails to press the picture-symbol within 5 seconds of indicating motivation OR fails to press the picture symbol with enough force to evoke the synthesized output.

Figure II. Level I Component Checklist used by researchers to assess percentage of Level I mand training performance accuracy.

Component Checklist- Level II

LEVEL II Mand Training Data Sheet

Student Name: _____ Date: _____ Training Start Time: _____ Training End Time: _____

Level/Session Type and Number: _____ Baseline Training Maintenance IOA: Yes No

<i>LEVEL 2 Trainee Responses</i>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DEVICE PREPARATION -Phase-specific field size -Device within 6 inches of learner															
CONTRIVE MOTIVATION -Item(s) in sight, out reach. -Learner indicates of motivation OR selects picture on iPad independently															
CORRESPONDENCE CHECK Following independent, accurate response, trainee presents two items displayed on iPad at equal distance from participant (no touch) and may/may not say "take one".															
CC- ACCURATE If learner reaches item that corresponds with the picture symbol selected, trainee delivers item w/i one second (REINFORCE).															
CC- INACCURATE If learner reaches for item does not correspond, trainee uses full physical prompt to evoke correct responding.															
ERROR CORRECTION -Following error, trainee uses immediate physical prompt to evoke correct responding.															
FIELD ROTATION -Rearranges pictures on the screen of the iPad.															
DATA COLLECTION -Written documentation on data sheet															

Learner responses

ACCURATE, INDEPENDENT = Learner presses the picture-symbol on the screen of the device with enough force to evoke the synthesized speech output (without any prompt) within 5 seconds of indicating motivation (i.e., prelinguistic behavior in the form of a reach or point).

ERROR: Learner fails to press the picture-symbol within 5 seconds of indicating motivation OR fails to press the picture symbol with enough force to evoke the synthesized output.

Figure I2. Level II Component Checklist used by researchers to assess percentage of Level II mand training performance accuracy.

Appendix J

Social Validity Survey

Modified Treatment Acceptability Rating Form-Revised (TARF-R)
(Reimers, T., Wacker, D., Cooper, L., & DeRaad, A., 1992; Langthorne & McGill, 2011)

Circle the number reflecting your level of agreement for each statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
1. I find this approach to be an acceptable way of training staff to implement request training procedures.	1	2	3	4	5
2. I would be willing to use job aids followed by Train to Code again to learn to identify/perform new teaching methods.	1	2	3	4	5
3. I believe it would be acceptable to use these training procedures without trainee/teacher consent.	1	2	3	4	5
4. I like the training procedures used in this research study.	1	2	3	4	5
5. I believe these training procedures are likely to be effective for teaching me to perform request-training teaching procedures accurately.	1	2	3	4	5
6. I believe there are disadvantages and/or undesirable side effects associated with the training procedures (job aids and TTC).	1	2	3	4	5
7. I believe these training procedures is likely to result in permanent improvement in my ability to perform request-training teaching procedures.	1	2	3	4	5
8. I believe it would be acceptable to use these training procedures with all staff members.	1	2	3	4	5
9. I believe participating in this training was disruptive.	1	2	3	4	5
10. Overall I had a positive reaction to these staff training procedures.	1	2	3	4	5
11. I believe other staff members will be to participate in this training.	1	2	3	4	5

Appendix K

5 Scripts per Level

Level I Scripted Trials

All five scripts will contain the same 20 trials, but the order will vary.

Instructions: Wait three seconds following delivery of reinforcement/termination of trial before beginning the next trial to allow time for data collection.

1. Do not indicate motivation (wait five seconds following trainee attempt to contrive motivation, then begin next trial).
 2. Do not indicate motivation (wait five seconds following trainee attempt to contrive motivation, then begin next trial).
 3. Do not indicate motivation (wait five seconds following trainee attempt to contrive motivation, then begin next trial).
 4. Do not indicate motivation (wait five seconds following trainee attempt to contrive motivation, then begin next trial).
-
1. Reach for item then select after 2 seconds (attempt to touch item if w/I reach)
 2. Point to item then select icon within 3 seconds (attempt to touch item if w/I reach)
 3. Reach for item then select icon after 4 seconds (attempt to touch item if w/I reach)
 4. Reach for item then select after 3 seconds (attempt to touch item if w/I reach)
 5. Select picture icon (mand) immediately
 6. Select picture icon (mand) immediately
-
1. Make error in touch responding (double touch)
 2. Make error in touch responding (touch and hold)
 3. Point to item then error in touch responding (double touch)
 4. Point to item then error in touch responding (touch and hold)
 5. Reach for item then error in touch responding (double touch)
-
1. Reach for item (continue reaching for five seconds). If trainee does not prompt after 7 seconds, trial is over and begin next trial.
 2. Point to item (continue pointing for five seconds). If trainee does not prompt after 7 seconds, trial is over and begin next trial.
 3. Reach for item (continue reaching for five seconds). If trainee does not prompt after 7 seconds, trial is over and begin next trial.
 4. Point to item (continue pointing for five seconds). If trainee does not prompt after 7 seconds, trial is over and begin next trial.
 5. Reach for item (continue reaching for five seconds). If trainee does not prompt after 7 seconds, trial is over and begin next trial.

Level II Scripted Trials

All five scripts will contain the same 20 trials, but the order will vary.

Instructions: Wait three seconds following delivery of reinforcement/termination of trial before beginning the next trial to allow time for data collection.

1. Do not indicate motivation (wait five seconds following trainee attempt to contrive motivation, then begin next trial).
2. Do not indicate motivation (wait five seconds following trainee attempt to contrive motivation, then begin next trial).
3. Reach for item (continue reaching for five seconds). If trainee does not prompt after 7 seconds, trial is over and begin next trial.
4. Point to item then error in touch responding (double touch)
5. Reach for item then select after 2 seconds (attempt to touch item if w/I reach).
 - a. If trainee conducts a correspondence check, select item for which you just manded.
 - b. Take item if delivered/allowed.
6. Point to item then select icon within 3 seconds (attempt to touch item if w/I reach)
 - a. If trainer conducts a correspondence check, select the item for which you just manded.
 - b. Take item if delivered/allowed.
7. Reach for item then select icon after 4 seconds (attempt to touch item if w/I reach)
 - a. If trainee conducts a correspondence check, select item for which you just manded.
 - b. Take item if delivered/allowed.
8. Reach for item then select after 3 seconds (attempt to touch item if w/I reach)
 - a. If trainee conducts a correspondence check, select item for which you just manded.
 - b. Take item if delivered/allowed.
9. Select picture icon (mand) immediately
 - a. If trainee conducts a correspondence check, select item for which you just manded.
 - b. Take item if delivered/allowed.
10. Select picture icon (mand) immediately
 - a. If trainee conducts a correspondence check, select item for which you just manded.
 - b. Take item if delivered/allowed.
11. Select picture icon (mand) immediately
 - a. If trainee conducts a correspondence check, select item for which you just manded.
 - b. Take item if delivered/allowed.
12. Select picture icon (mand) immediately
 - a. If trainee conducts a correspondence check, select item for which you just manded.
 - b. Take item if delivered/allowed.
13. Reach for item then select after 2 seconds (attempt to touch item if w/I reach).
 - a. If trainee conducts a correspondence check, select item for which you just manded.
 - b. Take item if delivered/allowed.
14. Point to item then select icon within 3 seconds (attempt to touch item if w/I reach)
 - a. If trainer conducts a correspondence check, select the item for which you DID NOT just mand.
 - b. Take item if delivered/allowed.
15. Reach for item then select icon after 4 seconds (attempt to touch item if w/I reach)
 - a. If trainee conducts a correspondence check, reach for item for which you DID NOT just mand.
 - b. Take item if delivered/allowed.
16. Reach for item then select after 3 seconds (attempt to touch item if w/I reach)
 - a. If trainee conducts a correspondence check, reach for item for which you DID NOT just mand.
 - b. Take item if delivered/allowed.
17. Select picture icon (mand) immediately
 - a. If trainee conducts a correspondence check, reach for item for which you DID NOT just mand.
 - b. Take item if delivered/allowed.
18. Select picture icon (mand) immediately
 - a. If trainee conducts a correspondence check, reach for item for which you DID NOT just mand.
 - b. Take item if delivered/allowed.
19. Select picture icon (mand) immediately
 - a. If trainee conducts a correspondence check, select item for which you DID NOT just manded.
 - b. Take item if handed to you.
20. Select picture icon (mand) immediately
 - a. If trainee conducts a correspondence check, select item for which you DID NOT just mand.
 - b. Take item if delivered/allowed.

Appendix L

General Description of Mand Training Procedures

Mand Training Procedures and Guidelines

- What is mand training?
 - Mand training is similar to requesting or functional communication training.
- Why is mand training important?
 - When we teach a child to request items or activities, we are teaching them how to functionally communicate with individuals in his or her environment.
- Who should be taught how to mand?
 - Any learner who does not independently and spontaneously mand should have mand training incorporated into his or her routine.
- What do people mand for?
 - People only mand for preferred or needed items or activities. It is unreasonable to expect a person to mand for something they don't want or need. You should always follow the learner's motivation when conducting mand training.
- What if a child can't talk?
 - Then we should use an Augmentative or Alternative Communication (AAC) device to teach them how to mand.
- What is an AAC?
 - An AAC is a device that either helps a learner to talk and/or works as the learner's primary voice or mode of communication.
 - Examples of AAC include picture exchange, sign language, and speech-generating devices.

General Procedures for Mand Training with a Speech Generating Device (Phase 1):

Present confederate/learner with one or more of the target items. The item that the participant reaches for/points to is the target item for the trial. If the learner/confederate does not reach/point, do not prompt. If the learner reaches for/point to an item, hold item within participant's sight but out of reach and wait 5 seconds. If participant independently mands—deliver the item. If participant does not independently mand within 5-seconds or makes an error, use full physical prompt to evoke correct responding. Following prompted or unprompted response, grant 20-seconds access to item. Collect data.

Steps for Mand Training with a Speech Generating Device (Phase 2 and 3):

Present learner/confederate with one or more of the target items. The item that the participant reaches for is the target item for the trial. Hold item within learner/confederate's sight but out of reach. Wait 5 seconds. If the participant does not mand within 5-seconds or makes an error in touch responding- use a full-physical prompt to evoke correct responding. If participant independently mands, conduct a correspondence check—Hold out two preferred items (one being the item just selected) represented on the screen of the iPad®. You can, but don't have to say "take one". If the learner reaches for the item that corresponds with icon selected, deliver the item immediately. If the learner reaches for the other item, use a full physical prompt to evoke correct responding. Following prompted or unprompted response, grant 20-seconds access to item. Collect data.

Phases

- 1- Field of 1 large picture
- 2- Field of four; 2 picture and 2 blanks
- 3- Field of four pictures

Appendix M

Procedural Fidelity Forms

Teaching Session Procedural Fidelity Checklist (Observing Researcher-IOA)

General Procedures for Teaching Sessions:

1. Ensure target toys/activities are on shelf located next to trainee.
2. Ensure iPad displays Target Level folders.
 - a. During Level I, four Phase 1 folders
 - b. During Level II, two Phase 2 folders and one Phase 3 folder
3. Present the following instructions to the trainee
 - a. Level I: Locate folder with item picture
 - b. Level II:
4. Set timer for 15 minutes.
5. Collect Data.
6. Stop session when time elapses.

Procedural Fidelity:

- | | | |
|---|-----|----|
| 1. Did the researcher follow the procedures as outlined above? | Yes | No |
| 2. Did the researcher provide instructions other than those outlined above? | Yes | No |
| 3. Did the researcher provide any feedback? | Yes | No |
| 4. Did the researcher collect the data as outlined above? | Yes | No |

Role-Play Procedural Fidelity Checklist (Role-playing researcher)

General Procedures for Roleplay Sessions:

1. Ensure target items/activities are on shelf located next to trainee.
2. Ensure iPad displays Target Level folders.
 - a. During Level 1, four Phase 1 folders
 - b. During Level 2, two Phase 2 folders
3. Present the following instructions to the trainee
 - a. Level I: "Conduct Phase 1 Mand training to the best of your ability".
 - b. Level II: "Conduct Phase _____ Manding training to the best of your ability."
4. Follow the script.
5. Collect Data.
6. Record session duration.

Procedural Fidelity (Roleplaying Researcher):

- | | | |
|--|-----|----|
| 1. Did I follow the procedures as outlined above? | Yes | No |
| 2. Did I provide instructions other than those outlined above? | Yes | No |
| 3. Did I provide any feedback? | Yes | No |
| 4. Did I collect the data as outlined above? | Yes | No |
| 5. Did I follow the scripted response sequence? | Yes | No |

Procedural Fidelity (Observing Researcher-IOA):

- | | | |
|---|-----|----|
| 1. Did the researcher follow the procedures as outlined above? | Yes | No |
| 2. Did the researcher provide instructions other than those outlined above? | Yes | No |
| 3. Did the researcher provide any feedback? | Yes | No |
| 4. Did the researcher collect the data as outlined above? | Yes | No |
| 5. Did the researcher follow the scripted response sequence? | Yes | No |

Appendix N

Graph of Teachers' Performance Accuracy

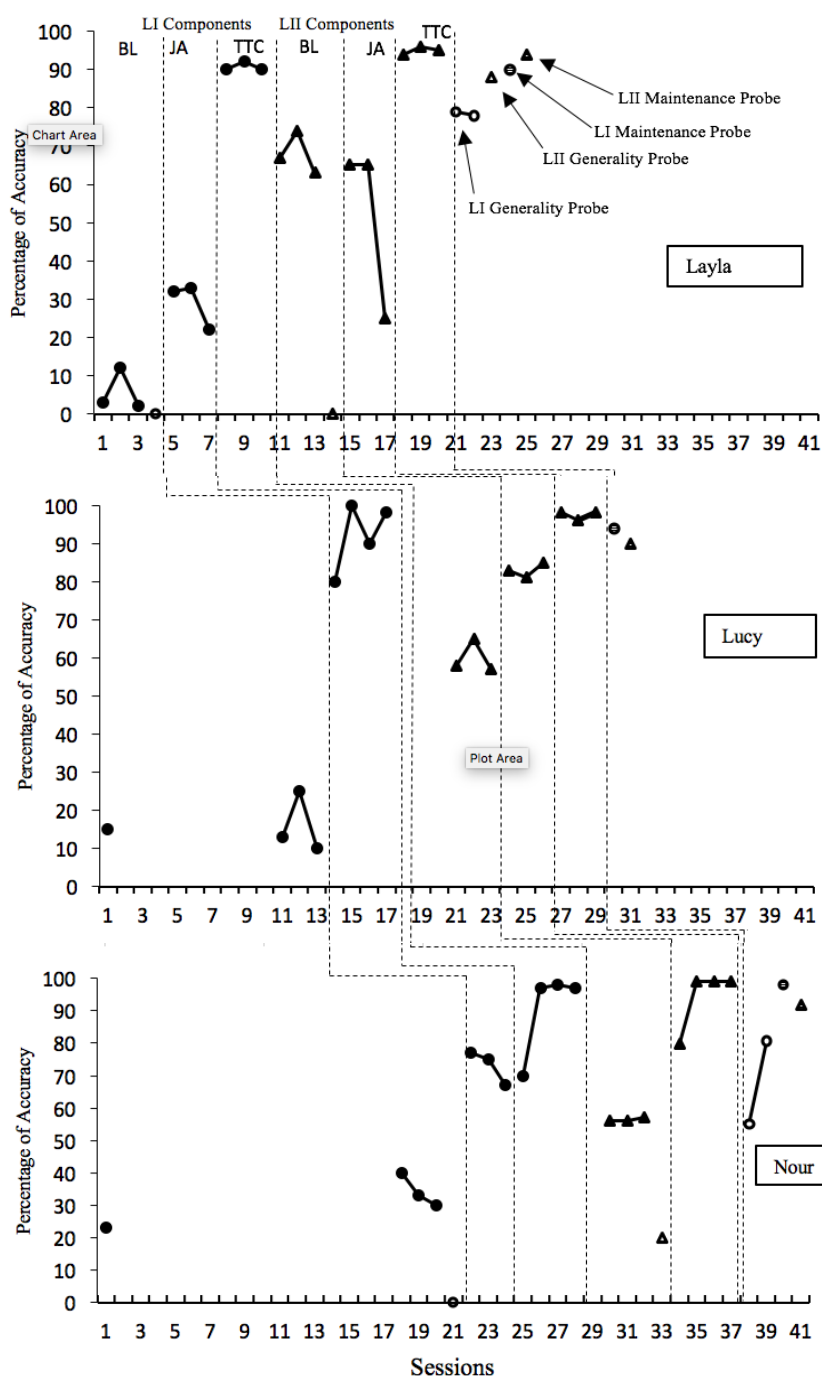


Figure M. Percentage of teachers' accurate performance of Level I (circles) and Level II (triangles) mand training components during baseline, training, generality probes, and maintenance probes for Layla, Lucy, and Nour. Closed data points represent baseline and training sessions, open data points represent generality probes, and striped data points represent maintenance probes. BL= Baseline; JA= Job Aids; TTC= Train to Code.

Appendix O

Child Participant's Manding Data

Table N. Mean Percentages and Frequencies of Children's Manding Across Phases

Child	Mand Training Level	Phase	<u>Mand Trials (#)</u>	<u>Independent Mand (%)</u>
			<i>M</i> (range)	<i>M</i> (range)
Lara (paired with Layla)	Level I	Baseline	0	0
	Level I	Training	8 (7-10)	32 (14-50)
	Level II	Baseline	0	0
	Level II	Training	10	40
Heddy (paired with Nour)	Level I	Baseline	0	0
	Level I	Training	12 (11-13)	92 (91-93)

Appendix P

Social Validity Survey Results

Table P. Social Validity Survey Results

<i>Social Validity Survey Results</i>			
Item	Question	<i>M</i>	Range
1	I find this approach to be an acceptable way of training staff to implement request training procedures.	4	4
2	I would be willing to use job aids followed by Train to Code again to learn to identify/perform new teaching methods.	4	3-5
3	I believe it would be acceptable to use these training procedures without trainee/teacher consent.	2.5	2-3
4	I like the training procedures used in this research study.	4	4
5	I believe these training procedures are likely to be effective for teaching me to perform request-training teaching procedures accurately.	4	4
6	I believe there are disadvantages and/or undesirable side effects associated with the training procedures (job aids and TTC).	3.33	3-4
7	I believe these training procedures is likely to result in permanent improvement in my ability to perform request-training teaching procedures.	4.67	4-5
8	I believe it would be acceptable to use these training procedures with all staff members.	4.67	4-5
9	I believe participating in this training was disruptive.	2	1-3
10	Overall I had a positive reaction to these staff training procedures.	4.33	4-5
11	I believe other staff members would be willing to participate in this training.	4	4

Appendix Q IRB Approval



Office of Research Compliance
Institutional Review Board

June 28, 2017

MEMORANDUM

TO: Ashley Parnell
Elizabeth Lorah

FROM: Ro Windwalker
IRB Coordinator

RE: PROJECT MODIFICATION

IRB Protocol #: 15-01-435

Protocol Title: *Effects of Train to Code Software on Staff Implementation of Communication Training Procedures*

Review Type: EXEMPT EXPEDITED FULL IRB

Approved Project Period: Start Date: 06/23/2017 Expiration Date: 02/17/2018

Your request to modify the referenced protocol has been approved by the IRB. **This protocol is currently approved for 9 total participants.** If you wish to make any further modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

Please note that this approval does not extend the Approved Project Period. Should you wish to extend your project beyond the current expiration date, you must submit a request for continuation using the UAF IRB form "Continuing Review for IRB Approved Projects." The request should be sent to the IRB Coordinator, 109 MLKG Building.

For protocols requiring FULL IRB review, please submit your request at least one month prior to the current expiration date. (High-risk protocols may require even more time for approval.) For protocols requiring an EXPEDITED or EXEMPT review, submit your request at least two weeks prior to the current expiration date. Failure to obtain approval for a continuation *on or prior to* the currently approved expiration date will result in termination of the protocol and you will be required to submit a new protocol to the IRB before continuing the project. Data collected past the protocol expiration date may need to be eliminated from the dataset should you wish to publish. Only data collected under a currently approved protocol can be certified by the IRB for any purpose.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.



To: Elizabeth R Lorah
BELL 4188

From: Douglas James Adams, Chair
IRB Committee

Date: 09/28/2017

Action: **Expedited Approval**

Action Date: 09/28/2017

Protocol #: 1708009089A003

Study Title: Effects of Train to Code Software on Staff Implementation of Communication Training Procedures

Expiration Date: 02/17/2018

Last Approval Date: 09/28/2017

The above-referenced protocol has been approved following expedited review by the IRB Committee that oversees research with human subjects.

If the research involves collaboration with another institution then the research cannot commence until the Committee receives written notification of approval from the collaborating institution's IRB.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date.

Protocols are approved for a maximum period of one year. You may not continue any research activity beyond the expiration date without Committee approval. Please submit continuation requests early enough to allow sufficient time for review. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study closure.

Adverse Events: Any serious or unexpected adverse event must be reported to the IRB Committee within 48 hours. All other adverse events should be reported within 10 working days.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, study personnel, or number of participants, please submit an amendment to the IRB. All changes must be approved by the IRB Committee before they can be initiated.

You must maintain a research file for at least 3 years after completion of the study. This file should include all correspondence with the IRB Committee, original signed consent forms, and study data.