AN EVALUATION OF AN EMBEDDED INSTRUCTION PROCEDURE FOR CHILDREN WITH AUTISM

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ABSTRACT

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Individuals diagnosed with Autism Spectrum Disorder (ASD) often have difficulty acquiring a tact repertoire. Given that functional language skills are correlated with better long-term social and educational outcomes, teaching individuals with autism to use language is a high priority in Early Intensive Behavioral Intervention (EIBI) programs (Paul, 2008). The current study examined an natural environment training (NET) procedure on tact acquisition using a multiple-probe design across sets. Participants were taught to tact nine, common, three-dimensional toys during sessions. During sessions, the experimenter modeled three play routines. Tact trials were presented approximately every 30 s until each target stimulus was presented three times, for a total of nine trials per session. Two pre-school aged children diagnosed with autism, who received 30 hours of applied behavior analysis therapy per week participated in the study. Results of the study indicated that NET is effective in teaching young children with autism to tact. However, for one of the two participants these tacts did not maintain during the last probe sessions. Limitations and future research are discussed.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

KEY TO SYMBOLS

™	Registered Trademark

KEY TO ABBREVIATIONS

BCBA-D	Board Certified Behavior Analyst- Doctoral Level
BCBA	Board Certified Behavior Analyst
EESA	Early Echoic Skills Assessment
EIBI	Early Intensive Behavior Intervention
NET	Natural Environment Training
ASD	Autism Spectrum Disorder
DTT	Discrete Trial Training
IOA	Interobserver Agreement
PI	Protocol Integrity

Introduction

The trajectory of language development in individuals with a diagnosis of Autism Spectrum Disorder (ASD) is delayed compared to typical development (Charlop & Haynmes, 1994). Typically developing children usually learn language without explicit training during daily, natural interactions (e.g., during play with parents, listening to people talk), however children with a diagnosis of ASD do not display similar learning patterns (Bates, Bretherton, Beeghly-Smith, & McKnew, 1982; Paul, 2008; Smith, 2001). Research has shown that better, long-term, social and educational outcomes are correlated with the development of functional language by the time children enter Kindergarten. Therefore, functional language training is a high priority in Early Intensive Behavioral Intervention (EIBI) programs (Paul, 2008).

Published assessments and curricula recommend beginning language training by teaching children with ASD how to request (i.e., mand) for items, and how to receptively (e.g., select) and expressively identify (i.e., tact) common nouns (Sundberg & Partington, 1998). A tact is a verbal response evoked by a nonverbal discriminative stimulus (S^D) and maintained by generalized social reinforcement (Skinner, 1957). Tacts are paramount for language development (Sundberg, 2015), are common in social interactions (Machese, Carr, LeBlanc, Rosati, & Conroy, 2012), and are vital to an individual's academic success (Sundberg & Sundberg, 2011).

Discrete trial training (DTT) is the most frequently and effective intervention to teach individuals with ASD to tact (Tarbox & Najdowski, 2008; Sautter & LeBlanc, 2006). It has been effective in teaching children with ASD to tact nouns (Marchese, Carr, LeBlanc, Rosati, & Conroy, 2012; Pistoljevic & Greer, 2006), actions (Williams, Carnerero, & Perez-Gonzalez, 2006), and emotions (Conallen & Reed, 2016). Discrete trial tact training typically involves a

teacher sitting across from a child at a table, artificially presenting a nonverbal S^D (e.g., flashcard or object), providing a verbal model which the child echoes, and then the teacher providing generalized conditioned reinforcement (e.g., social praise in combination with a point or token) contingent on a correct echo. Trials are quickly paced, the verbal model is systematically faded and eventually the child can independently tact the nonverbal S^D.

Although numerous studies have demonstrated that DTT is an effective procedure for teaching individuals with ASD how to tact (Sautter & LeBlanc, 2006), there are potential limitations. Reichow, Barton, Boyd, & Hume (2012) criticized DTT because it is often implemented in sterilized environments that do not mimic natural conditions that typically evoke language. Others have criticized DTT because it relies on "artificial" reinforcers such as tokens or edibles (Ingersoll & Schreibman, 2006) to establish responses. Additionally, some children with ASD may not be able to sit and attend to the instruction, stay motivated, or tolerate the quick pace of instruction, which may evoke escape-maintained problem behavior (Koegel, Openden, Fredeen, & Koegel, 2006; Koegel, Koegel, & Suratt, 1992).

To mitigate the above criticisms of DTT, researchers have developed and evaluated alternative teaching procedures that incorporate learning opportunities into play or naturally occurring routines, which has been shown to increase generalization (Delprato, 2001). This type of teaching arrangement closely resembles preschool and general education classroom settings (Hart & Risley, 1974). Delprato (2001) refers to these types of interventions as normalized intervention, although interventions that fall under this category have also been called incidental teaching (Neef, Walters, & Egel, 1984), the natural language paradigm (Koegel et al., 1992), and pivotal response training (Schreibman et al., 1991).

Incidental teaching, originated by Hart & Risley (1974), is the earliest developed procedure of normalized interventions (Delprato, 2001). An episode or session occurs in a natural environment and uses objects and activities to promote language. Unlike discrete trial training, incidental teaching sessions are child lead, that is, sessions begin when the child indicates that they want an object (e.g., toy) or activity (e.g., to be picked up) and may include pointing to something, a bid for attention, or language (e.g., saying "up"). To create an establishing operation, Hart & Risley (1974) placed items in glass-fronted cabinets, storage sheds, or high counters. This meant that toys and materials were only available to children upon request. Naturalistic reinforcers were provided contingent on correct responding by providing the child with the object or activity that they expressed interest in (Hart & Risley, 1968; Delprato, 2001).

Since the original incidental teaching literature was published (Hart & Risley, 1968) researchers have made procedural modifications and include the natural language teaching paradigm (Koegel, O'Dell,& Koegel, 1987) and pivotal response training (Koegel, Schreibman, Good, Cerniglia, Murphy, & Koegel, 1989). The main procedural components that were added were contrived antecedent conditions (e.g., playing with preferred items and modeling the target response), interspersed maintenance tasks, and reinforcement for successive approximations (Koegel et al., 1989). While variations of procedures are prevalent in the literature, all normalized interventions are loosely structured, are child-led regarding the target responses, and use reinforcers that are related to the target response (Delprato, 2001; Geiger, Carr, LeBlanc, Hanney, Polick, & Heinicke, 2012). Researchers have found that normalized procedures are effective in teaching language to children diagnosed with ASD (Delprato, 2001). Specifically, normalized procedures have been used to teach language skills including receptive language

skills (Geiger et al., 2012; Williams et al., 1981) and mands (McGee, Krantz, & McClannahan, 1985).

Natural environment training (NET) is outlined as an educational program based on the principles of Skinner's book, Verbal Behavior (Skinner, 1957). The procedure capitalizes on establishing operations and incorporates behavioral techniques (e.g., contingent reinforcement, prompting and shaping, multiple trials) into developmentally appropriate routines or activities (Daughery, Grisham-Brown, & Hemmeter, 2001; Charlop-Christy & Carpenter, 2000; Spradlin & Siegel, 1982; Scriebman et al., 2015; Sigafoos et al., 2006) to facilitate learning and early social-communication skills (Ingersoll & Scriebman, 2006). Natural environment training is similar to normalized interventions in a number of ways. First, the procedure uses the child's own motivating factors and interest to facilitate therapy and guide instruction (Sundberg & Partington, 1999). Second, NET is loosely structured as trials are presented during natural opportunities (e.g., breaks in activities, transitions from one activity to another, during routines). Natural environment training has been shown to increase generalization (Charlop-Christy & Carpenter, 2000; Spradlin & Siegel, 1982; Scriebman et al., 2015), and is hypothesized to increase spontaneous language (Kaiser, Hancock, & Nietfeld, 2000). Extensive literature demonstrates the effectiveness of the NET procedure across a wide variety of skills including manding (Koegel, Carter, & Koegel, 2003), imitating (Ingersoll & Schreibman, 2006), prelinguistic communication (Warren, Yoder, Gazdag, & Kim, 1993), play skills (Stahmer, 1995), peer interactions, and joint attention (Pierce & Schreibman, 1995). Given that NET has been effective in teaching children diagnosed with ASD in other operants, it seems possible that NET may be a promising intervention to teach individuals with autism how to tact.

Duenas & Plavnick (under review) evaluated the efficacy of a NET procedure on tact acquisition in young children with ASD. The play-based tact training procedure embedded tact trials during play routines. The play routines were developed to mimic routines commonly used in preschool classrooms, including: (1) taking toys out of a bin, (2) engaging in pretend play, and (3) cleaning up. Participants were three young children with ASD who attended an EIBI program, all of which had previously been taught to tact common nouns during traditional DTT. Nine trials were distributed across the three play routines. A trial began when the experimenter held up a non-verbal S^D and asked "what is it?" During intervention a 3 s constant time delay verbal prompt was provided to teach participants to tact target stimuli. If the participant correctly echoed the verbal prompt, the experimenter provided reinforcement in the form of social praise and physical contact while interacting with the child. The intervention was successful in teaching all three participants to tact target stimuli.

The procedures of normalized interventions lend better to teaching mands than other verbal skills (e.g., tacts). By definition, for a response to be considered a tact it must be evoked by a nonverbal S^D and the reinforcer cannot be related to the response. Therefore, normalized interventions would need to be modified to teach tacts. Specifically, to ensure that a response functions as a tact and not mand, the item named by the child could not be provided as a reinforcer. This modification resembles natural environment training (NET).

It is possible that participants' previous tact training histories with DTT facilitated the effectiveness of the procedure. Therefore, it is unclear if the participant's previous DTT history facilitated learning during the play-based procedure. To our knowledge, there are no published

studies that have evaluated a NET training instruction on naïve learners, or learners that have not had previous discrete trial tact training. Additionally, it is unclear the degree to which the play routines (e.g., talking toys out of a bin) facilitated the acquisition of tacts. Therefore, the purpose of the current study is to evaluate a natural environment tact training procedure similar to Duenas & Plavnick on tact acquisition in young children with ASD who have not had previous DTT exposure for tacts.

Method

Setting, Participants, and Materials

Two participants who attended an Early Intensive Behavior Intervention (EIBI) Applied Behavior Analysis (ABA) program participated in the study. The EIBI program was housed within an early childhood development preschool at a large Midwestern university campus. All participants attended the program 7.5 hr each day, four days each week (30 hours of therapy each week). To be included in the study, participants had to have a generalized echoic repertoire as demonstrated on the *Early Echoic Skills Assessment* (EESA; Esch, 2008), look or engage in toys for 5-10 s, have no previous discrete trial tact training, and have a medical diagnosis of ASD. All participants met the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-5) diagnostic criteria for ASD and had been diagnosed by providers who were not affiliated with the EIBI center.

All sessions were conducted in a small research room, adjacent to the therapy room that contained two sofa chairs, a child-size desk and chair, a one-way observation room, two large windows, and a large carpeted area. Materials included an iPad™ (5^{th} generation) to record sessions, pens, clipboard, stopwatches, data sheets, and three sets of age-appropriate toys. Each

set consisted of three target stimuli and 10 to 15 additional non-target toys. Participants were taught to tact a total of nine stimuli (3 sets of 3 target stimuli).

Dependent Variables

The dependent variable was the frequency of correct tacts emitted during each session. A participant's response was scored as either (a) independent, (b) prompted correct, (c) prompted incorrect, (d) error, or (e) no response. A response was scored as independent if the participant emitted the target response within 6 s, without a verbal model. A response was scored as prompted correct if the participant echoed the verbal model presented by the experimenter within 6 s. A response was scored as prompted incorrect if the participant emitted a response that did not match the verbal model (e.g., the child says "pen" after the experimenter provided the verbal model "cat"). A response was scored as an error if the participant emitted a response that did not match the nonverbal S^D presented, and a response was scored as a no response if the participant did not emit a response within 6 s of the verbal model or presentation of the nonverbal S^D

Interobserver Agreement

Interobserver agreement (IOA) was calculated during 34.5% of each condition (i.e., baseline, intervention, and probe sessions) of the study by an independent observer. The independent observer was a second-year master's student in the ABA program and a behavior technician at the EIBI center. The primary and secondary data collectors watched a single video session together and simultaneously scored the participant's responses using the response codes described above. Next, each observer scored two sessions independently. Interobserver agreement was calculated by dividing the number of agreements by the total number of trials and multiplying it by 100% (Ayres & Ledford, 2014). A trial was scored as an agreement if both

observers independently recorded the same response code. A disagreement was recorded if the primary and secondary observer recorded different responses for a trial. The observers were considered reliable once they demonstrated 100% reliability across two instructional sessions. The average IOA percentage for Landon was 92% (range: 33%-100%) and 98% (range: 89%-100%) for Aaron.

Selection of Discriminative Stimuli and Response. Table 1 lists the target responses taught to both participants. Several steps were taken to increase the likelihood that target responses were of equal difficulty across and within sets of stimuli. First, a list of approximately 20, one syllable nouns was generated for each play set (grocery store, tool kit, and household cleaning items). Words were removed if they included blends (e.g., "sp" or "br") because those typically do not appear until later in language development (Wellman, Case, Mengert, & Bradbury, 1931). Once the list was narrowed to 10 stimuli, each stimulus was given a number, and a random number generator was used to select 3 target stimuli. Once, three sets of three stimuli were created, the list was sent to a dual certified BCBA-D and speech-language pathologist for feedback. Target responses that were deemed to be more difficult or not fit the criteria above were removed and replaced by another item that met criteria.

Experimental Design

A multiple probe design across sets (Gast & Ledford, 2014) was employed for the experiment. This design was carried out by conducting a series of consecutive probe sessions for each set of target stimuli. A minimum of three sequential probe sessions (or until the graphed data showed a stable trend) were conducted before the introduction of the independent variable. Tact training first began with set A, while sets B and C remained in baseline. Following mastery

criterion of set A, probe sessions were conducted for all sets. Then set B was put into treatment while set C remained in baseline. This sequence of instruction continued until mastery of set C, at which time all sets were probed. Experimental control was demonstrated when participants started to tact target stimuli only after the introduction of the independent variable. This design was selected because continuous baseline conditions were deemed unnecessary for the acquisition of the target skill (Gast and Ledford, 2014) and repeated access to the toys might have caused children to become disinterested in the toys.

Procedure

Baseline and experimental sessions consisted of three play routines. Sessions lasted approximately 5 to 7 minutes. The play routines were used to provide opportunities for the participants to tact each target stimulus three separate times during a session, for a total of 9-trials. The order in which the stimuli were presented was changed for each play routine; such that, each stimulus was presented first, second, and third during each session. For example, during session 1, during the first play routine, the stimuli were presented in the following order can, gum, and bag; during the second play routine the order was bag, can, gum; and during the last routine the order was gum, bag, and can. On the subsequent session, the stimuli were presented in a new order.

Each trial was embedded into pre-determined play routines and the experimenter presented trials during natural breaks in play. That is, if the participant was engaging in the pre-determined play routine (e.g., putting items in a grocery bag), the experimenter would present a trial between when the child put one item in the bag and before the participant picked up another toy. At times, the participants were not interested in completing the pre-determined play

routines; when this occurred, the experimenter continued to model the play routine for 30 to 45 s. If after 45 s the participant was engaging in different actions with the toys the experimenter followed the participant's lead and incorporated play actions with the toys the child was using.

Description of Play Sets. Three thematic play sets (i.e., cleaning, community helpers, and grocery) were used and contained three target stimuli and 12-17 additional non-target stimuli. Table 2 provides a list of the toys that were included in each play set and the manufacture of each toy. Below is a description of the three pre-determined play routine for each set.

Grocery. The play routines completed with this set included actions typically completed during grocery shopping. Upon entering the room, the experimenter immediately handed the participant a grocery basket, wallet, and coupons. The experimenter opened up the wallet and took out play money and counted (e.g., "twenty dollars, five dollars") while handing the money to the participant. Next, the experimenter modeled placing the pretend food in the basket while making comments like "we need pees," "put some milk in the basket". The second play routine included placing the toys on the conveyer belt of the cash register and modeled how to use the cash register (e.g., pressing the buttons and putting money in the till). The third play routine included putting the items in a grocery bag and pretending to leave the store the store and eating items previously bought.

Cleaning. The play routines completed with this set included actions typically completed when cleaning and were modified to be age appropriate and fun. The first play routine started when the experimenter gave the participant a pictorial list of chores and said "we have to clean the windows." The experimenter then picked up the child-sized water bottle and sprayed water

on a one-way mirror while making comments (e.g., "the window is so dirty!" or "eww"). The experimenter then modeled using a squeegee to wipe down the windows while narrating the play actions (e.g., "wipe, wipe"). The last action during this routine was wiping the window with a rag. The second play routine included actions completed when cleaning a floor (e.g., using a broom, making soapy water, and mopping the floor). To begin the experimenter picked up the broom and modeled sweeping the floor while making comments (e.g., "brush, brush"). Next, the experimenter pretended to fill a bucket with soap and water. Throughout the routine, the experimenter provided comments like "we have to put the water in" or "squeeze the soap". Lastly, the experimenter modeled using a play Swiffer™ and put a pretend caution sign where the floors had been cleaned. The experimenter provided comments such as "be careful, it is wet." The third play routine included the experimenter dusting the room. This included using a dust pan and brush to pick up items from the floor. While dusting, the experimenter pretended to find a toy bug. The experimenter pretended to squish the bug with her foot and then catch the bug with the net while narrating (e.g., "eww, a big bug", "get it!", or "I caught it").

Community helpers. The play routines completed with this set included actions typically completed by community helpers including firepersons, police officers, and mechanics. The first play routine began with the experimenter handing the participant a pretend radio and saying "there is a fire, we need to call 911". The experimenter modeled putting on a firefighter uniform (e.g., putting on a fireman's hat, jacket, and oxygen tank) while narrating (e.g., "put on your hat", "now we need our jacket", and "we need oxygen" and helped the participants put on the items if they showed interest. The experimenter then modeled pushing the firetruck while making play sounds (e.g., "wee-woo, wee-woo"). The second play routine was designed to model actions that may be completed by a police officer. The experimenter picked up the radio

and called the police. During the phone call, the experimenter made comments like "911, we need help". The experimenter put on a police officer's hat and then gave it to the participant. Next, the experimenter picked up a pen and a notepad and scribbled while narrating that a ticket was being written. After the ticket was written, the experimenter placed the ticket on the firetruck. The experimenter provided comments such as "you can't park there" or "you were speeding". During the third play routine, the experimenter modeled actions commonly completed by construction workers and auto mechanics. To begin, the experimenter picked up a toolbox and shook the contents while making comments such as "shake, shake," the experimenter opened up the lid and dumped the items onto the floor. The experimenter made comments like "it is a hammer" or "look, a tape measure." Next, the experimenter picked up the hammer, made a comment about the firetruck being broken, and hit the hood of the firetruck with the hammer. After a few second the experimenter would say "it's fixed". Last, the experimenter selected the tape measure, pulled the ruler out, and measured a toy near the child.

Baseline. Sessions began when the participant and experimenter entered the room, and the experimenter said "look at all my toys." The experimenter then conducted the first play routine. The experimenter presented a trial approximately every 30 s (+/- 10 s) by placing the target stimulus in the participant's line of vision and waiting 6 s for a response. If the child correctly tacted the item, the experimenter provided praise (e.g., "that's right, it is a can!"). To eliminate the possibility of a response functioning as a mand, after a target stimulus was presented, the experimenter placed the stimulus behind her back or out of the participant's reach. The experimenter ensured the participant did not obtain the stimulus for at least 20 s after which the participants were free to play with the toy. After each stimulus was presented once the second play routine began. This was repeated until all three play routines were completed, at

which point the experimenter thanked the participant for playing and, both individuals exited the room. If a participant tacted a stimulus during baseline, the stimulus was removed from the set, replaced with another stimulus and additional baseline sessions were completed.

Natural Environment Training. Natural environment tact training sessions were identical to baseline except that the experimenter provided a verbal model using a most-to-least progressive time delay. The progressive time delay procedure included a 0 s time delay, 3 s time delay, and 6 s time delay. A trial during the 0 s time delay consisted of the experimenter (a) holding up a target stimulus (e.g., net) in the participant's line of vision, (b) immediately presenting a full verbal model (e.g., "net"), and (c) waiting 6 s for a response. If the participant correctly echoed the verbal model, the experimenter provided enthusiastic social praise (e.g., "It is a net!"). The stimulus was then placed directly behind the experimenter, out of the participant's reach, and the play routine continued. A trial during the 3 s time delay consisted of the experimenter (a) holding up a target stimulus (e.g., net) in the participant's line of vision, (b) waiting 3 s for an independent correct response, (c) presenting a full verbal model (e.g., "net") after 3 s if the participant did not emit a response, and (d) waiting 6 s for a response. A trial during the 6 s time delay consisted of the experimenter (a) holding up a target stimulus (e.g., net) in the participant's line of vision, (b) waiting 6 s for an independent correct response, (c) presenting a full verbal model (e.g., "net") after 6 s if the participant did not emit a response, and (d) waiting another 6 s for a response.

If a participant incorrectly echoed the prompt (e.g., the child said "mop" when the verbal model "net" was provided) or made an error the experimenter implemented an error correction. The error correction included the experimenter immediately removing the nonverbal S^D from the participant's line of vision, representing the nonverbal S^D and providing a full verbal model. If

the participant correctly echoed, the experimenter provided neutral affirmation (e.g., "that's it, it's a can!"), and continued with the play routine.

During the first set (i.e., *grocery*) for Landon, prompts were faded every two sessions in which prompts were effective at least 88% of trials (a participant could make 1 error or have 1 no response) and on subsequent sets (*community helpers* and *cleaning)*, prompts were faded every session in which the prompt was at least 88% effective. Sessions were conducted until mastery criteria were achieved, which was originally defined as three consecutive sessions of 88% or higher and was changed to two consecutive sessions of 88% or higher after the first set for Landon. This change was made because after several instructional sessions for the first set he no longer wanted to engage in the play routines or toys.

Probes. Probe sessions were conducted once a set of stimuli were mastered. Trials during probes were identical to baseline. The order in which the sets were implemented was pre-determined randomly using a random number generator. Once probe sessions were conducted across the three sets, the next set was placed into treatment.

Procedural Integrity

Protocol Integrity (PI) was calculated during 34% of all conditions (i.e., baseline, play-based, and probe-sessions) of the study by an independent data collector who also completed IOA. Procedural Integrity was calculated using two separate checklists, one for baseline and the probe sessions, and one for the intervention sessions. The baseline and probe sessions behaviors included: (a) completing the pre-determined play action or following the child's lead, (b) presenting the correct stimulus following the 30 s (+/- 10 s) intertrial interval, (c) holding the target stimulus in the participant's line of vision, (d) presenting the stimulus for 6 s, (e) providing

social praise within 1 s if the participant made a correct response or removing the item without feedback if child made an error or no response, and (f) removing the stimulus from the participant's reach for 20 s. During intervention sessions the behaviors included: (a) the experimenter completing the pre-determined play action or following the child's lead, (b) presenting the correct stimulus following the 30 s intertrial interval, (c) holding the target stimulus in the participant's line of vision for 6 s, (d) providing a prompt at the correct time delay, (e) implementing an error correction procedure (when necessary) or providing social praise within 1 s, and (f) removing the stimulus from the participant's reach for 20 s. Each component of the treatment was scored as either correct or incorrect.

The primary and secondary data collectors were trained using video sessions. The data collectors watched a video session of the baseline and intervention sessions together scoring the experimenter on each of the discrete behaviors. Next, each observer scored two sessions for each PI checklist independently. A plus was marked if the experimenter engaged in the correct target behavior. A minus was scored if the experimenter did not engage in the target behavior. The secondary data collector was considered reliable once they demonstrated 80% reliability across two instructional sessions with the primary data collector. During training, the primary and secondary data collectors reviewed all disagreements to determine a scoring consensus, and changed definitions when needed. A percentage of PI was calculated by dividing the number of pluses by the total number of behaviors and multiplied by 100%. Due to the nature of the sessions, participants were free to move about the room which at times meant that trials were conducted out of the recordings view. Trials that were out of the view of the camera were not scored. The average PI percentage for Landon was 94% (range: 60%-100%) and the average PI percentage for Aaron was 97% (range: 91%-100%).

Results

Figure 1 depicts the frequency of correct tacts for Landon across the three sets. During baseline sessions, Landon did not tact any stimuli in the *grocery, community helpers,* or *cleaning* play sets. Landon met mastery-level responding in 10, 4, and 12 sessions for *grocery, community helpers*, and *cleaning* respectively. During the first post probe, Landon made 9 correct responses during *grocery*, and did not tact any items for *community helpers* and *cleaning*. During the second probe session, Landon made 8 correct responses for *grocery* and made 9 correct responses for *community helpers* and tacted one stimulus twice during *cleaning*. Therefore, that stimulus was replaced and three additional baseline sessions were conducted. On the last probe session, Landon made 2, 2, and 9 correct responses for *grocery, community helpers*, and *cleaning* respectively.

During intervention sessions, a more-intrusive prompt was implemented if the participant emitted three trials of no responses, errors, or if the prompt was ineffective in one teaching session. For Landon, prompts a more intrusive prompt was implemented during session 8 during the *cleaning* set; from a 3 s time delay to a 0 s time delay. Therefore, Landon did not have the ability to make any independent responses during session 8.

Figure 2 depicts the frequency of correct tacts for Aaron across the three sets. During baseline sessions, Aaron did not tact any stimuli in the *community helpers, cleaning,* or *grocery* play sets. Aaron met mastery-level responding in 3, 10, and 8 sessions for *community helpers, cleaning*, and *grocery* respectively. During the first post probe for *community helpers*, Aaron made 9 correct responses, and did not tact any items for *cleaning* and *grocery*. During the second probe, Aaron made 8 correct responses during *community helpers* and tacted 8 correct stimuli in *cleaning*. Aaron did not independently tact any stimuli in *grocery*.

During the third post probe, Aaron made 9, 9, and 7 independent correct tacts for *community helpers, cleaning,* and *grocery* respectively.

During intervention sessions for Aaron, a more-intrusive prompt was implemented during *cleaning* session 6 and again during session 9. In both of these sessions a 3 s time delay was implemented after a session at the 6 s time delay. On each of the errors Aaron said mop or net in the presence of the opposite item. For the *grocery* set a more intrusive prompt was implemented during session three because the prompt was ineffective at a 3 s time delay.

While sessions to mastery criteria indicate acquisition of tacts, days to mastery for each participant are also worth noting. Landon mastered the *grocery* set in 9 days (6 therapeutic days), the *community helpers* set in 2 days (2 therapeutic days), and *cleaning* set in 15 days (9 therapeutic days). Aaron mastered the *community helpers* set in 1 day, the *cleaning* set in 14 days (8 therapeutic days), and the *grocery* set in 3 days (3 therapeutic days). The extended length of time needed to acquire tacts in the *cleaning* set for Landon may be a contributing factor as to why Landon emitted only 2 correct stimuli during the *grocery* and *community helpers* last probe sessions. That is, the 15 days it took to acquire tacts in the *cleaning* set meant that there was a longer period of time between the presentation of the *grocery* and *community helpers* play sets during probe 2 and probe 3, making the final probe similar to that of a maintenance probe.

Discussion

The present study evaluated a NET procedure on tact acquisition in young children with autism. The results of the current study add to the NET literature that has previously examined the procedures efficacy in teaching manding (Koegel, Carter, & Koegel, 2003), imitation (Ingersoll & Schreibman, 2006), prelinguistic communication (Warren, Yoder, Gazdag,

& Kim, 1993), play skills (Stahmer, 1995), peer interactions, and joint attention (Pierce & Schreibman, 1995). The present result extended Duenas & Plavnick (under review), that taught children with autism to tact items during play routines using a verbal model. Duenas & Plavnick (under review) used participants who had previous discrete trial tact training within three play routines (taking toys out, playing, and cleaning up), while the current study demonstrated that NET can teach children who do not have previous DTT experience. The participants in the current study acquired tacts at a slower rate than those in Duenas & Plavnick (under review). While these results suggest that NET may be a tenable intervention to first teach expressive (mand and tact) language skills to young children with autism, rate of acquisition of tacts varied across sets.

While measures were taken to ensure that the sets of stimuli were equal, results from the current study suggest that target stimuli across sets were of varying difficulty. This is supported by the patterns of responding for Landon and Aaron across sets. That is, both participants required the most sessions for mastery in the *cleaning* play set and required the least amount of sessions for mastery in the *community helpers* play set. There are a few possible reasons why rate of acquisition differed across sets.

First, the *community helpers* play set was broken down into three very distinct play routines. That is, the *community helpers* routine modeled pretend play actions typically seen for firefighters, police officers, and auto mechanics. During each play routine, the experimenter used different non-target stimuli to model actions during the free-play (intertrial interval). For example, the experimenter may have used a saw during the auto mechanic play routine but an oxygen tank during the firefighter routine. While the non-target stimuli remained freely available during the entire session, the experimenter infrequently observed the participant

engaging in toys outside of the routine. This is different from the *cleaning* and *grocery* play sets since the non-target stimuli were used across all play routines (e.g., the banana was placed into the basket, put onto the conveyer belt, and dropped into the plastic bag). The distinct difference in the routines for the *community helpers* may have led to higher participation and motivation for participants.

Second, the *community helpers* play set contained dress up items that participants were able to put on during the play routines. During sessions, participants typically played dress-up by wearing the firefighter and the police officer's hats on their heads, as well as clipping on the auto mechanics belt. Participants were frequently observed interacting with the stimuli in the *community helpers* session more than the *grocery* and *cleaning* play sets. Therefore, the dress up non-target stimuli may have functioned as preferred items within the sets. The saliency of each play routine and the selection of non-target stimuli (e.g., dress up items) may have been a contributing factor as to why participants acquired tacts faster in the community helpers set.

Physical characteristics of the target stimuli may also have played a role in the rate of acquisition. It is possible that the characteristics of the stimuli in the *cleaning* set (e.g., mop and net) were too similar. Both stimuli had a long body with an apparatus attached to an end. This was seen for Landon and Aaron as both made errors tacting the two target stimuli during intervention sessions. Landon continued to make the error between the two stimuli during the last probe session. Specifically, Landon made 11 errors and Aaron made 8, by tacting mop or net in the presence of the other stimulus (i.e., tacting "mop" when presented a net or tacting "net" when presented a mop). The stimuli in the *grocery* set (e.g., can and gum) were also similar in physical characteristics, as both stimuli were of similar size and shape. The stimuli in the *community helpers* set were vastly different in color, shape, and dimensions.

Motivation of participants to engage in play sets may have been a contributing factor in the rate of acquisition for Landon and Aaron. The primary experimenter noted that participants did not regularly engage in the play routines or actions modeled. The participants did not have age appropriate play skills and often engaged in inappropriate behavior during sessions. Specifically, during the first few intervention sessions, Landon would play with toys and participate in the play routines modeled by the experimenter. However, as sessions continued Landon no longer interacted with the toys or the play routines and would run around the room and hide behind furniture. It appeared Landon wanted to engage in gross motor play (e.g., chase) with the experimenter. Aaron regularly interacted with toys but did not use them as modeled by the experimenter during the play routines. For example, he would line up toys on the floor or furniture. When participants did not participate in the play routines, the sessions did not represent a meaningful, natural play interaction between experimenter and child, but rather a child engaging in free play between trials. Researchers have identified that play benefits children's language development as it incorporates social interactive and cognitive elements that have been shown to enhance language skills (Weisberg, Zosh, Hirsh-Pasek, & Golinkoff, 2013). Since there is a correlation between play and language development (Kasari, Paparella, Freeman, & Jahromi, 2008; Weisberg et al, 2013), participants limited play skills may have affected the rate of acquisition. That is, it is unclear that had participants had more advanced play skills they may have learned to tact stimuli more quickly and with fewer errors.

Limitations and Future Research

There are limitations to the study that are worth noting. First, low PI and IOA was found during intervention sessions for Landon. Across all conditions (baseline, intervention, and probes) and sets IOA for Landon's sessions was 94% (range: 60%-100%). Interobserver

agreement for *grocery* sessions was 84.6% (range: 33-100%), for *community helpers* was 100% and during *cleaning session was* (range: 89-100%). Procedural integrity for the grocery set was X%, and 98.6% and 100% for *community helpers* and the *cleaning* sets respectively. The low IOA (i.e., 33%) and low PI (i.e., 60%) for the grocery set occurred during the same session and was a result of poor articulation and the researcher reinforcing on inaccurate approximations of target responses. That is, the two independent observers did not record the same response code for the child (e.g., one scored an error and one scored correct). The experimenter recorded a correct response and therefore provided reinforcement, whereas the secondary observer recorded an error and also recorded an error on procedural integrity for providing reinforcement contingent on an error. Landon had only started speaking several months before the start of the study and behavior therapists often had a difficult time discriminating his vocal approximation.

Another limitation of the current study is that data were not collected on participants' play skills. During intervention sessions, the experimenter observed Landon and Aaron engaging in appropriate imitation and play during the *community helpers* play set. For example, the participants actively engaged in dress up routines (dressing up like a firefighter) and playing with toys from the toolbox. However, it was observed that participants engaged in more problematic behaviors (e.g., eloping and repetitive play) during the *cleaning* and *grocery* sets. As research has shown that play facilitates language, participant's lack of engagement in play routines during the cleaning and grocery sets may have affected the rate of acquisition. Given that play skills are of vital importance to the development of language (Kasari, Paparella, Freeman, & Jahromi, 2008), the lack of data collected on collateral play skills is a major limitation of the current study. Therefore, the study was unable to identify whether participant's play skills impeded their learning.

In conclusion, the results from the current study provide extended information on the effectiveness of an NET instruction to children with no prior tact training history. Although the results of intervention suggest that the procedure may be viable for teaching tacts, it is possible the procedure does not lead to maintenance of tacts over time. Given the outcomes of the procedure, future research is warranted.

APPENDIX

APPENDIX

Table 1.

Participant's Target Stimuli by Set

Intervention	Grocery	Community Helpers	Cleaning
Embedded DTT	Bag	Boot	Mop
	Gum	Keys	Net
	Can	Pen	Rag

Table 2.

Non-Target Stimuli by Set

Play Set	Manufacture	Manufacture's Name of Toy Set	Non-target stimuli included in set
Grocery	Melissa & Doug	Wallet Play	Wallet
			Coupon
			Cash
			Credit cards
			Coins
	Small World Toys	Grocery Shopping Basket	Basket
			Can
			Milk
			Peas
			Pizza slice
	NA	Other	Cash register
			Egg
Community Helpers	Toy Choi's	Toy Construction Tools	Tool box
			Goggles
			Belt
			Saw
			Screw
			Bolts
			Hammer
			Wrench
			Bolt
	SkaDoo	Toddler Rain Boots	Rain boot (yellow)
	Kangaroo	Red Firefighter Hat	Firefighter hat
	NA	Other	Fire truck
			Cone
			Oxygen tank
			Construction vest
			Hard hat
			radio
Cleaning	Melissa & Doug	Cleaning set	Spray bottle
			Rag
			Soap
			Dustpan

Table 2 (cont'd).

Non-Target Stimuli by Set

		Cleaning checklist
Click N' Play	Cleaning set	Squeegee Powder can Cloth Scrub brush Wet floor sign Brush Duster Dustpan Water bucket Broom
NA	Other	Bug

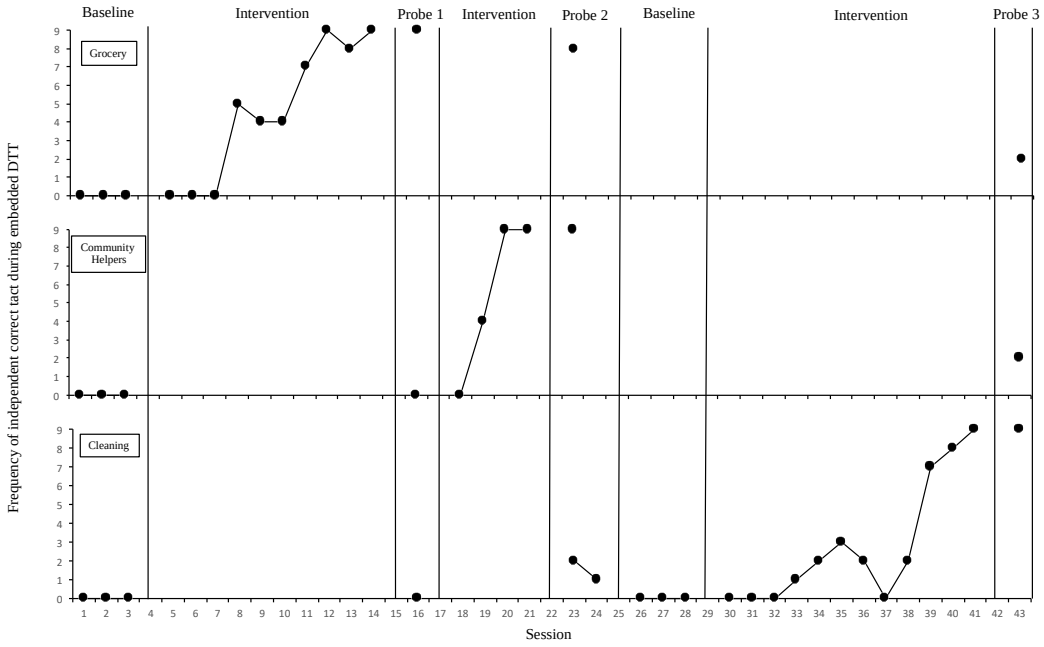

Figure 1. **Landon tact acquisition**. Frequency of independent tacts during NET instruction

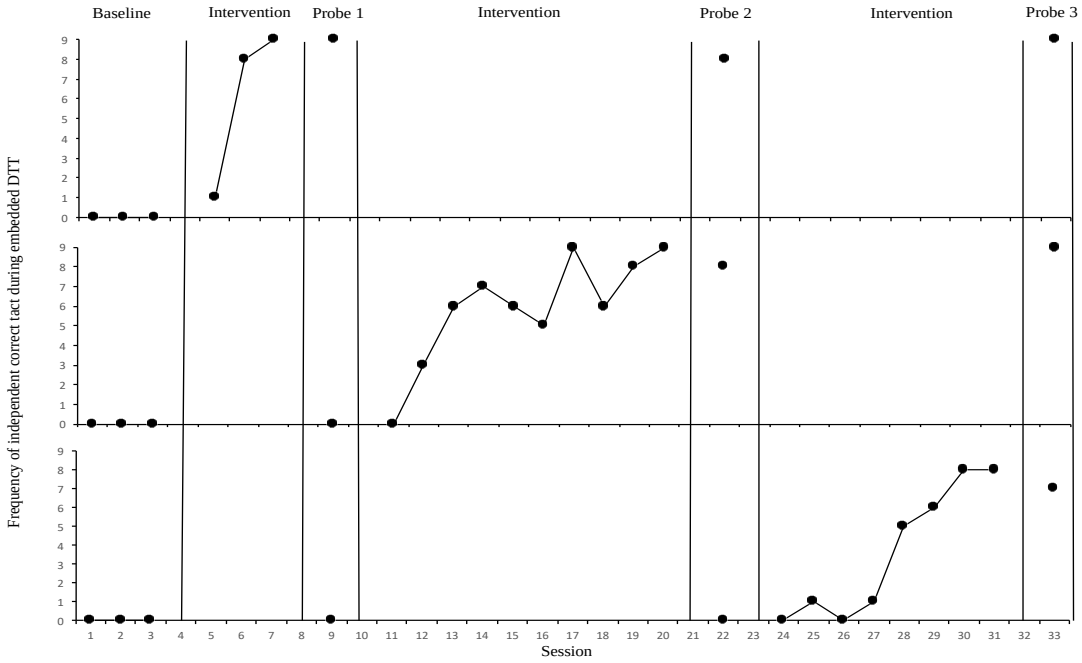

Figure 2. **Aaron tact acquisition**. Frequency of independent tacts during NET instruction

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