TEACHING VERBAL REPERTOIRES FOR STATIC AND DYNAMIC COMMUNICATION SYSTEMS FOR CHILDREN WITH LIMITED VOCAL VERBAL REPERTOIRES

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Abstract_ *Children with limited vocal verbal repertoires often benefit from the use of alternative forms of communication. Learning the sets of skills needed to use static and/or dynamic communication systems may result in improved communication for some individuals who lack vocal verbal capabilities. In order to teach many of the skills within these sets of repertoires, hundreds of learning opportunities that target multiple units of language are required. One male student, 8.1 years of age at onset, participated in this teaching protocol study. This student was selected for inclusion based on his limited verbal (including vocal and motor) skills. The participant's repertoires were limited to mands (requests) by pointing to preferred items during instructional sessions. Baseline data showed that this student had fewer than 20 tacts (comments) and intraverbal (answers) repertoires. Using picture icons, the participant was taught over a 1 ½ year period using a multiple-component treatment protocol that consisted of instruction in match-to-sample, point to stimuli, and tact stimuli (i.e., Multiple Exemplar Instruction) for two word combinations for more than 100 units of language. Post-intervention data showed the teaching protocol presented resulted in an increase in verbal behavior with a decrease in maladaptive behaviors.*

Keywords: *dynamic communication system, static communication system, mand, tact, intraverbal, operant, repertoire, multiple exemplar instruction.*

I. INTRODUCTION

The primary means of communication for the general population is achieved by means of vocal verbal communication skills. Many children diagnosed with Autism Spectrum Disorder (ASD), and other severe developmental disabilities, do not have the capacity to facilitate meaningfully communication with others without the benefit of alternative communication systems. It is estimated that over one-third of children with Autism do not have functional vocal verbal communication skills (Bryson, [1]; Centers for Disease Control and Prevention, [2]; Ganz, Davis, Lund, Goodwyn, & Simpson, [3]; Lord & Paul, [4]; Järvinen-Pasley & Heaton, [5]) at various stages of their individual instructional histories. The lack of developed vocal verbal communication skills can be attributed to several factors including, but not limited to, verbal dyspraxia (apraxia), mild cerebral palsy, and severe auditory processing disorders [6].

Verbal behavior refers to behaviors reinforced by the mediation of or interaction with a listener, the one who reacts to what was heard known as the verbal stimulus (Schlinger, [7]; Skinner, [8], Sundberg & Michael, [9]). The basic verbal repertoires defined by Skinner in his seminal treatise [8] included the mand (requests), tact (labels), intraverbal (answers), and autoclitic (describe). A mand was described as verbal behavior that is mediated by a listener and which specifies its own reinforcer (i.e., saying "water" to obtain water). A tact was described as contact with the non-verbal environment which labeled or described an event or stimulus (i.e., seeing a water bottle and saying "water" without the request to obtain the water). Autoclitics were described as modifying, negating, or otherwise describing other verbal behavior (i.e., seeing a water bottle and saying "I like that bottle"). An intraverbal was described as verbal behavior that followed the verbal behavior of other antecedent verbal behavior (i.e., what do you drink? "water"). Given that verbal communication skills (whether vocal or non-vocal verbal) are essential for a self-determined life, alternate means of communication should be identified such that children affected by limitations in these skills can learn to effectively communicate. This can be especially critical to children diagnosed with Autism Spectrum Disorder. Types of communication methods that either replace or supplement vocal verbal repertoires include sign language, picture systems, and dynamic communication devices. This research will discuss a protocol for the teaching of skills to target units of language, known as verbal operants.

A static communication system is commonly implemented for children with limited vocal verbal capabilities, utilizing pictures that are usually exchanged for preferred stimuli. Static communication is a term used for systems that do not provide vocal output, such as the Picture Exchange Communication System (PECS)® system. This type of system uses pictures instead of words to help children communicate (Ganz, Parker, & Benson, 2009). The individual selects those pictures or icons that he/she prefers to create a sentence. The only prerequisite identified by Collet-Klingenberg [10] for this picture communication system is the identification of a powerful reinforcer. The system uses behavioral principles including shaping, differential reinforcement, and transfer of stimulus control to teach a child to request (mand for items or people), respond to questions (emit intraverbals), and comment (tact items or events) throughout their day (Charlop-Christy, Carpenter, Le, LeBlanc, & Kelley, [11];

Millar, Light & Schlosser, [12]).

Technological advances have heralded the introduction of a myriad of devices that have functioned to provide and upgrade the capability of alternative vocal verbal output, providing a range of possibilities for augmentative communication and to supplement spoken communication for individuals with limited vocal verbal capabilities (Nunes, [13]; Sigafoos, O'Reilly, Lancioni, & Sutherland, [14]). This field is evolving quickly as a result of the rapid changes in technology. Many sophisticated augmentative vocal output devices are currently available, providing more expansive communication alternatives for students with limited vocal verbal repertoires. Several augmentative communication systems are available and are commonly implemented by practitioners (i.e., speech therapists, behavior analysts, classroom teachers). These include Mini-Mo ®, Dynavox V ®, iPod ®, i Pod Touch ®, and iPad ®with ProLoquo © software [15].

Clearly, the goal for many children who are diagnosed with Autism Spectrum Disorder and severe verbal apraxia is to find an alternate means of communication. For these children, strategies for communication should be emphasized in individual instructional programming [16]. Results of recent technological advances have provided children with limited vocal verbal repertoires the means for effective and flexible language interactions within the verbal operants defined by Skinner [8]. Given the intricacy of operating technological devices (aka dynamic communication devices), it may be more effective, resulting in rapid skill acquisition, if the child is first taught to communicate using low-tech means with the standard symbols that are found in the high-tech devices. This can be followed by the introduction of more expensive and complex high-tech devices. The empirical research herein tested the feasibility of first instructing students using a multiple-component treatment package followed by probes using dynamic communication devices.

II. METHOD

Participants and Settings

At the onset of this study, one participant, Stephen, was 8.1 years old. He was one of a set of triplets, and lived in a suburb of a major metropolitan area. Stephen was diagnosed with Autism and verbal apraxia when he was 2 years old. At the time of this study his instruction consisted of a 40-hour home-based data-driven program in which Stephen was afforded social opportunities in the general education setting with neurotypically developing students during lunch and recess. He was, however, unable to interact at all with peers or adult staff at school. Stephen's previous instructional history included six years of discrete trial instruction delivered in two different center-based programs that followed the principles and strategies of applied behavior analysis. Although Stephen had learned to use a picture communication system in the mand function (to make requests), he did not learn to spontaneously communicate with others in any functional or generalized manner. For example, Stephen did not take his picture communication system with him when he traveled in his home unless specifically reminded to do so. It was determined, therefore, that this system did not function for Stephen as a means of accessing reinforcement or for communication purposes.

Stephen had several behaviors that interfered with his ability to interact at any level with his siblings and with same-age peers. These included a lack of speaker behaviors, a high rate of non-contextual vocalizations across all settings, and maladaptive behaviors that were defined as tapping and scratching objects in his environment. Stephen had an extremely limited community of rein forcers, preferring to play only with puzzles. This puzzle play, however, was done in a repetitive manner as Stephen would put each piece in a memorized and systematic way, tapping each piece on the puzzle frame before inserting it into the frame.

Stephen's listener repertoires consisted of independently making eye contact for 1 second in response to his name called within a proximity of three feet, sitting with his hands on the desk when asked to "Sit Still," and pointing to pictures of 10 common stimuli in an array of three when presented using learn units [17]. Stephen did not know any colors, shapes, letters, and numbers, either as a listener or a speaker. He had learned to identify by pointing to 10 actions in photos. He was unable to sort 2-dimensional (such as pictures of food and clothing) and 3-dimensional (such as actual items of food and clothing) stimuli by category. Stephen did not have any functional speaker skills in his repertoire at the time of this study.

Stephen was evaluated for a high-tech alternative augmentative communication (AAC) device in a specialized speech/language department of a hospital. Subsequent to a speech/language assessment, this same speech/language pathologist determined that Stephen did not have the prerequisite skills that would have qualified him for an augmentative dynamic communication device; therefore, this device was not approved for purchase by Stephen's school district.

Using 10- and 20-learn unit [17] programming, Stephen was taught to identify picture symbols as both a listener and as a speaker. Learn units are defined as interlocking 3-term contingencies, 1 for the student and 2 for the teacher. The targets for Stephen included pointing to icons of actions, pointing to family members in photos, pointing to icons of food items, pointing to icons of body parts, pointing to icons for clothing, pointing to icons of places, and pointing to colors. It also included sorting by category for actions, people we know, things we eat, colors, places we go, body parts, prepositions, adjectives, things we use, things we wear, and things we feel.

III. DEPENDENT VARIABLES

The non-contextual vocalizations were defined as loud guttural sounds that lasted for 20-30 seconds per occurrence. Spontaneous mands were defined as Stephen initially using Boardmaker © icons and subsequently the Dynavox-V ® to request desired or needed items. Boardmaker® is a software system that provides educators and parents the opportunity to print icons representing areas of daily life, including communication for wants and needs, community settings, personal belongings, and so on. Pictures are printed and often mounted using Velcro; in the case of the current research, the pictures were organized by category. The Dynavox® systems of augmentative communication are expansive, and provide vocal output for students who have limited vocal verbal capabilities in their repertoire. The icons are consistent with Boardmaker® icons. Spontaneous mands and non-contextual vocalizations were recorded in numbers across the instructional day. Social interactions were defined as occurrences of initiations or responses to peers at school using either Boardmaker ® or Dynavox ®. Vocal verbal imitation was recorded in number according to the short term objectives learned through the systematic implementation of sounds, single syllables, bi-syllabic vocalizations, word approximations, and words.

IV. INDEPENDENT VARIABLES

The Boardmaker® software was utilized for preparing low-tech instructional stimuli. Classes of categories were organized using specific background colors intended to add an additional discrimination element (See Table 1) using the Boardmaker® software. Traditionally, discrimination skills are taught using discrete trial format with rotation of stimuli placement. However, when a communication system is implemented it is recommended that the placement of the pictures not be altered such that the learner be able to predict the location of the stimuli with ease. When new pictures/symbols are added, it is recommended that they be added on to existing rows and columns.

As Stephen met criterion for basic actions (i.e., eat, drink, play, sleep), foods (i.e., candy, pretzel, water, chicken nugget), and common useful objects (i.e., fork, spoon, pencil, puzzle), he was taught to combine two icons to construct 2-word phrases by first pointing to the verb followed by the noun. The first function that was introduced in this manner was the mand function using a mand training protocol.

Multiple Exemplar instruction [18] was presented to teach a multiple-component treatment package that consisted of instruction in match-to-sample, point to stimuli, and tact stimuli for two word combinations for more than 100 verbal operants. The researcher rotated different responses to a set of stimuli to elicit multiple responses from the participant.

Table 1
Examples of stimuli within each category (personalized for the participant in this study)

Category	Stimuli naming repertoires (MEI)
Things we eat/drink	pizza, pop tart, ketchup, lettuce, strawberries, chicken nuggets, cheese, butter, grapes, onion, bread, apple, pear, hamburger, pancake, rice cake, cupcake, cranberry juice, apple juice, grape juice, cookies, water, salt, pepper, garlic, eggs, candy, A-1 sauce, ribs, ham, turkey, steak, fish, french fries, crackers, ice cream, cereal, water, donut, yogurt, bacon, hot dog, popcorn.
Things that are body parts	mouth, stomach, arm, mouth, nose, ears, neck, foot, eyes, chin, neck, back, shoulders, calf, head, hair, tooth/teeth, knee, hands.
People we know	family members (each in individual photos, including Mom, Dad, Boomer and 2 sisters), teachers, man, woman, boy, girl, baby, doctor, dentist.
Things we use	puzzle, paper, book, pencil, crayon, glue, marker, scissors, chair, desk, computer, keyboard, TV, refrigerator, stove, sink, plate, glass, bowl, spoon, fork, knife, bed, dresser, toilet, washing machine, dryer, dishwasher, door, window.
Things we do/actions	drive, cook, wash, type, walk, write, break, shower, sit, build, brush, swim, cut, see, sleep, jump, go, ride, work, get dressed, work, wait, climb, help, pour, listen, watch, all done, dry, stop, quiet, clean up.
Things we wear/clothes	underwear, shirt, pants, shorts, socks, shoes, pajamas, bathrobe, bathing suit, sneakers, boots, jacket, scarf, gloves, hat, belt.
Places we go	home, school, grocery store, post office, playground, park, swimming pool, pizzeria, gas station, restaurant, camp.
Colors	red, blue, yellow, green, purple, pink, orange, white, black, gray.
Adjectives	big/little, hot/cold, tall/short, dark/light, empty/full, in/out.
Things we feel	happy, sad, hurt, bored, excited, frustrated, angry, silly.
Prepositions	in, out, on, under, off, between, next to, over

The first communication board used by Stephen consisted of the Mayer-Johnson Tri-Fold ® plastic folder with six clear plastic sleeves available for 8-1/2 X 11" paper inserts [19]. The pages were organized as follows:

First page People we know (in a single column)
Things we do (in a square grid)
Colors, prepositions, adjectives (each in separate single columns)

Second page Things we eat and drink (in a square grid)
Things we use (in a square grid)
Things we wear (in a square grid)

Third page Places we go (in a square grid)
Things that are body parts (in a square grid)
Things we feel (in a square grid)

Design

A multiple probe pre-post (A-B) design was used to evaluate the teaching from the multiple exemplar training. Pre-intervention data, the baseline probes (A), were taken prior to the onset of the intervention. No correction or reinforcement was provided for Stephen's responses during baseline. Post intervention data (B) were collected to assess responding. No correction or reinforcement was provided for Stephen's responses during the post intervention phase.

V. INTEROBSERVER AGREEMENT

During training and data collection, experimenters recorded the students' total responses using a pencil and a data form. Total number of correct responses were recorded with a plus (+) and incorrect responses with a minus (-). Total percentage cor-rect and incorrect for vocal verbal operants were calculated and graphed. We trained observers by providing them with written instructions and they observed data collection prior to their independent observation of experimental sessions. Once they achieved 90% agreement for two consecutive sessions, they began observation of the actual experimental sessions. Interobserver agreement (IOA) was collected on 31% of the sessions. Point-to-point agreement was calculated by dividing agreements by agreements plus disagreements and converting the outcome to a percentage. The mean IOA across all participants for probe and learn unit sessions was 98%, with a range of 97% to 100%.

Protocol

Multiple Exemplar Instruction (MEI) was used to teach all the aspects of naming [20]. MEI is an instructional procedure used to teach the naming repertoire within a match-point-tact protocol (Fiorile & Greer, [21]; Gilic & Greer, [22]; Greer & Ross, [18].). MEI involves two aspects. The first aspect of MEI involved rotating independent response topographies with the same stimulus, resulting in the joint stimulus control where by a single stimulus can evoke multiple responses. The second aspect of MEI involved rotating different establishing operations with the same response resulting in novel responses (Eby, Greer, Tullo, Baker, & Pauly, [23], Greer & Keohane, [24]). First, multiple exemplar instruction was implemented with the match and point response repertoires only. The steps for teaching MEI were as follows:

Step 1: Probe the match response. When presented with the 3-dimensional stimulus, the student was expected to independently match to a 2- or 3-dimensional sample by pointing to the corresponding picture on the tri-fold communication board.

Step 2: Teach the match response. If Stephen did not meet criterion during the probe for the match response, he was taught to independently match identical pictures or icons as those on the tri-fold folder to criterion level (95/100% across 2 consecutive sessions and 2 instructors).

Step 3: Probe the point response. The experimenter established antecedent in-structional control, presented a vocal antecedent naming the stimulus or action, and the student was expected to point to the corresponding picture on the communication board without an additional visual stimulus present (i.e., emit a multiply-controlled response that included a vocal antecedent in conjunction with an array of approximately 16 pictures presented in a grid).

Step 4: Teach the point response. If Stephen did not meet criterion during the probe for the point response, he was taught to independently point to pictures or icons on the Boardmaker folder when presented with 2- or 3-dimensional stimuli to criterion level (95/100% across 2 consecutive sessions and 2 instructors).

Step 5: Probe the mand and tact (i.e., speaker) responses. Stephen's reinforcers were identified using an approach/avoidance technique (i.e., present a selection of po-tential reinforcers and observe which reinforcers Stephen approached). A motivation operation [25]was utilized to evoke the mand. When presented with reinforcers, Ste-phen was probed to determine whether he was able to spontaneously mand for those stimuli when in his field of vision. When presented with 2- and 3-dimensional stimuli, Stephen was probed to determine whether he was able to spontaneously tact those stimuli.

Step 6: Teach the mand response. Stephen's reinforcers were identified using an approach/avoidance technique (i.e., present a selection of potential reinforcers and observe which reinforcers Stephen approached). A motivation operation [25]was utilized to evoke the mand. The experimenter provided a gesture prompt to the cor-rect icon in the category of foods we eat or things we use. The mand was taught to criterion level performance, and Stephen learned to independently mand using the form of the stimulus only during the initial stage of instruction.

Step 7: Teach the tact response. To the extent applicable, the stimuli within categories were taught in the tact function using the same instructional protocol as that of the mand function, except that Stephen did not receive the item for which he emitted a tact during instruction.

Step 8: Probe discrimination of categories on the tri-fold folder. When the experimenter provided a tact for any of the 11 categories, data were collected to determine whether Stephen was able to identify as a listener and as a speaker for all categories.

Step 9: Teach the discrimination of categories. The experimenter first provided a tact for the category and provided a gesture prompt in the form of an open palm moving in a circular motion over the corresponding section on the tri-fold folder (i.e., "Show me things we eat/foods"). This process was continued until Stephen met criterion for all categories at an independent level.

VI. RESULTS

Prior to the introduction of the systematically implemented alternative com-munication protocol, Stephen was considered to be a pre-speaker; he was unable to emit verbal responses across any setting. Using MEI and the Boardmaker© icons in a one-to-one instructional setting, Stephen learned to mand and tact all stimuli that were mastered as listener responses. Pre-intervention data showed zero spontaneous mands emitted; post-intervention data showed a mean of 45 spontaneous mands emitted per day. Pre-intervention data showed zero independent intraverbals, either during instruction or as greetings. Using family members, Stephen also learned to tact person plus action (two words) in vivo, to identify actions in photos, and to tact and identify as a listener all 11 categories targeted for instruction. Stephen learned to produce two word phrases using these same icons. In addition, although vocal approximations or targeted words were not demanded for every non-vocal response using the icons, echoics were evoked during both listener and speaker instruction. Data for echoics were not collected. However, data for spontaneous vocal mands were collected and are reported herein. Results also showed that maladaptive behaviors decreased while adaptive behaviors increased.

Subsequent to the implementation of this protocol, Stephen emitted in excess of 100 intraverbals daily, primarily in response to instructional demands including responses to social interactions. Social interactions included stating his name, age, address, telephone number, names of siblings and parents, and peers. These social interactions extended to Stephen reciprocating these conversational elements by asking the instructor, family members, or peers the same questions.

Prior to the implementation of the communication protocol, Stephen did not emit independent verbal behavior, either spontaneous or in response to other verbal or non-verbal behavior, to family members, instructors, and peers, and he did not respond using intraverbals to social initiations. Post intervention data showed an increase in intraverbal responses to peers ranging from 2 to 5 during a typical lunch period compared to zero from pre-intervention. During recess, responses to peers increased to a mean of 4, and responses to siblings outside of the school setting increased from zero to a mean of 5 when compared to pre-intervention probes.

VII. DISCUSSION

The purpose of this instructional protocol was to first teach a student with severe communication deficits using a low-technology system to gain the prerequisite skills necessary to subsequently use a high-technology AAC device. An analysis of the repertoires acquired as a result of MEI showed that for Stephen, he acquired all prerequisite skills and was first able to independently use the static (low-tech) communication system. An important outcome of this study was that, after 1-1/2 years of instruction using the static low-tech device in the acquisition of prerequisite skills identified for use of the dynamic communication device, Stephen qualified for the dynamic AAC. When Stephen returned for a follow-up evaluation at the speech clinic, he was determined to have all prerequisite skills in his repertoire. Additional collateral outcomes of this study were that Stephen began to spontaneously interact with his siblings at home, and with peers and staff at school and in community settings. While Stephen's communication skills improved, his maladaptive behaviors showed significant decreases. This was a significant outcome.

Stephen was recommended for the Dynavox-V® and was provided for 30 days to determine whether he would be able to use this dynamic and complex device. Surprising both his instructors and family, when shown how to work the device for a brief half-hour session, Stephen demonstrated the spontaneous capability to use the Dynavox-V and to recombine verbal operants for novel mand/tact/intraverbal/autoclitic combinations. Skills were probed and mastery criterion documented, and within one week a device was purchased for Stephen by his school district.

Stephen uses the Dynavox-V for diverse language functions, including mands, tacts, intraverbals, skill acquisition, and reciprocal social communication with same-age neurotypical peers and adults in his environment. Not only does Stephen use the device to compose complex sentences, he uses it across instructional skill acquisition within his home-based ABA program. Stephen continued to use the Dynavox-V while at home. However, he has also learned to use an iPod Touch and iPad, which have the advantage of portability. Transfer of stimulus control and generalization of responses across all three devices was accomplished using the same protocol as that used for the initial instructional protocol.

In conclusion, a student who lacks vocal verbal capabilities should be considered for instruction initially using low-tech means, with the intent of implementing a dynamic communication device (such as the Dynavox or iPad/ProLoquo combination). Consideration should be given to first teaching the student a set of prerequisite skills such that a student with limited repertoires as a listener and speaker may be immediately reinforced for successful communication using the aforementioned technical devices.

Strength

Given the complexity and high expense of operating technological devices, along with the difficulty in obtaining these devises for students' school districts, it may be more effective if the child is first taught to communicate using low-tech means with the standard symbols that are found in the high-tech devices. Once students acquire this prerequisite skill, the introduction of more expensive and complex high-tech devices would have increased success. Stephen was denied a high-tech alternative augmentative communication by his school district stating he did not have the prerequisite skills that would have qualified him for an augmentative dynamic communication device. In collaboration with his speech pathologist, specific skills were taught within Stephen's individualized home-based instructional program. For a student not presenting the skills or pre-requisite to communication, this was a successsful treatment to increase vocal verbal communication skills. Additionally, the data showed an increase in verbal behavior with a decrease in maladaptive behaviors.

Limitations

A multiple probe pre-post (A-B) design was used to evaluate the teaching and skill acquisition from the multiple exemplar training. The current sample size limits analysis for the strength of the relationship between the multiple exemplar teaching and vocal verbal behaviors of students with limited vocal verbal skills. A larger sample size would have added to the conclusions about the efficacy of teaching augmentative or alternative communication to children diagnosed with Autism. Although the results have shown the multiple exemplar training to be effective for Stephen, the implementation of a single-subject design methodology to more carefully and systematically measure change would have further strengthened these findings.

Future Research

The need for efficient and effective teaching strategies for students with limited vocal verbal communication skills has increased as the number of children diagnosed with ASD without the skill to interact meaningfully with others has increased.

School districts are not readily providing augmentative communication systems as experienced by Stephen. Stephen was evaluated for a high-tech alternative augmentative communication device in a specialized speech/language department and determined not to have the prerequisite skills necessary. Without these prerequisite skills, a student will not have the opportunity to gain access to a device through a school district. The future replication and implementation with a larger sample size for this research would add to the effective practices among students diagnosed with ASD. Further replication of this research study, as well as increasing the sample size, would assess effectiveness for many children diagnosed with ASD and other severe developmental disabilities. As over one-third of children with Autism do not have functional vocal verbal communication skills this is an extremely needed area for future research.

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Table 2

Category labels and corresponding background colors for Boardmaker icons used in communication folder.

Name of Category	Background Color
Things we eat, things we use, things we wear	Orange
People, pronouns, proper nouns	Yellow
Things we do	Green
Adjectives, adverbs	Blue
Places we go	Purple
Things we feel/emotions	Gray

Table 3

Adduction of response objectives

Tactic	Skill
MEI for two-word messages	subject-verb, verb-object, subject-adjective, adjective-object
MEI for three word message	subject-verb-object
MEI for pronouns	"Stephen go car." "Yes, say, 'I go car.' " Mom-Stephen eat pizza." " You're right, say, 'We eat pizza."

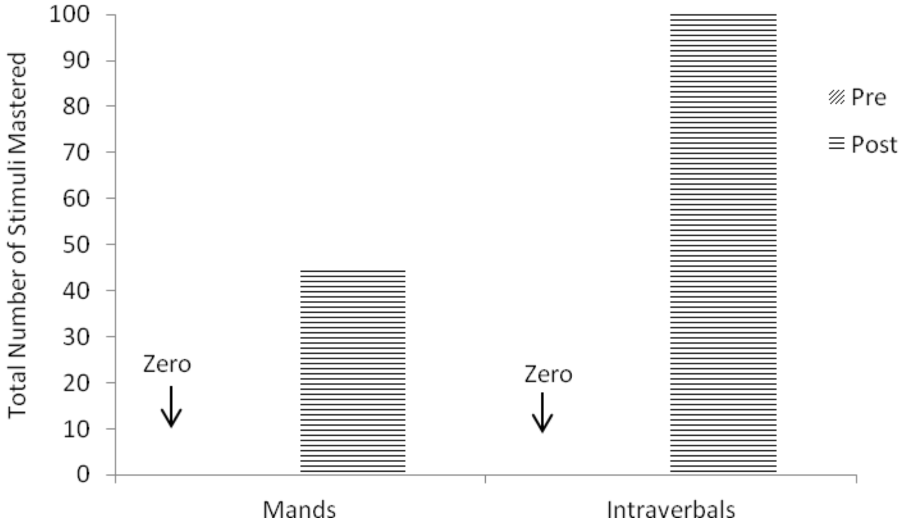

Figure 1

Responses to pre and post MTS instruction for correct responses to stimuli in various categories

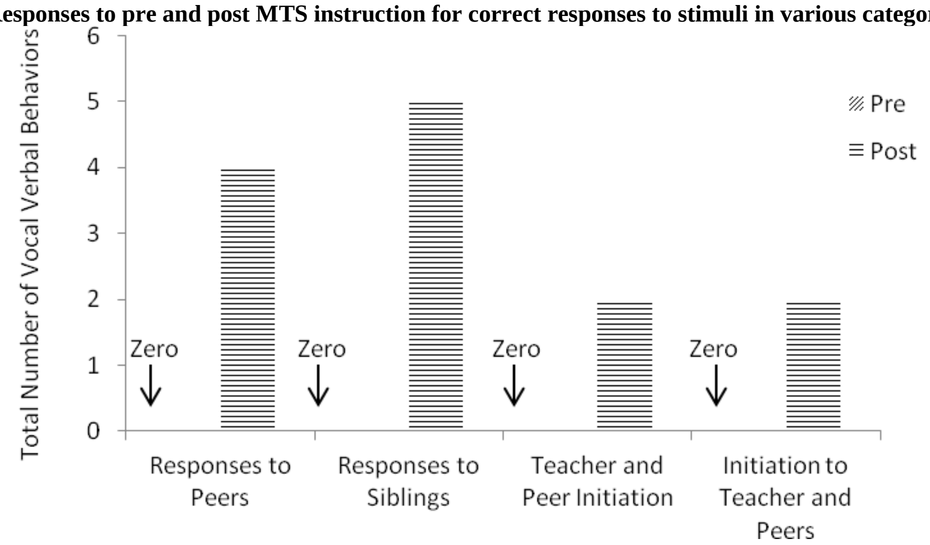

Figure 2

Responses to individual pre and post MTS instruction across settings

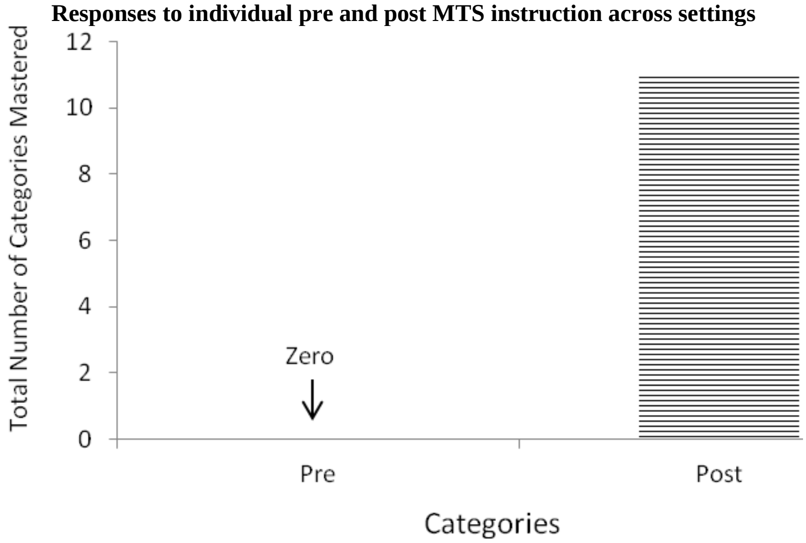

Figure 3

Cumulative number of categories mastered for pre and post MTS instruction

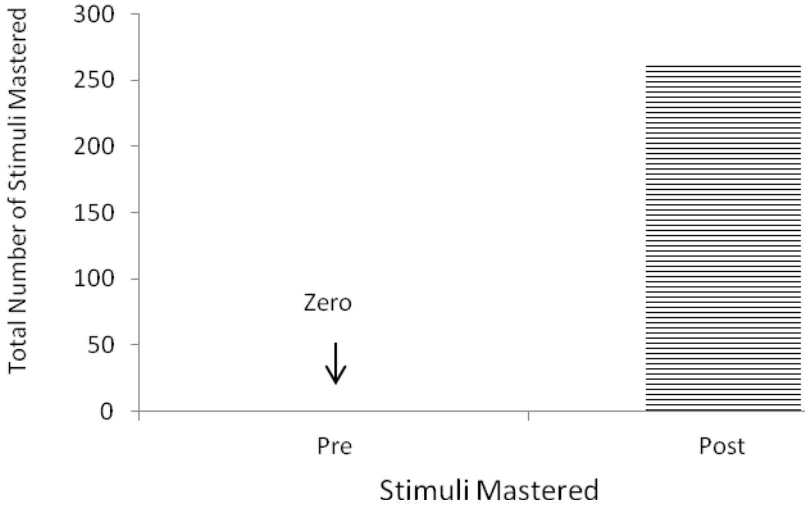

Figure 4
Cumulative number of stimuli mastered for comparison to pre and post MTS instruction