EFFECTS OF ORAL MOTOR IMITATION BEHAVIORAL FLUENCY ON MEASURES OF ECHOIC BEHAVIOR

A Dissertation in Special Education

by

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ABSTRACT

The proposed study examined the effects of behavioral fluency in oral motor imitation on echoic behavior in elementary children with autism. A multiple baseline multiple probe design was employed across students. The researcher examined (a) what are the effects of acquisition and behavioral fluency in a component oral motor skill on the composite skill of echoic behavior; and (b) does behavioral fluency in oral motor imitation result in retention of the target behavior for children with autism. Results of the study indicate behavioral fluency in oral motor imitation increases the behavior frequency of echoic measures of the target vocalization and that children with ASD retain echoic behavior over long periods of time.
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Effects of Oral Motor Imitation Behavioral Fluency on Measures of Echoic Behavior

Autism is a growing epidemic in the world today, with a prevalence of 1:110 children being diagnosed (Rice, 2009). More children are diagnosed with an autism spectrum disorder (ASD) than are diagnosed with cerebral palsy, hearing loss and vision impairment (Boyle, Yeargin-Allsopp, Doernberg, Murphy & Schendel, 1996) and the rates of ASD appear to be higher in active military families (Yazbak & Gallup, 2008). Autism spectrum disorders affect a range of social and communicative behaviors including expressive language, receptive language, joint attention, relationships, and play skills (American Psychiatric Association [DSM-IV-TR], 2000). One of the most notable features of ASD is the lack of communicative spoken language which for most children will remain significantly delayed without intensive interventions (Bryson, Clark, & Smith, 1988; Rutter, 1985).

Interventions based in behavior analysis have demonstrated increases in vocal behavior (e.g. Lovaas, 1977). Behavioral interventions can be conducted for up to 40 hours a week with a child in a 1:1 setting at home, school or clinic environments providing multiple opportunities for skill practice (Eikeseth, Smith, Jahr, & Eldevik, 2002; Green, Brennan & Fein, 2002; Maurice, Green & Luce, 1996; Smith, Buch, & Gamby, 2000). Applied behavior analysis (ABA) has been known, in part, for the development and research on effective methods of skill development, functional demonstration of control over behavior change, focus on objective descriptions of contingencies surrounding behaviors, and the social importance of behavior change (Baer, Wolfe, Risley, 1968). Following the descriptive article on applied behavior analysis by Baer, et al. (1968), Hingtgen and Bryson (1972) compiled an annotated bibliography on research related to early childhood psychosis, including autism. One section from the bibliography highlighted behavioral interventions from 1964 through 1970. Operant conditioning and reinforcement
procedures were found to increase target behaviors and reduce problematic behaviors in the target populations, most of which were children with ASD. Kahng, Iwata and Lewin (2002) conducted a review of behavioral treatment specific to self-injurious behavior (SIB) covering the period from 1964 through 2000. They noted an increase in reinforcement procedures and a decrease in punishment procedures over time, and noted the overall effectiveness of behavioral procedures to reduce SIB within the reviewed studies. Reviews demonstrating the effectiveness of behavior analytic procedures, such as the ones previously described, have provided the foundation for scientific, government and private agencies to recommend ABA as the best practice for treatment for children with ASD (e.g. American Psychological Association, 1989; Department of Health and Human Services, 1999; National Institute of Mental Health [NIMH] 2004; Wilczynski, 2009).

Many current behavioral programs for children with ASD are based on the seminal work of Lovaas (1987). Intensive behavioral interventions are recommended for children with ASD at a minimum intensity of 30 hours a week (Green, 1996; Lovaas, 1987) and focus on bringing skills to a mastery criterion such as 80% accuracy for three consecutive sessions, or 90% accuracy across two sessions (Maurice, et al., 1996; Weiss, 1999). Skills are taught systematically and gradually increase in complexity over time. During intensive intervention, children with ASD may benefit from the targeting of pre-speech behaviors to build a foundation from which to shape future verbal communication. A range of deficits in communication related skills are present within the ASD population, including joint attention, eye contact, gesture use, echoic behaviors, and imitation (McDuffie, Turner, Stone, Wolery & Ulman, 2007; Rogers & Pennington, 1991; Roeyers, Van Oost, & Bothuyne, 1998).
Imitation is an early instructional component in behavior interventions (Maurice, et al., 1996) and has been demonstrated by research to be correlated to later language development (Charman, Baron-Cohen, Swettenham, Baird, Drew, & Cox, 2003; McDuffie, Yoder & Stone, 2005; Stone, Ousley, & Littleford, 1997; Thurm, Lord, Lee & Newschaffer, 2007; Toth, Munson, Meltzoff & Dawson, 2006). Interventions based on ABA curricula have used physical imitation as a precursor to echoic behavior (Baer, Paterson & Sherman, 1967; Green, et al., 2002; Lovaas, 1977; Maurice, et al., 1996). The association between motor imitation and echoic behavior is supported by research demonstrating motor imitation in pre-speech children is a predictor of later vocal skills (Luyster, Kadlec, Carter, & Tager-Flusberg, 2008; Stone & Yoder, 2001) and related to later language output, specifically in children with a developmental delays such as ASD (Stone, Ousley, & Littleford, 1997; Thurm, et al., 2007). A series of studies conducted by Gernsbacher, Sauer, Geye, Schweigert and Goldsmith (2008) supported a relationship between physical imitation and language development, highlighting the role of oral and manual motor imitation skills in the prediction of later language development. Results suggest a strong association between early oral and manual motor skills and later speech fluency in children with ASD.

Viewing oral motor imitation as a potentially important component of speech production provides the basis for further examination of oral motor imitation and language development. If a child cannot manipulate the oral muscles and orchestrate the combination of oral muscle movement with vocal cords and air passage, speech production would be very difficult indeed. Conducting a structural analysis on speech production would demonstrate the physical component of oral muscle control necessary for the production of sounds. Deficits in imitation and speech production are evidenced in children with ASD leading to the use of interventions
based on imitation training and echoic development (Lovaas, 1977; Rogers, Hepburn, Stackhouse, & Wehner, 2003). As with motor imitation, echoic behavior (i.e. vocal imitation) has been found to be significantly correlated to later language development (Siegel, 1981; Thurm, et al., 2007). Echoic behavior precedes the development of increasingly complex verbal behavior, establishing an echoic repertoire as a prerequisite for verbal conditioning (Hartung, 1970; Sundberg & Michael, 2001).

Skill proficiency as demonstrated by mastery criterion has not been shown to facilitate long term maintenance, generalization, or foster more complex skills (Fabrizio, 2003). Though extensive and intensive, behavioral interventions for children with ASD typically do not include a behavioral fluency component (Matson, Benavidez, Compton, Paclawskyj, & Baglio, 1996; Fabrizio, 2003; Weiss, 2001). Behavioral fluency programs build the performance rate to a fluency criterion which is typically set by (a) peer comparisons, (b) percentage of improvement over baseline and previous scores, or (c) comparison to behavior rates attained by individuals deemed to be proficient in the skill (Evans & Evans, 1985; Pennypacker & Binder, 1992).

Behavioral frequencies that occur at a specified performance criterion have been associated with application of the skill to more complex skills, retention of the skill over time, and increased behavioral stamina (Binder, 1996). Application refers to learning component skills to behavioral fluency performance levels and “applying” the learned skill to a composite skill. Composite skills are learned at a faster rate once the component skill reaches behavioral fluency aims (Binder, 1996). When examining sound production as a composite skill, related component skills include movement of the mouth, lips, tongue, vocal cords and breath control. For example, when a child says “ahhhh” the mouth is open, tongue on the floor of the mouth, and vocal cords are activated. The components of the sound output include (a) open mouth; (b) tongue on base
of mouth; and (c) activation of vocal cords. The overtly physical movements of opening the mouth and tongue placement may be facilitated by a therapist whereas instruction in breath control may prove to be more difficult to prompt. Interventionists, such as speech and language pathologists as well as behavioral interventionists, have included instruction in oral motor movements as a part of facilitating language (Maurice, et al., 1996; Sparks, 1989).

Behavioral fluency procedures and outcomes have been researched and used as intervention components in the fields of education and behavior (Ardoin, McCall & Klubnik, 2007; Johnson & Layng, 1992; Lin & Kubina, 2005) yet there remains a paucity of peer reviewed research examining the use of behavioral fluency instruction within ABA curricula. To date, no research has been conducted specifically on instruction in oral motor imitation behavioral fluency and effects on speech production. Within ABA curricula oral motor imitation precedes verbal imitation (echoic behavior), and therefore decreasing the time and effort involved in acquiring echoic behavior through the achievement of behavioral fluency in oral motor imitation will result in time and costs benefits for the student.

Targeting one potential component of sound production, the oral motor movement, and bringing the skill to behavioral fluency performance criterion imitatively, it is hypothesized the student would apply the skill of oral motor imitation to the more complex skill of echoic behavior of a sound from which the oral motor movement is a component. The specific experimental questions asked are (a) what are the effects of acquisition and behavioral fluency in a component oral motor skill on the composite skill of echoic behavior; and (b) does behavioral fluency in oral motor imitation result in retention of the target behavior for children with autism.
Methods

Participants

Prior to contact with potential participants, study approval from the Pennsylvania State University Institutional Review Board (IRB) through the Office for Research Protections was attained by the primary experimenter. Following IRB approval, an informational letter describing the study was sent home to parents of potential student participants (Appendix B). Interested parents then had the option of contacting the primary experimenter to meet to discuss participation. During the meeting with the parents, the primary experimenter provided parents with a participant consent form (Appendix C), a child information questionnaire (Appendix D) and a social validity pre-intervention questionnaire (Appendix E). To participate in the study, parents were required to complete the questionnaires and sign the parental consent form for student participation. During the meeting the parents had the opportunity to ask questions and to discuss the intervention.

Three participants in an autism support classroom were targeted to participate in the study. Student participants received an independent diagnosis of an autism spectrum disorder prior to the onset of the study. Inclusion criteria for the study included students be between the ages of four to six years old, autism diagnosis, lack of physical impairment to speech, and echoic behavior of five or less sounds out of 22 modeled sounds. Twenty of the pre-assessment sounds were taken from the Early Echoic Skills Assessment (EESA) found in the VB-MAPP (Sundberg, 2008) and two additional sounds that are common within behavioral echoic programs were added. The EESA was developed by Dr. Barbara Esch, CCC-SLP and was included as a subtest within the VB-MAPP to test student performance on echoic behavior. The assessment includes five levels of echoic skills, ranging from simple and reduplicated syllables to prosody. Dr. Esch
has published several peer reviewed articles on echoic behavior (e.g. Esch, Carr, & Michael, 2005; Esch, Esch, McCart, & Petursdottir, 2010; Esch, LaLonde, & Esch, 2010) and given the VB-MAPP is an available behavior skill assessment for children with autism, the EESA was chosen as the basis for a pre-assessment for participants within the study. The pre-assessment occurred prior to baseline and was used to identify a common dependent variable for all three students.

Student one, known as “Jermaine”, was five-years-seven-months old at the time of the study. He had been receiving behavioral services approximately two years with hours in the home and school environments. For the duration of the study, Jermaine received 37 hours of 1:1 therapy across settings a week and eight hours a month of Behavior Specialist Consultant services. Jermaine attended a specialized preschool prior to kindergarten where he received speech, occupational therapy, and physical therapy services. He was not prescribed medication at the time of the study. Jermaine’s behaviors were characterized by difficulty attending to others in his environment, fleeting attention to tasks, escape behavior when instructions were given, elopement, aggression, self injurious behaviors, and minimal communication skills. Per parent report, he had a scant vocal vocabulary and did not point to items he wanted, though he would lead adults to the area in which the desired item is located. Parents reported Jermaine demonstrated slow acquisition of skills over the course of his involvement in early intervention preschool and behavioral services. He could follow simple one step instructions and imitation of gross motor actions. Within the three months prior to the onset of the study, Jermaine began to echo some basic sounds during his therapy sessions at home, though by parent report he echoed fewer than five sounds or words. During pre-baseline assessment, Jermaine was on the cusp of
inclusion to the study as he echoed five of 22 sounds. During pre-assessment he was attentive and followed instructions.

Student two, referred to as “Antoine,” was six-years-one-month of age at the start of the study. Antoine had previously been participating in behavioral services, specialized preschool, speech, occupational, and physical therapy. When enrolled in kindergarten, Antoine continued to receive specialized services including speech, occupational therapy and physical therapy. Antoine received biomedical treatment in the form of vitamins and herbs provided by parents as well as being on a gluten and casein free diet. Parents reported a lack of spontaneous communication, but he would attempt to echo sounds, lead adults to an item he wanted, responded to his name, followed simple instructions and was compliant with instructions. Antoine had difficulty with imitation of others. Though Antoine attempted to echo sounds and words, parents reported he echoed less than 5 sounds/words consistently and had fleeting attention to others in his environment. During pre-baseline echoic assessment, Antoine attempted many of the sounds though intelligibility was poor. Due to unintelligibility of sounds, Antoine met inclusion criteria of five or less echoed intelligible sounds.

Student three, known as “Zack,” was five-years-eleven-months of age at onset of the study. As with other students, he also had previously participated in specialized preschool, speech and occupational therapy. Zack was not on medication. Zack was not receiving behavioral services at the onset of the study, but by week five of the study he was receiving services in the home and school. Zack’s parents reported he would pull an adult to the location of a desired item and would use some sounds and gestures to mand. Zack followed simple instructions and attempted to imitate actions and sounds. During all three sessions of pre-baseline assessment Zack was non-compliant, non-attentive and non-responsive. Zack was difficult to keep on task as he
repeatedly stood up, attempted to leave the area, yelled, and flopped on the floor. He needed light physical and repeated verbal prompting to follow simple instructions.

**Setting**

Intervention was conducted in an autistic support classroom within a public school in rural Pennsylvania. Staff in the classroom included the teacher, a teaching assistant, and therapeutic support staff. The intervention was primarily held in a corner of the classroom away from regular educational activities. Intervention location included a child sized chair for the student to sit in during the intervention. The research assistant was a behavioral therapist who had received training from the experimenter in past through a local behavioral services company. The research assistant had prior experience implementing behavioral interventions with children with ASD. The experimenter and research assistant sat facing the student during interventions. Reinforcement for each student was based on the results of a stimulus preference assessment and was specific to each individual student.

**Pre-Intervention Assessment**

The experimenter conducted an assessment of echoic skills across three sessions with each potential participant using a combination of syllables from level one of the EESA and two additional common sounds (Appendix F). The experimenter worked with students individually at the identified intervention location in the classroom to familiarize students with working in that area. The experimenter assessed each student’s initial echoic repertoire by instructing student to “say (sound)” and recorded the student’s responses as an echoic match, an attempt, or no response. Twenty-two sounds were probed with the students across three sessions. The sound the students consistently did not imitate became the dependent variable.
Materials

Materials needed for the intervention included a video camera to record sessions for reliability, a chair for the student to sit in, potential reinforcers for each student, and data collection forms. The experimenter organized materials prior to beginning the session with each student. Materials stayed in the classroom in a locked cabinet for use by the research assistant and the experimenter.

Dependent Variable

The sound missed most frequently across the three pre-assessment sessions by all three participants was “nee”. The frequency of the imitated target sound per 20-second timing served as the dependent variable. The target sound was measured following intervention. The number of correct and incorrect responses was recorded on a Standard Celeration Chart (SCC) for analysis (Graf & Lindsley, 2002). The SCC provides a measure of behavior frequency called celeration. Celeration is a unit of measure that is count/time over time. Celeration permits the quantification of learning by a celeration multiplier. For example, a X2.0 (said times two) means the frequency of a behavior doubled in a week. The terms acceleration and deceleration refer to increasing and decreasing frequencies of learning over time respectively. Correct responses, noted on the SCC with a single dot, included audible vocal imitation of the modeled sound within two seconds of the presentation of the sound. Incorrect responses, recorded with an X, included sound production that did not match the sound modeled by the experimenter, no audible response after a two second pause, unintelligible sounds, or repetitive sounds.

Independent Variable

The independent variable was delivered in two phases. Within both phases, correct responding involved the topographical matching of the modeled oral motor movement and
incorrect responses included no response after a 2-second pause and actions that did not topographically match the modeled oral motor action. The targeted oral motor movement was derived from the physical oral motor movements involved in the production of the sound “nee”. The action involved opening the mouth in the form of a semi-smile and touching the tongue to the back of the top, front teeth. Due to the difficulty in visually observing this movement, slight protrusion of the tongue past the teeth was permitted as an acceptable response. Tongue protrusion past the lips or placement other than touching the back of the top teeth was considered an incorrect response.

The first phase, acquisition of oral motor imitation of the target movement, involved teaching oral motor imitation to an acquisition criterion through the use of 20 discrete trial instructions. Criterion for the acquisition phase involved a correct responding rate of at least 50% for two of three consecutive sessions. Percentage of correct responses per session was graphed on an interval graph. Students moved on to intervention phase two, frequency building to a performance criterion, once the accuracy criterion is achieved. Frequency building to a performance criterion (FBPC) consisted of five 10-second practice trials to increase behavioral fluency in oral motor imitation. Students were presented with a model of the oral motor movement at a minimum of every two seconds for 10-second timing. Students reached the performance criterion when they matched response rates based on peer response frequency comparisons (seven correct responses with one or less incorrect responses in 10 seconds). The current performance criterion parallels performance criterion for see/do oral motor imitation as identified by Fabrizio and Moore (2003).
Retention

A retention assessment on the dependent variable was conducted a year following the completion of the study and was conducted on all three students. Retention check included measures of the dependent variable collected during a 20-second timing of echoic behavior. Students were provided one practice trial for 20-second, then a second 20-second trial was conducted for data collection. Students were provided a choice of potential reinforcers for participation in the retention check session.

Experimental Design

A multiple baseline multiple probe design across students (Horner & Baer, 1978) was used to determine if a functional relationship existed between behavioral fluency in oral motor imitation and echoic responding. The multiple baseline multiple probe across students design provided control over environmental factors that may have influenced results, such as teaching, various therapies, and other classroom variables. During the first week baseline was conducted for three sessions on each student. For the remainder of the study, baseline data was only collected once a week to probe baseline skills until the student began intervention phase one. The first student started phase one of intervention once a stable baseline was established. Upon the first student meeting acquisition criteria, the next student started phase one. This process was continued until all students were receiving intervention.

Procedures

Baseline. During baseline, the experimenter prepared the intervention area and called the students over to sit in the provided student chair. The experimenter set a timer for 20-second and presented an instruction (“say”) then the target sound (“nee”) followed by a two second pause. The experimenter continued this sequence until the timer beeped then recorded the frequency of
correct and incorrect echoic responses on an SCC. The experimenter provided a choice of potential reinforcers and verbal praise for participation. No verbal or physical feedback on responding was provided during the baseline condition. Initially three consecutive days of baseline data were collected. Upon the beginning of intervention with the first student, baseline continued for subsequent students in the form of weekly probe data to assess the effects of maturation and extraneous variables the students may have been exposed to during the course of the study.

Upon entrance to intervention phases, measurement of the dependent variable occurred following the intervention sessions. At the end of each intervention session the experimenter started a timer for 20 seconds and provided the verbal instruction, “Say nee” and waited up to 2-second for a response. If the student did not respond within 2-second, the experimenter presented the sound again. After the student responded, the experimenter presented the verbal instruction again and modeled the target sound. The experimenter stopped presenting the instruction and target sound when the timer beeped at 20-second and then documented the number of correct and incorrect responses in which the student echoed the target sound on an SCC.

**Acquisition Phase.** Prior to beginning intervention, the experimenter ensured materials were available and present. The experimenter called the student to come over and sit down in the student chair. The experimenter presented 20 acquisition mass trials of the target oral motor action, lifting the tongue to touch the back of the top teeth with lips open in a half smile. For each trial, the experimenter instructed “do this” and modeled the targeted oral motor behavior. If the student did not imitate the modeled behavior, the experimenter used a least to most prompting strategy which included first an exaggerated model of the movement, then the
exaggerated movement with the experimenter pointing to her own face to bring attention to the movement, then the model accompanied by verbal instruction and physical tap or point to the student’s mouth/teeth. Successive approximations to the target behavior were shaped over time through differential reinforcement. Within each trial, students were allowed up to two seconds to respond independently. If no independent response was forthcoming, or if the student began to engage in an incorrect response, the experimenter prompted the student to perform the action. Independent imitation of the targeted oral motor behavior was reinforced verbally by the experimenter. The experimenter then presented the next trial by giving the instruction “do this” and modeling the targeted oral motor action. This process was repeated for all 20 trials. Upon completion of the 20 trials, students were offered a choice of potential reinforcers to play with for up to one minute. The experimenter recorded the number of prompted, correct and non-responses and graphed the percentage of correct responding on an interval graph. Measurement of the dependent variable followed each session. A criterion for the acquisition phase was met when the student responded correctly for 50% for two of three consecutive sessions.

**Frequency Building to a Performance Criterion (FBPC).** Once each individual student had met acquisition criteria, the student began behavioral frequency building to a performance criterion. Performance criterion aims were based on a sample of typical peers matched for age (5 and 6 yr olds) as conducted by the experimenter. A sample of five typical peers indicated behavioral fluency for imitation of the oral motor movement specified within this study is within a range of 6-8 imitative oral motor movements with one incorrect response during a 10 second interval. Building from this range provided by typical peers, the criterion for oral motor imitation of the targeted movement was seven imitations of the movement during a 10-second trial with only one incorrect. Over the course of one hour, the experimenter conducted five 10-
second FBPC trials on oral motor imitation of the targeted oral motor behavior. The experimenter prepared the intervention location as was done during the acquisition phase, and called the student over to sit in the provided chair. Prior to starting a timer, the experimenter said “do this” and modeled the targeted oral motor behavior. After presenting the model of the oral motor movement up to two seconds was provided for the student to respond before the experimenter modeled the specified movement again. The experimenter began the timer upon the first response of the student. The experimenter ended the FBPC trial when the timer beeped and provided verbal feedback or prompted instruction using a least to most prompting hierarchy for the targeted oral motor movement. At the end of each 10-second FBPC trial, the experimenter verbally praised the student for participation and provided choice of potential reinforcers for the child to play with for up to one minute. Correct and incorrect responses were recorded. A sixth FBPC trial was conducted for charting behavioral frequency on a SCC for analysis.

**Procedural Integrity**

Procedural integrity on the experimenter’s implementation of interventions was assessed by observation of at least 20% of sessions and documenting a match to the methods described herein. The experimenter instructed a research assistant to implement the procedure and data collection for occasions when the experimenter was not available. The identified research assistant had received previous instruction in behavior management, use of variable ratio schedules of reinforcement, prompting procedures, shaping successive approximations, differential reinforcement and data collection as well as experience implementing behavioral programs with children with ASD. Prior to conducting intervention with students, the research assistant attended a two hour training reviewing basic behavioral principles and was provided
with written instructions for conducting the study summarizing the procedure and target behavior. Instructions were reviewed and discussed during follow up training sessions. Five video clips of the intervention and baseline conducted by the experimenter were observed by the research assistant prior to the research assistant working with students. During the first two videos, the experimenter discussed the format and related it to the experimental instructions. Data was collected on the video by both the experimenter and the research assistant. Initial reliability was at 70%. A criterion for responses was discussed again. During observation of the fourth and fifth intervention videos both the experimenter and research assistant collected data. A reliability of 90% for each video was attained. The research assistant rehearsed intervention procedures and data collection until obtaining 100% accuracy. When the experimenter was unavailable, the research assistant was instructed to video record the sessions. The experimenter rated the video and compared data for reliability. Reliability on recorded sessions remained between 90-100%.

**Results**

The current study examined the effects of frequency building to a performance criterion (FBPC) of an oral motor behavior on an echoic behavior for three students with ASD. A multiple baseline multiple probe across participants design was used to examine whether a functional relationship existed between the independent and dependent variable. Figure 1 displays the dependent variable across students charted on Standard Celeration Charts (SCC) (Pennypacker, Gutierrez, & Lindsley, 2003) prepared on an Excel template (Graf, 2010) in multiple baseline format for visual comparison across participants. Figure 2 provides a magnified version of the students’ charts for a more detailed visual analysis. Table 1 summarizes the celeration multipliers for students across phases of the independent variable. The SCC was used to provide a visual examination of frequencies of behaviors in calendar time.
The advantages of displaying behavior in calendar time are seeing the impact of the intervention in real units of time, examining the effects time off missed during the experimental phases (e.g., weekends, illnesses) has on student behavior, and a fair depiction of how the intervention unfolded across time (Kubina, & Yurich, in press). Additionally, the SCC provides a unit of measurement called celeration defined as a “dimensional quantity that describes change in the frequency of responding over time” (Johnston & Pennypacker, 2009). A number of additional advantages are listed in Graf and Lindsley (2002) and Pennypacker, Gutierrez, and Lindsley (2003).

The conventions used for charting in Figures 1, 2, 3, and 4 are a dot for correct responses and an X for incorrect responses. The horizontal dashes on the 3 frequency line (number 3 not shown, 3 appears between the 1 and 5 on the left-hand side of the chart) represent the 20 second observation time for the dependent variable echoic behavior “nee”. The horizontal dashes are called time bars and are standard conventions that represent the precise amount of time spent measuring the target behavior (Graf & Lindsley, 2002). When a dot or an X falls below the time the count means zero. The SCC converts all frequencies to a per minute count (as indicated by the vertical axis label “Count Per Minute”). The lines drawn through the corrects (i.e., dots) and incorrects (i.e., X’s) are celeration lines. The celeration measures the weekly amount of learning. A X2.0 means the behavior doubled in a week. Celeration measures reported in this dissertation also have the time unit attached to the celeration to show the exact amount of days for which the behavior accelerated or decelerated. Dotted vertical lines indicate a phase change with each label and an arrow describing the phase. The last part of the chart is the bottom of the labels contain all relevant information regarding each student, these are called labeled blanks and describe the who, what, where and when of the charted behavior (Pennypacker et al, 2003).
All three students completed three days of baseline prior to a holiday break and intervention began following the holiday break. Jermaine did not echo the target sound “nee” correctly during baseline and had X1.0 celeration/3 days. His incorrect responses did accelerate by X1.86/3 days with a range of 5-8 incorrects during the 20-second timing. Due to zero correct responses for all three sessions of baseline, Jermaine’s data did not show a change in trend or level and remained stable. Additionally, Jermaine’s incorrects were accelerating, therefore, Jermaine entered into the acquisition phase first.

During the acquisition of oral motor imitation phase, Jermaine’s responding on echoic measures ranged from 0-6 correct responses and 2-9 incorrect responses indicating high variability in both. Jermaine’s correct echoic responding decelerated by ÷1.84/33 days after an initial jump up in correct responding. His incorrect responding accelerated after an initial jump down in frequencies. Overall Jermaine’s X1.30/33 days of incorrects during acquisition of the oral motor movement demonstrated a worsening of performance. During the acquisition phase Jermaine began to echo the target sound at higher rates than he had during baseline. Within the first four sessions of acquisition, Jermaine echoed the target sound three to six times then on subsequent sessions his echoic behavior decreased, resulting in a downward trend for correct responding.

Echoic measures resulted in an accuracy improvement measure (AIM) of ÷2.39. The AIM provides “a picture of learning, defined as improvement in the quality of behavior over time” (Pennypacker, et al., 2003, p. 68). Therefore, a ÷2.39 means the overall quality of the behavior as measured by accuracy worsened by 2.39. Jermaine met acquisition criteria for oral motor

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1 A minimum of 5-7 data points is necessary to draw celeration line (Graf & Lindsley, 2002). There were two instances when the students had less than the minimum of 5 data points. One was in Jermaine’s baseline and second was during Zack’s FBPC phase. Therefore reader should exercise caution when interpreting the celerations in those two phases.
imitation after 13 total acquisition sessions across 33 calendar days, responding with 70% accuracy the day before another holiday break for school and 55% upon return to school. A death in the family occurred over the holiday break which affected the family dynamics and Jermaine’s school schedule to a significant degree.

Upon meeting acquisition criteria of 50% accuracy in responding for oral motor imitation of the target movement, Jermaine began the FBPC phase, Figure 2, on calendar day 46 of the study. On calendar day 138 of the study, following 46 sessions of FBPC, he reached the oral motor imitation performance criterion of seven correct responses and one error. Jermaine’s correct responding on imitating the oral motor movement accelerated modestly by X1.10/92 days and incorrect responses decelerated by ÷1.04/92 days, almost no change. Jermaine’s FBPC of oral motor imitation resulted in an AIM of X1.14. During FBPC correct responding on echoic behavior accelerated X1.10/92 days and incorrect responding decelerated ÷1.00/92 days or stayed the same, with an AIM of X1.10 indicating a modest overall improvement. A comparison of acquisition and FBPC echoic results demonstrated a trend change from one phase to the other, as responding during the acquisition phase resulted in a downward trend then changed to an upward trend during FBPC. Correct echoic responding had increased variability and incorrect responding variability decelerated becoming less variable.

The other two students remained in baseline until Jermaine entered FBPC. Antoine responded with three correct echoic responses the first day of baseline then with one correct response during day two and three of baseline. Antoine’s responses ranged between 6-10 incorrect responses during initial baseline. Over the course of weekly dependent variable measures, Antoine responded in a range of 2-4 correct responses and 5-9 incorrect responses. Antoine’s correct echoic behavior showed an acceleration X1.01/44 days, remained the same,
during baseline and incorrect responses decelerated very slightly by $\div 1.07/44$ days. An AIM of X1.08 was demonstrated through baseline which suggested a minimal change in accuracy of responding. Antoine entered into intervention the second due to the stability of correct celeration rates and a very minimal worsening of his incorrect echoic responding. Zack continued to have difficulty with instruction and demonstrations of aggressive behavior throughout baseline and was entered into intervention last to provide time for him to adjust to working with a new adult (i.e., the experimenter).

Antoine began the acquisition of oral motor imitation phase on calendar day 46, following Jermaine meeting acquisition criteria for oral motor imitation. During the acquisition of oral motor imitation phase, Antoine’s correct responding on echoic behavior of the target sound “nee” initially jumped up in level but decelerated by $\div 1.68/22$ days, a rapid downward trend. Incorrect responding also increased in level from baseline, and accelerated slightly by X1.04 /22 days. The AIM decreased $\div 1.75$ which signaled a worsening of accuracy for the phase. Correct echoic responses ranged from 0-3, and incorrect echoic responses ranged from 6-10 responses during the 20-second timings. Antoine met oral motor imitation acquisition criteria after 10 sessions and entered the FBPC phase. Antoine’s oral motor imitation FBPC chart is provided in Figure 3.

Antoine began the FBPC phase on calendar day 71 of the experiment. Measures of echoic responding showed a significant level increase from the previous phase and an acceleration of X1.18 /67 days for correct responding and a slight deceleration of $\div 1.02/67$ days as well as a level decrease in incorrect responses. Correct and incorrect responding during FBPC was highly variable. During FBPC correct responses of oral motor imitation accelerated very slightly by X1.04/67 days and incorrect responses decelerated modestly, $\div 1.10/67$ days. Antoine’s response
frequency resulted in an AIM X1.14, an overall improvement. Antoine did not meet performance criterion for oral motor imitation fluency within the time constraints of this study. His highest response rate of oral motor imitation during FBPC was five correct responses with one incorrect. For the last 13 sessions his responding leveled at 1–3 correct responses. Antoine’s correct and incorrect responding was moderately variable during FBPC. As with Jermaine, Antoine’s responses resulted in a downward trend during acquisition, and an upward trend during FBPC.

Zack’s responding during his two month baseline, Figure 4, remained stable with 0 correct responses and 5-6 incorrect responses. During baseline, Zack continued to engage in tantrum behaviors and was under weak instructional control. Throughout the initial three days of baseline and weekly probes of the dependent variable, Zack’s echoic responding level was stable at 0-1 correct response while incorrect responding was highly variable. Correct responding accelerated by X1.02/72 days and incorrect responding accelerated X1.03/72 days throughout baseline data collection and remained level; both celeration measures indicated stability of performance. Zack’s AIM ÷1.05 meant the quality of his responding was not improving over baseline. Zack began the acquisition of oral motor imitation phase on calendar day 73, when Antoine met the acquisition criterion.

During the acquisition phase, Zack’s data on echoic responding indicate correct responding accelerated by slightly by X1.08/29 days and incorrect responding decelerated by ÷1.09/29 days, signifying a change from baseline performance and more accurate responding with an AIM of X1.18. Correct echoic responding resulted in an upward trend during acquisition, and incorrect responding resulted in a slight downward trend. An increase in level of correct echoic responding from baseline to the acquisition phase was observed, though incorrect responding
level remained primarily stable. Acquisition phase resulted in moderate bounce of incorrect echoic responses and a slight bounce of correct echoic responses including two outliers. Zack met acquisition criterion of oral motor imitation in 14 sessions, on calendar day 102 and began FBPC the following week on day 106.

Zack met FBPC aim for oral motor imitation of seven correct responses and one incorrect response within four FBPC sessions. Zack’s incorrect responding on oral motor imitation accelerated X1.0/4 days and his correct responding accelerated by a very large X5.2/4 days. During FBPC Zack had his highest frequency of correct responding on the dependent variable at three correct responses with nine incorrect responses. FBPC corrects echoic responses decelerated ±1.45/4 days and incorrect responses also decelerated ±2.40/4 days after a jump up in level, resulting in a significant AIM X3.48. The reduction of errors indicates improvement in the quality of responding. A high variability in correct responding and moderate variability in incorrect responding was evidenced.

**Retention**

Retention of echoic behavior was measured 13 months following the completion of the study. Students worked individually with the experimenter. A practice trial was provided to reacquaint students with the procedure and with working with the experimenter. Following the 20-second practice trial, a second 20-second trial was conducted for measuring echoic behavior. During the retention checks, Jermaine echoed the target sound seven times with one incorrect response; Antoine echoed the target sound 12 times with two incorrect responses, and Zack echoed the target sound correctly two times with three incorrect responses. During the final week of intervention, Jermaine’s highest level of echoic responding was five correct with four incorrect responses. The retention check on Jermaine indicates a higher level of echoic
responding for the sound “nee” at the 13 month follow up. Antoine’s retention measure on the dependent variable was also higher than responding during the final week of intervention, increasing from an average of 5.4 correct responses and six incorrect responses to 12 correct responses with two incorrect responses. Zack maintained the same level of correct echoic responding from intervention to the retention measure, and had a large decrease of incorrect responding.

**Interobserver accuracy**

The research assistant provided the primary experimenter with video of sessions conducted by the research assistant (one session per participant). The primary experimenter scored behaviors and compared to the research assistant’s scores for each response. IOA was 100% for occurrence and nonoccurrence of target behaviors. The research assistant provided intervention for one week during the duration of the study.

**Procedural Integrity**

Procedural integrity was conducted for 21% of sessions through video observation and recording of intervention procedures for the dependent variable and for both phases of the independent variable. Of the 21% of sessions during which procedural integrity was conducted, 57% of the sessions included video of the dependent variable, 26% included video of the acquisition phase of the independent variable, and 15% included video of the FBPC phase of the independent variable. Within measures of the dependent variable, procedural integrity was 84%, during acquisition 93%, and during FBPC 66%. The experimenter conducted interventions with an overall accuracy of 83%.
Social Validity

Parents were provided with a pre and post intervention questionnaire for social validity of the study. The questionnaire had a Likert scale to indicate level of agreement with questions regarding importance of children with autism spectrum disorders being involved in an ABA program, language skills, oral movement skills, and social behaviors. The scale ranged from strongly disagree (1) to strongly agree (5). Appendix G provides questions and parents’ pre and post responses for comparison. Target questions 11, 12, and 13 measure parental observation on child language skills. Results for question 11, “My child imitates more than 10 sounds or words”, indicates two of three students went from the disagree range to the agree range, the third student scoring strongly agree on both pre and post ratings. Question 12, “My child imitates 5-10 sounds or words” resulted in a one point increase for all participants. Question 13, “my child imitates less than five sounds or words” indicated a score change from agree to disagree for all three students, one of which went from strongly agree in the pre assessment, to strongly disagree in the post assessment. Another question, number 18 “My child imitates the actions of others” was also analyzed to examine if an increase of other imitation had occurred during the study. Only one student recorded a change from pre to post, reducing from agree to disagree.

Discussion

With the widespread and growing increases in children being diagnosed with autism, effective interventions for improving behavior are paramount. Very few studies, however, have examined the combination of behavioral fluency procedures and interventions based in applied behavior analysis and the outcomes for children with ASD. By combining methods from the two applied sciences, students may reap the added benefits of long term retention, endurance and application of basic skills to more complex skills (e.g. Binder, 1996; Kubina & Wolfe, 2005; Weiss, Fabrizio & Bamond, 2008), and the benefits of early intensive interventions (e.g.
Eikeseth, Smith, Jahr & Eldevik, 2007; Weis, 1999). The present study, a combination of behavioral fluency and an acquisition strategy from ABA, examined whether teaching an oral motor skill in imitation to a behavioral fluency criterion could lead to application of the element skill to the compound behavior of speech production through echoic measures. The experimental questions asked were a) what are the effects of attaining acquisition and behavioral fluency with oral motor imitation on an echoic behavior and b) does the outcome of retention as demonstrated in behavioral fluency programs apply to children with ASD?

**FBPC Effects on Echoic Behavior**

The element oral motor behavior targeted for imitation was the tongue and mouth formation for the sound “nee” with the compound echoic behavior being the vocal production of the sound “nee.” In children with ASD, application of an element skill to compound skill has been demonstrated in the areas of visual patterning (Fabrizio & Schirmer, 2002), sound imitation (Foley & Fabrizio, 2005), complex math skills (Singer-Dudek & Greer, 2005) and pronoun labeling (Moors & Fabrizio, 2002). The present study further supported application as a result of frequency building to performance criterion (FBPC) in children with ASD. A functional relationship between the oral motor imitation intervention and echoic measures was demonstrated through the multiple baseline multiple probe design.

The effects of the intervention on the outcome measures are highlighted by the stable baseline of students not receiving intervention. In particular, it is notable that Zack was in baseline condition for two months without significant changes to the acceleration of his echoic behavior. Zack’s echoic measures accelerated slightly during acquisition and incorrect responses decelerated. During FBPC Zack scored his highest echoic response rate of three correct responses in 20-second, as well as high incorrect responding rates (eight and nine incorrect
responses) indicating an overall increase in response rate and effort. The other two students’
correct echoic celerations decelerated considerably during the acquisition phase then accelerated
significantly during FBPC. Figure 1 illustrates the minimal changes in echoic frequency during
baseline across all three students and celeration changes of echoic frequencies during acquisition
as well as FBPC. The notable acceleration of echoic responding during FBPC phase strongly
indicates a functional relationship between the behavioral fluency intervention and echoic
behavior.

One of the keys for FBPC is to select the proper performance criterion. In the present
study the target performance criterion for oral motor imitation was based on a sample of typical
peer responding. Koorland (1990) provided recommendations for the use of typical peer
samples, first being the use of peers without disabilities and the second to conduct “1-minute
performance samples of the peer(s) for three days and selects the median correct rate and
incorrect rate” (Koorland, p. 65). A sample of peer responding on oral motor imitation of the
target movement was collected and the median of seven correct responses with one error was set
as the target performance criterion for oral motor imitation during FBPC. The use of peer
performance as a performance criterion helps to ensure the skills measured were within
developmental ranges and provided a realistic comparison of performance as the peers sampled
were from the same locale. Based on the results of three students, the performance criterion
appeared to be appropriate for facilitating application with the oral motor skill and the echoic
behavior. The long term retention data, discussed later, further supports the use of the frequency
aim and the method for attaining it.

The celeration measure used in the present study provides a quantitative guideline for
comparing learning across time. Binder (1996) indicated a response acceleration range of
X1.25-X2.0 is an acceptable learning rate. Zack exceeded the range during oral motor imitation FBPC with an acceleration of X5.20. It is also significant that during the acquisition phase Jermaine’s echoic responding decelerated ÷1.84 but then accelerated X1.10 during FBPC, a dramatic turnaround in celeration. Antoine experienced similar phenomena, as his correct echoic responding decelerated ÷1.68 during acquisition and accelerated X1.18 during FBPC. Zack’s echoic correct and incorrect responding decelerated during FBPC by ÷1.45 and ÷2.40 respectively.

Though two students met the performance criterion on oral motor imitation, their celerations were below the suggested learning rates as identified by Binder. One reason for this may be that the target oral motor imitative action was only one potential element of the complex behavior of producing the sound “nee”. There may have been other, more effective oral motor elements not identified by the researchers that would have had greater effects on the echoic behavior. Second, it is possible the students were not used to using the muscles associated with saying “nee” and needed to build up the musculature to increase echoic behavior. Third, in addition to oral motor movements, there are other deficit skills involved in speech production that could have influenced echoic outcomes including breath control, attention to the model, motor planning, matching the action of a model, lip movement control, tongue movement control, and so forth. Even with the previously mentioned considerations, two of three students met oral motor imitation performance criterions and demonstrated progress in echoic measures. The results of this study demonstrate the oral motor imitation FBPC had a significant effect on the production of the sound “nee” when previously students could not echo this sound.

Though changes in correct celerations are an important outcome of this study, the incorrect celerations were equally salient. For example, during the acquisition phase Jermaine’s incorrect
responding accelerated X1.30 then during FBPC decelerated ÷1.00. The change from acquisition to FBPC demonstrated Jermaine’s responses became more accurate and focused as he produced a significantly lower rate of incorrect responses. Though not as dramatic, Antoine also experienced a change from acceleration of incorrect responses during acquisition (X1.04) to a deceleration during FBPC (÷1.02).

The acceleration of correct responding and deceleration of incorrect responding during FBPC for Jermaine and Antoine also indicates the increase in accuracy of responding helped to reduce incorrect responding, and possible use of the skills outside of the intervention parameters. Within the acquisition phase, Zack’s incorrect responding decelerated ÷1.09 indicating an increase of accuracy with responding. Zack experienced a slight acceleration of incorrect responding during baseline, which was conducted over the course of two months. Zack’s extended baseline and stability of his responding during this time strongly indicates any changes in response celeration were due to the interventions and not extraneous variables. In addition to Zack’s extended baseline, it is also important to note that Jermaine and Antoine had been receiving 1:1 intensive therapy for a minimum of two years prior to the onset of the study, and had not to date demonstrated the target echoic behavior. Following the intervention, both students significantly increased their echoic behavior of the target sound.

On the SCC a linear trend can be projected from the behavior frequencies, facilitating the prediction of future behavior frequencies (Pennypacker, et al, 2003). Upon examination of the celeration trends for echoic behavior in the FBPC stage, it can be predicted that given another two weeks of intervention Jermaine’s data would have had a crossover effect wherein the rate of incorrect responding would be lower than the correct responding. Antoine demonstrated the crossover effect during FBPC (Figure 1). Antoine’s ascending trend during FBPC indicates he
most likely would have continued to demonstrate an increase in echoic responding had the intervention continued.

The SCC provides a visual record of behavioral frequencies over real time. On first glance it may appear the intervention occurred for an extended duration for echoic measures of one sound, and in calendar time this was true. An examination of the intervention, however, demonstrates the intervention only occurred five minutes or less per day, not interfering with the regular school schedule or activities. Jermaine’s intervention occurred over 95 sessions, Antoine’s over 53 sessions, and Zack’s over 30 sessions, with each session only lasting a couple minutes. An increase of two to three sessions daily would have reduced the number of calendar days used in the completion of the study. Therefore, the total time of the intervention was not overly burdensome. It is highly probable the intervention could have been conducted throughout the school day on various sounds and oral motor movements as a time effective method of increasing echoic behavior for the children with autism.

Social Validity

The FBPC procedure employed was only conducted for a few minutes daily, making it a beneficial procedure for use within a typical school day of instruction, due to the short duration of the sessions. Even with the short duration of intervention implementation, two of three parents noticed an increase in sound imitation in the home. Prior to the onset of the study, all three sets of parents indicated their child imitated five or less words, but following the study students were observed by the parents to be imitating more than five words at home. All parents agreed they would recommend the current research study procedures to other parents of children with developmental delays.
Retention Outcomes for Students with ASD

Kubina and Wolfe (2005) indicated a positive outcome of attaining behavioral fluency for students with autism is long-term retention of behavior. Retention was 13 months following the completion of the intervention and the data indicate a substantial degree of retention. Jermaine and Antoine exceeded past echoic behavior frequencies and Zack maintained the echoic responding levels he had reached during intervention. The significance of these findings is highlighted in that the students who participated in the study were considered to have low functioning autism and were non-vocal in that they did not have functional communication at the onset of the study. Additionally, for the behavior to still occur so long after the intervention ended meant students most likely were still using the behavior, a possible effect of automatic reinforcement with the tongue movement (independent variable) or the increased sound production (dependent variable).

It is important to note to the significant language deficits of the participating students. Tager-Flusberg, et al. (2009) defines five key developmental phases of expressive language acquisition. Phase one, preverbal communication, consists of babble and gestures to communicate, typically seen in children between the ages of six-to-twelve-months. Phase two involves the use of non-imitative single words used in a variety of settings. Word combinations emerge in phase three, sentences in phase four, and complex language in phase five. The students in this study fit into the phase one category, preverbal communicators.

Additionally, the American Speech-Language-Hearing Association (ASHA) notes that by two years of age typically developing children are combining words into two word phrases to communicate and by kindergarten children can not only follow a conversation, but initiate conversation and have spoken language that is readily understood by most people (ASHA, n.d.).
According to ASHA, difficulty sounds for 4-to-5-year-olds are l, s, r, v, z, ch, sh, and th. Figure 5 illustrates typically emergence of sounds, indicating the “n” sound emerges between the ages of two and three. Given the students in this study were five and six years old, the severe deficit in language development is obvious. Furthermore, in the course of their lifetime, none of the students had learned to produce the sound “nee” but readily echoed the sound following FBPC procedures and maintained or exceeded prior performance levels at the 13 month follow up.

**Behavioral Fluency Intervention and Students with ASD**

Heinicke, Carr, LeBlanc and Severtson (2010) posed critical questions regarding emerging behavioral fluency programs for children with ASD. First, Heinicke et al. ask if behavioral fluency outcomes can be produced in children with ASD. As demonstrated with all three students in this study, the answer to this question on retention and application appears yes, the outcomes of behavioral fluency programs were possible with students with ASD. The present study experimentally examined the package of acquisition of oral motor behavior and FBPC on the echoic outcomes in children with ASD. FBPC of the element skill resulted in the application of performance to the compound skill as well as retention over a year following the intervention.

A second question asked by Heinicke and colleagues is that of identification of curricular areas that are most appropriate for behavioral fluency interventions. This study examined one behavior, oral motor imitation, on another behavior, echoic outcomes, and demonstrated a positive outcome. Another area in need of further examination, as identified by Heinicke, et al., is the specification of which specific methods of building response rate are the most beneficial for children with ASD. This study incorporated FBPC (i.e., multiple practice trials) with reinforcement for participation not contingent on the number of responses and demonstrated
overall improvements on echoic behavior for all three students as measured by celeration and AIM.

And third, Heinicke et al. questioned if behavioral fluency interventions might increase escape related behavior. The results of this study indicate escape was not an intervention imposed problem with the students but had a possible contrary effect. Namely, an increase of aggressive and escape behavior was observed with Zack during the acquisition phase, but during FBPC he was attentive, focused on the experimenter, and sought out the experimenter between sessions. Zack even pushed other children out of their chair when they were working with the experimenter in an effort to gain the experimenter’s attention. Jermaine exhibited fluctuating escape behaviors throughout the study, but in no higher degree than during any other instructional setting, and Antoine was compliant though inattentive throughout, behaviors that were also observed throughout the school day during all activities.

**Study Limitations**

A study limitation occurred with the systematic delivery of sessions during the study. Several missed sessions were due to snow days and illness as the intervention was intended to be conducted daily. Days off from school broke up consecutive sessions for the students at different times over the course of the study, and in differing amounts for each student. Weather interruptions created a reduced number of available consecutive sessions. Students contracted illnesses that affected the number of consecutive daily sessions, as well as the student’s data pre and post sick days. In addition, the death of one of Jermaine’s family members also had adverse effects related to time off school and changes in the home environment and schedule. Another limitation of the study occurred due to a change in 1:1 therapists and novel staff in the classroom, which resulted in reduced accuracy percentages and increased aggression in Jermaine.
Instructional control for Zack was an issue, as Zack had not received any intensive behavioral services prior to the onset of the study and engaged in aggressive escape behaviors all through baseline and acquisition phases.

**Future Directions for Research**

While this study answered some questions regarding behavioral fluency programs and outcomes for three students with ASD, the study focused on a specific element behavior and one compound behavior. Future research should examine a higher acquisition criterion than the one used in the present study. During phase one, acquisition criteria was set at 50% correct responding for two of three consecutive sessions. The acquisition criterion of 50% was arbitrarily set by the experimenter to assure the students had the oral motor movement in their skill repertoire prior to beginning FBPC. It is noted this acquisition criterion was not an accepted mastery criterion, as behavior intervention programs have an accuracy rate of 80% or higher to indicate mastery of a skill (Maurice, Green & Luce, 1996). The lower acquisition percentage could have masked skill deficits in the target behavior. In addition to acquisition criterion, future research might examine how performing at the performance criterion for several days would affect performance. For example, if Zack’s intervention would have continued a few more days to ensure the behavior frequency remained at or above the performance criterion, a precise celeration could have been identified and potentially afforded the students with even more robust results.

Another option for future research related to the acquisition and fluency of behaviors would be the examination of subjects matched on cognitive, verbal, and imitative skills. With the present research study it is unknown what effects a strict matching of skill level would have in alternate outcomes on the dependent variable or number of sessions required for acquisition and
attainment of the performance criterion. Expansion of research in other populations, age groups and subjects matched for cognitive and skill levels would increase external validity of the intervention. The outcomes reported here are specific to a very limited population and should be reviewed in that light.

Speech production is a complex skill involving many muscles in the mouth and throat, as well as breath control. The targeted imitation was only one of several element skills that could have been taught to the students. It was observed throughout the study that the oral motor movement related to the sound “nee” was difficult to observe and may have been developmentally difficult for students with a pervasive developmental delay. Although all three students were age five or older, the age at which a typical child would have the sound “nee” within their sound repertoire, the pervasive developmental delays experienced by the participants of this study could have influenced the rates of sound production. Continued examination of speech production in relationship to ASD and element oral motor actions could provide greater understanding of the development of speech production in children with ASD, as well as offer information on other speech elements which would potentially lead to speech production more readily. Also, FBPC could contribute to the growing body of literature for speech–language pathologists examining practice and oral motor behaviors (Maas, Robin, Austermann-Hula, Freedman, Wulf, Ballard, & Schmidt, 2008).
References


young children with autism: A manual for parents and professionals (pp. 29-44) Austin, TX: Pro Ed.


Appendix A

Tables and Figures
### Table 1

**Participant Celeration Results Summary**

<table>
<thead>
<tr>
<th>Student</th>
<th>Baseline</th>
<th>Acquisition</th>
<th>FBPC</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Correct</td>
<td>Incorrect</td>
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</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DV</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
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</tr>
<tr>
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<td>-</td>
</tr>
<tr>
<td>DV</td>
<td>X1.02</td>
<td>X1.03</td>
<td>1.05</td>
</tr>
</tbody>
</table>

*Note: Independent variable (IV) was frequency building to performance criterion (FBPC). The dependent variable (DV) was the echoic frequency of the target sound “nee”. Oral motor imitation FBPC trials did not start until phase two of the study. Accuracy improvement measure (AIM) indicates quality of behavior over time.*
Figure 1. Dependent Variable for Visual Analysis Across Students.
CALENDAR WEEKS

Dependent Variable

SUCCESSIVE CALENDAR DAYS

Count per minute

 Succesive Calendar Days

22 Nov 09
6 Dec 09
20 Dec 09
3 Jan 10
17 Jan 10
31 Jan 10
14 Feb 10
28 Feb 10
14 Mar 10
28 Mar 10
11 Apr 10

Baseline
Acquisition of Oral Motor Imitation
Incorrects
Frequency Building to a Performance Criterion

13 Month Retention Measure Conducted May 2, 2011

Echoic behavior (Hear sound "nee" and says "nee")

<table>
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<tr>
<th>NA</th>
<th>Rick Kubina</th>
<th>Dana Gamer</th>
<th>Jermaine</th>
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<td>Dana Gamer</td>
<td>Dana Gamer</td>
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<td>TIMER</td>
<td>COUNTER</td>
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Figure 2. Multiple baseline, multiple probe design across students demonstration dependent variable
Figure 3. Jermaine oral motor imitation FBPC phase.
Figure 4. Antoine oral motor imitation FBPC phase.
Figure 5. Zack oral motor imitation frequency building to performance criterion.
<table>
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</table>
Birth  1 year  2 years  3 years  4 years  5 years  6 years  7 years  8 years

j
v
v
th (thumb)
   th (thumb)
   th (that)
   th (that)
zh (measure)
zh (measure)

*Figure 5.* Sound chart by age. Two of each sound are displayed, the top being for females and the bottom for males. Chart was retrieved from [http://www.talkingchild.com/speechchart.aspx](http://www.talkingchild.com/speechchart.aspx) as recommended by ASHA. Chart was adapted from Sander, 1972; Smit, et al., 1990 and the Nebraska-Iowa Articulation Norms Project.
Appendix B
Informational Letter to Parents

Dear Parents and Caregivers!

A new and exciting study is looking for young children aged between 3-6 years with a significant communication delay. The research study is being conducted as part of graduate requirements in the department of Special Education at Pennsylvania State University. Diagnosis of an autism spectrum disorder who are non-verbal and imitate less than 5 sounds/words. Children need to have some basic attending skills (sit with an instructor for five minutes) and be available for approximately 40 minutes per day four days a week. Experimenter or experimental assistants will come to the child’s location to implement interventions for the study.

The study is a very simple one-on-one procedure implemented and/or supervised by a Ph.D. student in Special Education under the direction of PSU faculty. The study involves oral motor and verbal imitation. The intervention is designed to be fun and interactive. There is no risk associated with this study beyond everyday frustration related to instruction. In addition, your child may learn to imitate sounds, which could lead to an increase of communication.

If you are interested in participating or would like additional information, please contact:

<table>
<thead>
<tr>
<th>Principle Investigator: Dana Garner</th>
<th>PSU Supervising Faculty: Dr. Richard Kubina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email: <a href="mailto:dmv136@psu.edu">dmv136@psu.edu</a></td>
<td>Email: <a href="mailto:rmk11@psu.edu">rmk11@psu.edu</a></td>
</tr>
<tr>
<td>Phone: (570) 279-9090</td>
<td>Phone: (814) 863-2400</td>
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</tbody>
</table>

Thank you very much!
Dana Garner
Appendix C
Informed Consent for Social Science Research

Title of Project: The effect of oral motor imitation instruction on verbal imitative behavior
Principal Investigator: Dana Garner
PO Box 5802
South Williamsport, PA 17702
Dmv136@psu.edu
570-279-8990

Advisor: Dr. Kubina
208 CEEDAR Building
University Park, PA 16802-3109
(814) 865-2400
Rmk11@psu.edu

Other Investigator(s): n/a

1. Purpose of the Study: The purpose of this research is to examine the effects of oral motor imitation training on verbal imitative behavior of children with developmental delays.

2. Procedures to be followed: Parents will meet with primary investigators prior to onset of interventions. Parents will be asked to complete a mini-freer assessment, a child information questionnaire, and a pre-intervention social validity questionnaire. Primary investigator will discuss informed consent and provide parent with a copy. Parent has the option to provide consent for participation of child under the age of 18.

   Intervention consists of 20 second timed fluency measures on oral motor and verbal imitative skills as well as training in oral motor imitation. Oral motor imitation training will take place for 20 trials per session. Target behaviors will be shaped through reinforcement and prompting procedures. After the completion of intervention, the primary investigator will mail parents a post-intervention social validity questionnaire with a SASE. Sessions will be videotaped to ensure reliability of data collection.

3. Discomforts and Risks: There are no risks in participating in this research beyond those experienced in everyday life.

4. Benefits: The benefits to you include the possible development of echolalic behavior which can help your child in the development of future language skills.

   The benefits to society include increased participation in social events due to the increase of echolalic skills and collateral joint attention skills.

5. Duration/Time: The research study will be conducted for five weeks. Implementation of the intervention will take place on 3 of 5 days weekly, for a maximum duration of 10 minutes.

6. Statement of Confidentiality: Your participation in this research is confidential. The data will be stored and secured at PSU in a locked file cabinet in Cedar 124. The file cabinet is located in a locked office. The Pennsylvania State University’s Office for Research Protections, the Institutional Review Board and the Office for Human Research Protections in the Department of Health and Human Services may review records related to this research study. In the event of a publication or presentation resulting from the research, no personally identifiable information will be shared. Dana Garner and Dr. Kubina will have access to the data for analytic. Materials will be
7. Right to Ask Questions: Please contact Dana Guers at (570) 270-3000 with questions, complaints, or concerns about this research. You can also call this number if you feel this study has harmed you. If you have any questions, concerns, problems about your rights as a research participant or would like to offer input, please contact The Pennsylvania State University's Office for Research Protections (ORP) at (814) 865-7773. The ORP cannot answer questions about research procedures. Questions about research procedures can be answered by the research team.

8. Voluntary Participation: Your decision to be in this research is voluntary. You can stop at any time. You do not have to answer any questions you do not want to answer. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would receive otherwise. Your participation and your permission for your child's participation is voluntary. You may revoke your permission and stop participating at any time. You do not have to answer any questions you do not want to answer. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you or your child would receive otherwise.

You must be 18 years of age or older to consent to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below. Parents or legal guardians can provide consent for participants under 18 years of age.

You will be given a copy of this consent form for your records.

Print Child’s Name

______________________________

Legal Guardian/Parental Signature

______________________________ Date

Person Obtaining Consent

______________________________ Date
Appendix D

Child Information Questionnaire

Please answer the following questions the best you can. You may choose to skip a question if you want. Your participation is completely voluntary.

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<th>Parent Initial:</th>
<th>Child Code:</th>
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</thead>
<tbody>
<tr>
<td>Person completing form:</td>
<td>Date:</td>
</tr>
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</table>

1. Child’s date of birth: __________
2. Child’s current age: ___________
3. Previous interventions (please circle all that apply)
   a. TSS, MT, BSC
   b. Specialized preschool/school/daycare
   c. Speech and language therapy
   d. OT
   e. PT
   f. Other: ___________________________
4. Does your child have a current diagnosis of a developmental delay from a physician or licensed psychologist (eg. Autism, Aspergers Syndrome, Retts Disorder, PDD-NOS)
   a. Yes ____________
   b. No ____________
5. Is your child currently on medication? Yes_____ No _____
6. Can your child work with an adult for a minimum of three minutes? Yes_____ No _____
7. Child’s communicative strengths:
8. Child’s communicative weaknesses:
9. Parent’s primary communication concern: (please describe)
10. Which of the following describes your child? (circle one)
    a. Never cooperates with adults, avoids all tasks and demands
    b. If a favorite reinforcer is present- will do 1 task
    c. Will comply with at 2-5 tasks or responses with no inappropriate behavior
    d. Will follow directions and comply for a period of 5-7 minutes
    e. Will follow directions and comply for a period of 8-9 minutes
11. How does your child ask for things they want or need?
   a. My child does not communicate; I have to guess what he/she wants.
   b. He/she will lead me to the item or location
   c. My child uses some sounds and gestures
   d. My child will use 2-5 words
   e. My child uses more than 5 words to communicate needs.

12. Receptive Skills (following directions)
   a. My child does not follow any instructions
   b. Will follow instructions if repeated more than once.
   c. Will answer to his/her name
   d. Can follow instructions to do simple activities
   e. Can follow multi step instructions.

13. Physical Imitation (imitates what you do)
   a. My child does not imitate any physical actions
   b. He/she will try to imitate others
   c. He/she can imitate simple movements
   d. He/she can imitate chains of actions

14. Vocal Imitation
   a. My child does not imitate any speech sounds.
   b. He/she will try to imitate some sounds
   c. He/she can imitate less than 5 simple sounds
   d. He/she can imitate more than 5 simple sounds
   e. He/she can imitate 5 or less words
   f. He/she can imitate more than 5 words

15. Behavior Frequency
   a. My child tantrums daily
   b. He/she tantrums at least 3 times a week
   c. He/she might tantrum 1 time a week
   d. My child tantrums a few times a month
   e. My child does not tantrum often.

16. How willing are you to implement a communication intervention?
   a. I am not willing to implement an intervention at this time
   b. I am a little willing to implement an intervention at this time.
   c. I am very willing to implement an intervention at this time.

Additional comments:
Appendix E

Pre-Post Social Validity Questionnaire

Pre ______ Post_______ Date:______________ Name:____________
Please answer the questions to the best of your ability. Your honest responses are greatly
appreciated. You may choose not to answer questions if preferred. Circle the number that best
fits, with 1 = Strongly disagree, 2= disagree, 3=neutral, 4=agree, and 5= strongly agree.

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<th>#</th>
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<td>Intensive behavioral interventions are an important component of language development in children with severe communication delays.</td>
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<td>It is important for children with communication delays to receive one on one instruction a couple of times a week.</td>
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<td>Children with communication delays can benefit from imitation training</td>
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<td>Children with communication delays can benefit from fluency training (quick, accurate responding)</td>
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<td>Children with communication delays benefit from oral motor imitation instruction</td>
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<td>Children with communication delays benefit from verbal imitation instruction</td>
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<td>Gains in verbal imitation are beneficial for my child</td>
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<td>Learning to orally imitate another person is beneficial for my child</td>
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<td>Increasing imitation skills will help my child function in the world</td>
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<td>I would recommend the current research study procedures to other children with developmental delays</td>
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<td>My child imitates more than 10 sounds or words</td>
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<td>My child imitates 5-10 sounds or words</td>
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<td>My child imitates less than 5 sounds or words</td>
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<td>My child looks at people’s faces all the time.</td>
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<td>My child understands what is said to him/her</td>
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<td>My child talks in 3 word sentences or longer</td>
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<td>My child does not tantrum</td>
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<td>My child imitates the actions of others</td>
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<td>My child seeks out social interaction</td>
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Additional Comments:
## Appendix F

### Pre-Assessment for Echoic Skills

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### Appendix G

#### Pre and Post Questionnaire Ratings

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<td><strong>Student Parent Report</strong></td>
<td>Pre</td>
<td>Post</td>
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<td>1</td>
<td>Intensive behavioral interventions are an important component of language development in children with severe communication delays.</td>
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<td>It is important for children with communication delays to receive one on one instruction a couple of times a week.</td>
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<td>Children with communication delays can benefit from imitation training</td>
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<tr>
<td>4</td>
<td>Children with communication delays can benefit from fluency training (quick, accurate responding)</td>
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<td>5</td>
<td>Children with communication delays benefit from oral motor imitation instruction</td>
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<td>Children with communication delays benefit from verbal imitation instruction</td>
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<td>7</td>
<td>Gains in verbal imitation are beneficial for my child</td>
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<td>Learning to orally imitate another person is beneficial for my child</td>
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<td>Increasing imitation skills will help my child function in the world</td>
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<td>I would recommend the current research study procedures to other children with developmental delays</td>
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<td>My child looks at people’s faces all the time.</td>
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<td>My child understands what is said to him/her</td>
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<td>My child talks in 3 word sentences or</td>
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<td></td>
<td>longer</td>
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<td>My child does not tantrum</td>
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<td>My child imitates the actions of others</td>
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<tr>
<td>19.</td>
<td>My child is quick to imitate sounds or words others say</td>
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<tr>
<td>20.</td>
<td>My child seeks out social interaction</td>
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<tr>
<td></td>
<td>3 2 1 2 4 4</td>
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Appendix L

Literature Review

An average of 1:110 children is diagnosed with an autism spectrum disorder, reflecting a 57% increase between the years 2002 and 2006 (Rice, 2009). Though a higher prevalence has been documented in active duty military families (1:88 children diagnosed) autism spectrum disorders (ASD) are apparent across economical, social, cultural, racial and ethnic groups (Rice, 2007; Yazbak & Gallup, 2008). Up to 40% of children with ASD do not have spoken language and many present with deficits in imitation and echoic behaviors (Rogers & Pennington, 1991; Roeyers, Van Oost, & Bothuyne, 1998). Without intervention, few individuals with ASD will develop a language repertoire (Bryson, Clark, & Smith, 1988; Rutter, 1985). Streamlining and identifying effective components of interventions aimed at language facilitation would result in time and outcome benefits for individuals with ASD. Time is of the essence as early intervention has been shown to have the greatest results for this population (Eikeseth, Smith, Jahr, Eldevik, 2007; Lovaas, 1993; Rogers, 1996). Specifically, interventions based on the principles of applied behavior analysis (ABA) have been demonstrated to be effective in increasing the language repertoire in children with low vocal repertoires (Barbara, 2007; Green, Brennan, & Fein, 2002; Luiselli, Cannon, Ellis, & Sisson, 2000; Lovaas, 1977; Lovaas, Freitas, Nelson & Whalen, 1967; Yamaguchi, 1980).

Behavioral intervention curricula include instructing the student in a variety of skill areas, such as matching to sample, receptive discrimination, expressive language, and imitation (Maurice, Green, & Luce, 1996). Behavioral programs focus on teaching a skill, such as imitating gross motor movements, to an acquisition accuracy criterion of 80-90% across two to three days (Maurice, et al., 1996; Weiss, 1999). A growing number of researchers are calling for
the addition of behavioral fluency procedures to be included in behavioral intervention programs because even though extensive and intensive, behavioral interventions for children with developmental delays typically do not include a behavioral fluency component (Fabrizio, 2003; Kubina, Morrison, & Lee, 2002; Kubina & Yurich, 2009; Matson, Benavidez, Compton, Paclawskyj, & Baglio, 1996; Weiss, 2001). Behavioral fluency involves accuracy and speed within a skill area to a specified aim, or criterion, at which outcomes of behavioral fluency are reached (Binder, 1996). The outcomes of behavioral fluency are retention, endurance and application. Bringing skills to a behaviorally fluent criterion could help students with ASD maintain skills over time, engage in skills even with distractions, and learn related complex skills quicker.

Effective, early interventions for children with ASD are of utmost importance because many children with ASD are at risk of never developing spoken language. Targeting imitation as a modality for language intervention is supported through the correlation and predictive properties between imitation and later language skills, vocal output, and vocabulary growth in children with developmental delays (Charman, Baron-Cohen, Swettenham, Baird, Drew, & Cox, 2003; Luyster, Kadlec, Carter, & Tager-Flusberg, 2008; Stone & Yoder, 2001; Smith, Mirenda and Zaidman-Zait, 2007; Stone, Ousley, & Littleford, 1997; Thurm, Lord, Lee & Newschaffer, 2007). Combining two bases of research, it is highly probable that teaching imitation to a behavioral fluent criterion could result in the application of the skill to the more complex skill of speech production. The focus herein was on oral motor imitation due to the topographical similarities between oral motor movements and speech production. To examine this concept further, a review of the literature on oral motor imitation and behavioral fluency with children with ASD follows.
Oral Motor Imitation and Effects on Children with Autism

Oral motor movements are part of the complex skills involved with speech production. Intensive behavioral interventions for children with ASD usually include oral motor imitation as part of the sequence of imitation lessons or as a precursor to language facilitation (Maurice, Green & Luce, 1996; Sparks, 1989). To explore the relationship between oral motor imitation and speech output, a search for research articles on the outcomes of oral motor imitation interventions on children with ASD was conducted using a multi-data base search through Pennsylvania State Library System, the Journal of Precision Teaching and Standard Celeration, and finally Google Scholar. The multi-data base search was conducted through PsycINFO, Mental Measurements, PubMed, and ERIC databases. Due to the scarcity of published research articles on oral motor imitation interventions and outcomes for children with ASD, an additional search was conducted through the Journal of Precision Teaching and Standard Celeration which provides case studies and chart shares on topics related to precision teaching and behavioral fluency. Finally, Google Scholar was utilized in order to throw out a wide net in an effort to identify additional research that may have been missed or overlooked. The search yielded few articles examining oral motor imitation in isolation (i.e. not as part of a treatment package) as an intervention for children with ASD. Of the studies located, four compared the oral motor skills of children with ASD to peers (Adams, 1998; Noterdaeme, Mildenberger, Minow & Amorosa, 2002; Rogers, Hepburn, Stackhouse, Wehner, 2003; Stone, Ousley, & Littleford, 1997), three focused on description of oral motor skills in children with ASD (Page & Boucher, 1998; Thurm, Lord, Lee & Newschaffer, 2007; Manno, Fox, Eicher, & Kerwin, 2005), and one noted how many times a child with autism imitated a video or pictorial depiction of oral-facial movements (Tardif, Laine, Rodriguez, & Gepner, 2007).
From this literature pool, researchers demonstrated children with ASD performed significantly worse on oral motor tasks than typical peers (Adams, 1998; Rogers, et al., 2003) and one study did not find a significant difference between the oral motor tasks of children with ASD and a control group (Noterdaeme, et al., 2002). Adams (1998) compared the oral motor movements of children with ASD to a control group of children normally developing children. Four children with autism and four normally developing children were assessed with an adaption of the Kaufman Speech Praxis Test for Children and results on oral-motor and oral-speech behaviors were recorded. The targeted areas for assessment were oral movement, simple phonemic production and complex phonemic production, all of which involved the child imitating the oral motor actions or speech of the experimenter, or producing oral motor movements on command. The total possible score for oral motor movements was 11. The mean score on oral motor movement for normally developing peers was 11, but children with ASD had a mean score of 7.25 indicating a statistically significant difference between the oral motor movements of children with ASD and a control group. Results of the study conducted by Adams also indicated students with ASD had significantly more difficulty with the production of complex phonemic production than matched peers. Adams noted children with ASD had the most difficulty with elevating the tongue to the alveolar ridge and with alternating between a pucker and spreading their lips. Elevating the tongue and control over lip movements are necessary oral motor movements for the production of specific phonemes, and the inability to physically organize mouth movements would related in difficulty producing various sounds.

Rogers, et al. (2003), compared imitation skills between young children with autism, children with fragile X syndrome, a group of children with developmental delay, and a group of control children who had displayed normal development patterns. The Imitation Battery,
developed by the authors, was included as one of the many assessments given to the participants. In addition to actions on objects and manual tasks, the Imitation Battery consisted of five oral-facial movements, though only three items from each category were included in analysis. The three oral movements included in the analysis were sticking out the tongue and wiggling from side to side, blowing, and making a kissing noise. The scores from manual, object and oral imitation were combined into a total imitation score for analysis as the results of the three were highly correlated, indicating the different types of imitation were not independent. Rogers, et al. found children with ASD who were poor imitators also performed worse in assessments of receptive language, fine motor skills, and social responsiveness. Overall, results strongly demonstrated children with ASD performed significantly worse on imitation skills when compared to the other study groups.

In contrast, Noterdaeme, et al. (2002) did not find a significant difference between the imitative performance of children with ASD and other participant groups. Noterdaeme, et al. (2002) conducted a neurological examination of 44 children in four groups of 11 children each. The participant groups were children with autism, expressive language disorder, receptive language disorder and a control group. The neurological examination included assessments in gross motor skills, fine motor skills, coordination, and oral motor skills. The oral motor skill component of the assessment involved the children engaging in lip movements, tongue movements and the overall quality of the child’s oral motor movement while engaged in speech. Noterdaeme, et al. did not specify if the oral motor movements were on command or if they were elicited via imitation. The outcomes of the study demonstrated a difference between the oral motor movements of the control children and children in the other three developmentally delayed
groups combined, but when compared specifically to children with ASD, no significant difference was noted.

Oral motor skills may be a critical component of language development as evidenced by the correlation between language deficits and poor performance on oral motor tasks in children with ASD. An issue with the current literature pool is that specific results related to oral motor imitation interventions and outcomes for children with ASD become difficult to discern due to combination of imitation topographies for study result analysis (Rogers, et al., 2003), mixed presentation of oral motor movements on command or through imitation was not delineated (Adams, 1998), typical peer control groups are not used (Page & Boucher, 1998) or operational definitions of oral motor intervention are not clearly provided (Forrest, 2002).

Descriptions, as opposed to research, on oral motor skills in children with ASD were provided by Page & Boucher, (1998) and Thurm, et al., (2007). In children with ASD, oral motor impairment was evident in 79% of the participant sample (Page & Boucher, 1998) though a typical peer comparison was not provided by the researchers. The percentage of children with ASD who presented with an oral motor deficiency was also found to be significantly higher than the percentage of children with ASD who had difficulty with gross motor activities. These results may be related to research on oral motor skills of children with speech-sound disorders as Newmeyer, et al., (2011) found deficiencies in oral motor skills predicted poor fine motor skills in this population. Rogers et al. (2003) did not find a correlation between oral motor skills and expressive language, yet results of a study by Thurm, et al., (2007) supported a link between oral motor ability and expressive language in children with ASD. Using only parent report of the child’s ability to imitate raspberries or to do tongue clicking, Thurm et al., indicated a predictive relationship between oral motor imitation at age two and expressive language at age five. The
association between oral motor skills and speech production was again stressed by Gernsbacher, Sauer, Geye, Schweigert, and Goldsmith (2008)

Gernsbacher et al. (2008) conducted three studies examining imitation in children with and without ASD. In the first study, the authors interviewed caregivers of children diagnosed with ASD and caregivers of typically developing children. At the time of the study, the mean age of the participants was 7-years-old. The authors used a landmark based interview format to help caregivers remember specific events during the child’s infancy to provoke accurate memories of the child’s milestones, oral motor and manual motor skills during the time in question. Current speech fluency for each child was assessed through caregiver interview or direct observation of the child. Gernsbacher et al. found positive correlations between the productions of oral or manual motor imitation at an earlier age, e.g. six months, and at a later age, e.g. 24 months. Delays in early oral and manual motor skills were found to correlate with the child receiving an autistic diagnosis when older. In addition, oral and manual motor skills in infancy were found to correlate to minimal speech fluency in children with ASD. The second study used home video to corroborate information gleaned from the landmark based interview and actual events as shown on video. The video supported information from interviews in all but one instance. In the third study, Gernsbacher et al. re-assessed a third of the children with ASD from the first study for speech fluency and oral/motor skills. The children who were classified as minimally fluent had more difficulty on oral motor skills than children with ASD in the highly fluent category, demonstrating specific difficulties with lip puckering, controlling saliva, and producing sounds. The outcomes of these studies reveal the relationship of oral motor skills and speech fluency, as children who exhibited deficiencies in oral motor movements as infants grew to have difficulties with speech production as well.
In an effort to investigate methods of improving oral motor imitation, Tardif, et al., (2007) presented video representations of oral-facial movements at differing speeds and with or without accompanying sound. The movements modeled were described as “oral-facial” and included a combination of oral motor as well as facial motions to indicate a range of emotional and non-emotional expressions. The expressions were either presented as pictures, played very slowly, played slowly or played at normal speed. Sound either accompanied or was absent from the presentations. Tardif et al. found students with ASD imitated more of the presented oral-facial movements when sound was added. Non-emotional oral-facial presentations were imitated more often when they were presented very slowly as opposed to being presented at normal speed or at slow speed. In contrast, emotional expressions were imitated more often by children with ASD when the visual was slowed down, but not when it was slowed to the point of being classified as “very slow”. Tardif et al. surmised based on their findings the slowing down of facial movements helped to increase imitation of the presented models by children with ASD. In the examination of oral-facial imitation in children with ASD, Tardif, et al. demonstrated children with ASD scored better on facial movement and sound imitation when the model was significantly slowed down.

Research on oral motor imitation in children with ASD demonstrates children with ASD experience deficits in this skill area (Adams, 1998; Gernsbacher et al., 2008). Oral motor skills of infants are correlated with later speech production and speech fluency, and could be valuable predictors of autism (Gernsbacher et al., 2008; Thurm et al., 2007). Though not consistently studied, specific oral movements have been found to be more difficult for children with ASD when compared to typical peer performance, namely tongue movements (Adams, 1998; Rogers, et al., 2007). Slowing the presentation of oral-facial movements and expressions may be one
way to help facilitate oral motor imitation (Tardif, et al., 2007) and by increasing oral motor control by children with ASD, speech outcomes for the children have the strong potential to improve.

Oral motor imitation has been a component of intensive behavioral intervention curriculum for many years (Lovaas, 1977; Lovaas, Berberich, Perloff & Schaeffer, 1966; Maurice, Green & Luce, 1996; Tarbox, Madrid, Aguilar, Jacobo & Shiff, 2009). Within behavioral programs, imitation is usually taught through a series of stages, beginning with actions on objects, then gross motor, fine motor, oral motor, and finally vocal imitation. Due to being embedded within a program package, it is difficult, if not impossible, to ascertain the independent effects oral motor imitation has on language development. Two examples of how oral motor imitation is utilized within operant learning programs are as follows. Baer, Peterson, & Sherman, (1967) conducted a study in which children diagnosed with mental retardation (MR) were taught imitation across topographies, from object manipulation, to large motor, small motor, oral motor, verbal imitation and chained behaviors. Though the study included an oral motor imitation component, the effects of oral motor imitation were not examined in isolation. Results of the study by Baer, et al. showed two of the three participants increased vocal output either following verbal imitation instruction or with the use of oral motor imitation as a prompt for the verbal imitative behavior. Stark, Giddan and Meisel (1968) examined verbal imitation outcomes in children with ASD when the children participated in an imitation instruction program. The participants were gradually and systematically taught different topographies of imitation, from gross to fine to verbal imitation. Stark et al. used oral motor imitation as a prompt for the verbal imitation phase and as with Baer, et al., Stark et al. did not isolate the effects of the oral motor imitation on vocal outcomes.
Intensive behavioral interventions for children with ASD focus on imitation as a foundational skill for language and other complex skills, though the specific effects of different topographies of imitation and their relation to measures of vocal output are not identified clearly.

The last topography in the sequence of imitation, echoic behavior, is perhaps the most notable due to the pervasive language deficiency within the ASD population. Procedures increasing echoic behavior lay the foundation for more complex language skills, as echoic behavior is considered a prerequisite for verbal conditioning (Hartung, 1970; Lovaas, 1977; Skinner, 1957; Sundberg & Michael, 2001).

**Effects of Behavioral Fluency Interventions on Children with Autism**

It is recommended behavioral fluency programs supplement intensive behavioral programs for children with ASD (Fabrizio, 2003; Kubina, et al., 2002; Weiss, 2001) though a search of the literature reveals a scant pool to review. A search for research articles on behavioral fluency interventions and response outcomes for children with autism yielded seven articles, five of which were case studies published in the *Journal of Precision Teaching and Celeration*.

Two articles examined outcomes of behavioral fluency instruction on children with ASD using a single subject research design (Fienup & Doepke, 2008; Singer-Dudek & Greer, 2005). Fienup and Doepke (2008) examined criteria based reinforcement for fluent responding in a child with autism. The student was asked a series of calendar related questions and was reinforced for quick, accurate responding. Fienup and Doepke found contingent reinforcement procedure to be effective in increasing fluent responding in children with ASD. Students were able to respond quicker and accurately to calendar related questions following the intervention,
simulating the speed and accuracy of responding that would be expected in a typical school setting.

Singer-Dudek and Greer (2005) recorded the number of learn units to mastery and compared with the number of learn units used within a behavioral fluency intervention for the same target behavior. A learn unit is similar to a discrete trial in that a learn unit involves providing the student with an opportunity to respond (instruction, activity, worksheet, etc), gaining an active student response, and the provision of performance feedback. In the study, students were taught component math skills. The four participants were diagnosed with a developmental delay and assigned to one of two conditions, either mastery or behavioral fluency criterion. In the mastery criterion condition, students were reinforced for accuracy and in the behavioral fluency condition students were reinforced for rate of responding on component math skill tasks. It was found that the number of learn units was comparable in both conditions, i.e., both mastery criterion and behavioral fluency criterion required approximately the same number of presentations of the target skill for criterion to be met. At the two month follow up, composite math skills were assessed. Students in the behavioral fluency condition performed better on retention and composite skill tests than did the students in the mastery criterion condition.

The search yielded five case studies that examined outcomes for children with ASD receiving behavioral fluency interventions (Fabrizio & Schirmer, 2002; Fabrizio, Pahl & Moors, 2002; Foley & Fabrizio, 2005; McElwee & Munson, 2002). Three studies measured vocal output in the form of improved articulation (Fabrizio, Pahl, & Moors, 2002); expanding vocalizations to include pronouns (Moors & Fabrizio, 2002); and sound reproduction (Foley & Fabrizio, 2005).
Fabrizio, Pahl and Moors (2002) used precision teaching to improve the articulation in a 7-year-old student with ASD. The student could communicate in 3-4 word phrases, but intelligibility was low as he would make sound substitutions and drop the ends of words. With a home therapist, the student practiced specific sounds in isolation for 10-second practice trials daily, and increased accurate sound production from 43 correct responses per minute to over 100 correct responses per minute. In the second phase of the study, the therapist said a word containing the target sound and the student echoed the word, with all sounds intact, also called a “hear/say” procedure. The student and therapist practiced words during 1-3 timed practice trials a day, and the student’s correct responding accelerated at X1.2 over 15 days, going from 22 correct responses to 61 correct responses in a minute. Further mixing of the target sound within words during the hear/say process, the student’s correct responding accelerated at X1.15 across 23 days of intervention to a final frequency of 100 correct responses. Following intervention, the family reported the student was no longer making sound substitutions or dropping final sounds from words, and therefore the authors did not specifically test for retention, application or endurance.

Moors and Fabrizio (2002) used frequency building to a performance criterion to increase the use of labeling with pronouns in an 8-year-old child with ASD. The student was shown a picture and the correct response involved making a true statement about the picture that also included use of pronouns. The performance criterion was measured in words per minute (120) which was determined by assessment of the student’s other verbal skills. The student reached the performance criterion of 120 words in one minute when labeling pictures with two identified pronouns within two days. Eight new pronouns were added to the program and the procedure was continued until performance criterion was met with all presented pronouns. Following the study, while the student was at summer camp, the authors tested for endurance, application and
retention. The student matched his previous performance when shown novel pictures, and for a 2-minute timing at a picnic bench at camp. The student demonstrated retention of previously learned skills, application to novel stimuli, and endurance with increased time and additional distracters.

Foley and Fabrizio, (2005) built a 3-year-old with ASD’s behavioral fluency in repeating auditory stimuli to a performance criterion to help increase the child’s auditory discrimination skills. The therapist would present a sound once, twice or three times in hear/say format and the child was expected to repeat the sound the same number of times it was repeated. The therapist engaged the child in 30-second practice trials daily for up to 10 minutes or until a specified criterion for that day was reached. The child reached performance criterion on 1-3 sounds, then experienced some difficulty with 4-5 hear/say sounds. Past experience with the child had indicated a hear/say criterion performance of 40-60 syllables per minute was sufficient for the child to demonstrate retention, application, and endurance of the skill. The authors found, that regardless of the number of practice sessions, the student would only perform as high as 60 correct responses per minute. The performance criterion of 60 correct responses per minute was hypothesized to be related to the child’s age. During checks for application, retention and endurance, the child’s performance maintained at previous behavioral frequency levels.

Of the remaining two case studies, one taught color pattern matching to performance criterion (Fabrizio & Schirmer, 2002) and the other examined receptive identification of pictures (McElwee & Munson, 2002). Fabrizio and Schirmer employed frequency building to a performance criterion for a 5-year-old child with autism for the skill of pattern reproduction. Color patterns were presented to the student in a see/do format, and the student would then match the color pattern, repeating this process for 30-second timings during practice sessions 2-5
times a week. Upon reaching performance criteria for matching patterns of four colors, checks for application, endurance, stability and retention took place. The student’s performance dropped slightly during the endurance check, but remained stable throughout other outcome checks demonstrating matching patterns to a performance criterion resulted in the skill being performed under distracting circumstances, for longer periods of time, on novel tasks, and over time.

One additional study was found which examined generativity and communication deficits in children with ASD and compared results to typical peers (Dichter, Lam, Turner-Brown, Holtclaw & Bodfish, 2009). The task involved free operant responding, where the children were asked to name as many animals as they could within one minute. Results of the study indicated students with autism had significantly more incorrect responses and significantly less correct responses compared to typical peers. Dichter, et al. suggested increasing communication in children with ASD may in turn improve generativity.

Behavioral fluency building to a performance criterion has been shown to increase intelligibility when hear/say procedures are employed (Fabrizio, Pahl, & Moors, 2002). The timing varied between the studies, ranging from 10-second to one minute (Foley & Fabrizio, 2005; Moors & Fabrizio, 2002). Four of five case studies examined and demonstrated identified outcomes of behaviorally fluent responding including retention (McElwee & Munson, 2002; Fabrizio & Schirmer, 2002; Foley & Fabrizio, 2005; Moors & Fabrizio, 2002), endurance (Fabrizio & Schirmer, 2002; Foley & Fabrizio, 2005) and application (Fabrizio & Schirmer, 2002; Foley & Fabrizio, 2005; Moors & Fabrizio, 2002).
Summary

Oral motor imitation is correlated to later language development, yet there remains a paucity of research examining specific outcomes of oral motor imitation on vocal output. Oral motor imitation is a component of program curricula for operant learning programs, though it is taught along a continuum of topographies of imitation or used as a prompt for verbal imitation. ABA-based interventions are highly recommended for children with ASD (NIMH, 2004) and though they have been found effective in increasing various skills, these programs do not include a fluency component. Behavioral fluency to a performance criterion in children with ASD has been shown to result in application of the skill to novel skills, endurance of skill performance for longer periods of time and in the face of distractions, and retention over long periods of time (Binder, 1996; McElwee & Munson, 2002; Fabrizio & Schirmer, 2002; Foley & Fabrizio, 2005; Moors & Fabrizio, 2002).
References


VITA
DANA GARNER

EDUCATION
2011  Ph.D  Special Education  The Pennsylvania State University
2003  M.A.  Applied Behavior Analysis  Penn State Harrisburg
1995  B.A.  Psychology  Indiana University of Pennsylvania

PRESENTATIONS/WORKSHOPS

HIGHER EDUCATION TEACHING AND EXPERIENCE
2010-present  Course Instructor  Pennsylvania State University World Campus
SPLED 498D: Online ABA Practicum Supervision
2009-present  Adjunct Professor  Arcadia University Online
ED 581: Disabilities and Special Education Law
ED 683 Applied Behavior Analysis and Child Development
2008, Fall  Course Instructor  Pennsylvania State University,
SPLED 395W, Experience in Exceptional Settings, Writing intensive course.

SUPERVISORY EXPERIENCE
2010-present  Instructor of ABA Practicum Students  Pennsylvania State University
SPLED 498D
2009, Fall  Supervisor of Pre-Service Teachers  Pennsylvania State University
SPLED 495G
2008, Fall  Supervisor of Pre-Service Teachers  Pennsylvania State University
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