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Increasing Vocal Behavior and Establishing Echoic Stimulus Control in Children with Autism

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INCREASING VOCAL BEHAVIOR AND ESTABLISHING ECHOIC STIMULUS CONTROL IN CHILDREN WITH AUTISM

by

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Many children with autism fail to demonstrate vocal-verbal behavior, including echoic behavior, as early as their typically developing peers. Some also make very limited vocal sounds in general, remaining mostly mute aside from crying or engaging in stereotypy. Echoic behavior involves auditory discrimination and matching, and functions as a beneficial, if not necessary, prerequisite for many other vocal-verbal skills. The purpose of this study was to develop and implement an echoic training procedure for primarily non-vocal children who did not demonstrate auditory discrimination in baseline. The intervention consisted initially of sessions in which any vocal sounds were reinforced. Then differential reinforcement and shaping were used to increase the variety of sounds made. This was followed by a simplified echoic protocol to establish auditory stimulus control. The echoic protocol first targeted only the highest rate sound from previous phases in isolation, and introduced other high rates sounds in subsequent sessions. Echoic skills were tested prior to and throughout the intervention. This procedure produced an echoic repertoire in two out of three children.

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Longitudinal Studies of Children with Autism Spectrum Disorders – Identifying Non-Responders to Treatment

Longitudinal analyses of children with autism spectrum disorders (ASD) who received intensive early behavioral interventions typically categorize children into one of three groups, based on their success in these programs (Lovaas, 1987; Sallows & Graupner, 2005). Approximately 50% of the children do very well in the programs, and within two to three years are able to transition to regular-education settings (with no or minimal supports). We might consider these children to be "normalized," meaning they can learn in a standard classroom setting and should not be easily discriminable from their peers. Another 40% are able to acquire some important skills from early behavioral intervention programs, but still require moderate support in future settings. The remaining approximately 10% in these programs do not make significant progress, even with high-quality, intensive instruction. These lowest performers typically do not acquire basic prerequisites to academic skills (such as imitation, matching, and language) and, therefore, service providers instead focus on functional, basic daily living skills. (Lovaas, 1987; Sallows & Graupner, 2005).

In 1987, Lovaas described the successes and failures of his program at UCLA in a longitudinal report (Lovaas, 1987). Children who received intensive behavioral treatments (40 hours or more per week) were compared with groups receiving minimal treatment (10 hours or less). Each group received the same type of one-to-one behavior analytic treatment, with the less intensive groups also receiving supplementary treatment from other community sources. After two years in their respective programs, Lovaas reported that the children receiving intensive behavioral intervention made more

significant gains, as expected. From the control groups, only 2% of participants achieved normal functioning (placed into first grade and obtaining an IQ score of 99), 45% had made some improvement but were still placed into classes for those with language delays, and the final 53% were in the most restrictive placements.

The experimental group showed that 47% of their participants were considered "normalized," however another 40% still exhibited language delays and required extra support; and the final 10% of students in the intensive group were still considered "profoundly retarded" and had acquired little to no skills in the program. Even though not every child was able to make significant progress, these results were still encouraging, and far better than the results of the control group.

An interesting aspect of this study is that the criteria for inclusion prevented 15% of referrals from participating because of a requirement that each participant have a prorated mental age of at least 11 months or more at a prorated chronological age of 2.5 years old. This was true for both the experimental and the control groups. At the time, children who did not meet that criterion would have been labeled as "profoundly retarded." Children in that group likely would have made little progress had they been allowed into the study, but because there was low agreement on an actual autism diagnosis in that population, they were excluded. If these children had been accepted as participants, it is likely that there would have been more children in the lower categories, though comparisons between groups would not have changed. It may be plausible that shifting diagnostic practices have resulted in more children in recent years being given an ASD diagnosis, in addition to or instead of alternative diagnoses.

The children who did not "recover" in the experimental group continued to receive intensive (40+ hours per week) behavioral intervention for more than six years. Lovaas reports that some progress was made each year, but only one child "recovered." This may lend support to the idea that early intervention and early progress are crucial.

In 2005, Sallows & Graupner published the results of their longitudinal investigation of children's progress in an early intensive behavioral intervention program. This is the only study of the Lovaas model which has met the evidence standards set forth by the What Works Clearinghouse (U.S. Department of Education, 2010). Their results mirrored the Lovaas study. Twenty-four participants received services either from a clinic-directed or parent-directed program, and their progress was tracked for four years. Time exposed to one-to-one treatment ranged between 30 and 39 hours per week (the clinic-directed program provided 37 hours per week on average, with parent-directed averaging 31). Out of the 23 participants who remained in the programs for the duration of the study, 48% were considered rapid learners based on the skills they were able to acquire. These children were succeeding in typical first and second-grade classrooms at the conclusion of the study. The remaining 12 children (52%) were referred to as moderate learners, but two (9%) from this group made little to no improvement. Out of the moderate learners, four (17% of total participants) were placed into regular classrooms with the assistance of an aide and modified curricula. Six (26%) spent time both in special education and regular education classes; and two (9%) received full-time special education placements.

As previously mentioned, these longitudinal analyses identified a small portion of children receiving services who did not make any substantial progress. Neither group of researchers was able to discover methods for achieving reliable success with these lowest-functioning children, though their successes with the other participants should not be understated. It is apparent when looking at the published research, reviews, and meta-analyses of the existing literature that applied behavior analysis has much to offer individuals with autism spectrum disorders (Howlin, Magiati, & Charman, 2009; Levy, Kim, & Olive, 2006; Rogers & Vismara, 2008). However, it is also apparent that the standard intervention packages are not successful with every child. Therefore, determining how to best help the children who are not succeeding should be a priority for behavior analytic researchers.

Language Skills in Children with Autism Spectrum Disorders

A variety of variables (age, skills present at intake, etc.) might help to predict a child's success in early intervention programs, though there is no clear agreement (Howlin, Magiati, & Charman, 2009; Sallows & Graupner, 2005; Toth, Munson, Meltzoff, & Dawson, 2006). Individuals with autism spectrum disorders often have marked delays in language development, and these are readily apparent when children enter early intervention programs at a young age (CDC, 2007). Many young children with ASD do not vocally request reinforcers, label things, or vocally imitate other speakers. Without early intensive behavioral intervention, they continue to fall behind their typically developing peers in many areas (see Howard, Sparkman, Cohen, Green & Stanislaw, 2005 for a summary of incoming repertoires and changes after early

intervention). These language delays are especially apparent in the lowest-functioning subset of children with ASD. Recent research does seem to indicate that even children with severe language delays may still be able to acquire fluent or basic speech as they grow older and receive behavioral services (Wokda, Mathy, & Kalb, 2013). However, children with low nonverbal intelligence (low nonverbal IQ), especially those who do not show social interest and engagement, are less likely to attain these outcomes.

Spoken Language as a Predictor of Success and an Important Skill

Language is a critical component of human behavior at both individual and societal levels. It allows us to interact with others; and language affects other behavior through the use of rules. Spoken language, as opposed to sign language or icon exchange, is more functional when fluent (society already knows how to react to spoken language). The presence of spoken language at intake, or its relatively quick acquisition during early intervention programs, is positively correlated with better outcomes (e.g., greater gains in many skill domains, better academic placement, etc.) (Eldevik, Eikeseth, Jahr, & Smith, 2006; Gillberg, & Steffenburg, 1987; Howlin, Mawhood, & Rutter, 2000; Magiati, Charman, & Howlin, 2007; Mawhood, Howlin, & Rutter, 2000).

There are numerous other predictors, such as IQ, imitation skills, younger age, and social skills (like joint attention), but language is a reliable predictor (Sallows & Graupner, 2005). Certain combinations of repertoires and demographic variables appear to be likely predictors of success. Vocal imitation (echoic behavior) combined with higher IQ scores and lower age made the acquisition of spoken language more likely (Goldstein, 2002). Having non-vocal imitation (motor imitation, manipulative imitation,

facial imitation, etc.), being able to acquire echoic behavior quickly, and the presence of auditory discrimination (e.g., following instructions) has also been correlated with good results (Weiss, 1999).

If the presence of language or the ability to acquire it quickly is highly correlated with success in early intervention programs, and it is useful in and of itself, then efforts should be made to target these skills. The ability to acquire language is only possible when the prerequisite skills are present, and perhaps targeting those skills early is more effective than targeting language directly.

There may not be anything special about language as it pertains to acquiring other skills (aside from its usefulness in affecting the environment). It may be that the ability to acquire any complex skills quickly is likely to predict generally positive outcomes. In other words, the presence of language skills may not have a causal relationship with most other skills, only a correlational one. It may be that a child who has not developed language skills from exposure to the natural environment also has failed to develop any other complex skills. In this project, our rationale for targeting language did not depend upon its status as a predictive variable, but rather on the idea that language is useful and important in its own right. If acquiring language skills plays a small part in helping the lowest performers make more progress, then our efforts are justified.

Traditional Approaches to Language Instruction

When behavior analytic interventions were first used with individuals with developmental disabilities, language acquisition was typically approached differently than it is currently. Behavioral language instruction often relied upon the same

terminology as general educators (Sundberg & Michael, 2001). This shared terminology may have affected which language skills behavior analysts targeted, and in what sequence. For instance, in his work with developmentally delayed children, Lovaas first focused on imitation (including facial movements). He then suggested teaching following simple instructions. Vocal imitation (echoic behavior) was also targeted early, but the programs included discriminative stimuli such as instructions for the child to "talk." Sounds were trained in isolation, then combined. Imitation of more complex sounds and words and specific topographies was targeted later as well. There was a heavy emphasis on receptive language skills throughout his program, and it was suggested that teachers target specific words in a receptive context before expressive (Lovaas, 1981). While these programs did help many behavior analysts teach language skills to many people, Lovaas noted how difficult it could be and there was a major emphasis on listening to, discriminating between, and following instructions, even before the child had many other skills.

Skinnerian Approaches to Language Instruction

More recently, behavior analysts have argued for an approach to teaching language based on Skinner's analysis of the basic verbal operants (Skinner, 1957). These operants include mands (requests), tacts (labels), echoics (vocal imitation), and intraverbals (filling in blanks, completing sentences, etc.). This approach has helped the field restructure early language interventions (Sundberg & Michael, 2001). A greater emphasis has been placed on early language development, especially on manding (requesting) and echoic behavior (Sundberg, 2004).

An echoic is an operant in which the vocal response of the speaker matches a vocal model. Echoic behavior is basically sound imitation (vocal imitation). Skinner provides more specifics and complexity in his analysis of this operant, but for early intervention, vocal imitation is an adequate interpretation.

Vocal imitation is crucial for early language development, as children are able to imitate fluent speakers in order to acquire words that can function as other operants (such as mands and tacts). Echoic behavior, like many other imitative behaviors, allows a learner and instructor to take many “short cuts” to acquire new skills. Speaking a new word does not have to be shaped from nothing when the instructor can simply provide a model for the child to echo (Kodak & Clements, 2009). However, when an individual does not have an echoic repertoire, acquiring other important vocal-verbal operants is sufficiently difficult and laborious as to make language development less likely.

As Sundberg and Michael (2001) point out:

> Information regarding the quality and strength of the echoic repertoire can reveal potential problems in producing response topographies that are essential for other verbal interactions. If the child cannot echo specific sounds, then the probability of those responses occurring in other functional units of verbal behavior is quite low *(*p. 706*)*.

Echoic behavior is also theorized to be an important part of other skills, such as receptive identification or direction following. For example, when given a two-component instruction such as “go to the kitchen and get a cup,” the ability to echo “kitchen, cup” throughout the response chain helps to ensure the direction is followed. Scanning an array and covertly echoing the name of the item that needs to be selected until there is a match between the tact of the visual stimulus and the echoed word is

another example. This application of the concept of joint control relies heavily on an echoic repertoire (Lowenkron, 1998; Palmer, 2006).

Although the benefits of echoic behavior are apparent, the most effective way to teach it is not. The general consensus seems to be that it depends on the individual, as some comparison studies have found mixed results across participants (Cividini-Motta, 2014). Some methods commonly used to establish an echoic repertoire include vocal imitation training, rapid motor imitation (RMI), stimulus-stimulus pairing (SSP) procedures, and mand-model training. Each of these procedures has strengths and weaknesses, and requires certain prerequisites from the participants.

Common Methods for Teaching Echoic Behavior

We will briefly present four typical and accepted approaches to teaching echoic behavior.

Vocal imitation training (standard echoic training).

Standard echoic or vocal imitation training involves presenting a vocal model, and providing access to reinforcers if the participant imitates that model within an established amount of time. This is a relatively simple procedure that is easy to implement. It is effective in some cases (Carroll & Klatt, 2008; Stock, Schulze, & Mirenda, 2008). But, if a child is primarily non-vocal and is not likely to ever emit a correct response, this procedure will probably not be successful. If correct responses never occur, the reinforcement contingency will never be implemented. Therefore, this approach may not be ideal for the lowest-functioning children.

Rapid motor imitation (RMI).

Another option is to establish a strong physical imitative repertoire to increase the likelihood of successful attempts or approximations following echoic models. The typical strategy is to establish a strong physical imitative repertoire, and then occasionally model vocal responses following several correct physical responses. When behavior analysis was just beginning to be applied with a variety of populations, researchers studied the effects of shaping and differential reinforcement in regards to establishing vocal imitation (Baer, Peterson, & Sherman, 1967; Brigham & Sherman, 1968; Lovaas, Berberich, Perloff, & Schaefer, 1966). Although these studies were not conducted with individuals with autism, the results were promising. More recent research has lent additional credibility to this rapid-motor imitation procedure (Ross & Greer, 2003; Tsiouri & Greer, 2003, 2007; Tsiouri, Simmons, & Paul, 2012). The necessary prerequisite for this approach is a strong imitative repertoire, or the ability to acquire one quickly. But often the lowest-functioning children struggle to acquire imitation, especially generalized imitation (imitating novel models), and therefore this approach may not be feasible with them.

Stimulus-stimulus pairing (SSP).

Skinner’s conceptualization of language and the development of language led to an increased awareness in the probable role of automatic reinforcement (Skinner, 1957). Early in life there are many repeated pairings of caregivers’ speech sounds with learned and unlearned reinforcers (e.g., food), and those speech sounds become learned reinforcers through the pairing procedure. When a child babbles and it resembles those

speech sounds, then it results in automatic reinforcement, and the babbling of those sounds is more likely in the future (Skinner, 1957; Sundberg, Michael, Partington, & Sundberg, 1996). One approach, therefore, is to provide structured pairings to children with autism who have language delays, in an attempt to utilize this same process. As Sundberg et al. (1996) pointed out, “a major problem faced by many language delayed children is that their vocalization rate is too low to acquire the muscle control necessary to emit echoic responses” (p. 36). This procedure attempts to remediate that by changing the reinforcing value of self-produced vocal sounds. Many researchers have studied this procedure, in different variations, and the results are mixed but generally positive (Esch, Carr, & Michael, 2005; Fronapfel-Sonderegger, 2012; Miguel, Carr, & Michael, 2002; Stock, Schulze, & Mirenda, 2008; Yoon & Bennett, 2000).

A consistent methodology has not been established, and results vary. It is not clear what prerequisites are necessary for success with this approach nor why it is effective with some children but not others. We might theorize that children who do not already engage in some small amount of vocal behavior may not be vocal enough for automatic reinforcement to control that behavior. Or perhaps for some children, adult voices are not salient enough parts of the environment for the pairings to be effective. Additional research is needed to help determine how to make this approach more effective with low-functioning children with autism.

Mand-model.

A fourth approach to establishing an echoic repertoire involves first focusing on teaching mands. Developed by Rogers-Warren and Warren (1980), the mand-model

procedure was based on incidental teaching techniques (Hart & Risley, 1975). For the original procedure, the goal was to increase appropriate manding as a response to an instructor's request to do so (i.e., the child would receive an item if they labeled it after the instructor blocked access and said "tell me what you want"). While this procedure was successful in increasing the number of vocal mands the children would emit (Rogers-Warren & Warren, 1980), it was the role of the echoic prompt that spurred some research into using the mand-model to help establish other operants.

Drash, High, and Tudor (1999) reported on a modification of this procedure and its result on echoic and tact behavior. They first established manding for desired items by keeping them just out of reach until the children responded to the tutor's verbal prompts (e.g., "what do you want?", "do you want this?") with an appropriate word or approximation. They used shaping to improve approximations and reduce problem behavior such as screaming. Once the children were reliably emitting different sounds as mands (which the tutors paired with specific reinforcers), they incorporated an echoic prompt. For example, whenever the child made the "ah" sound for a bite of apple, the tutor paused before delivering the apple, said "ah," and provided the reinforcer only after the child again made the "ah" sound. They described this process as bringing the response under mand, echoic, and tact control simultaneously. Once the child would reliably emit these echoic responses to models of sounds they had frequently used as mands, the researchers expanded into novel sounds which they paired with new reinforcers. Eventually they also moved on to tact training. Drash et al. (1999) reported that the procedure was able to quickly and successfully produce mand and echoic

repertoires in their participants. Within six sessions, all three children were manding reliably, and within seven sessions they were also echoing.

The mand-model has been adapted for other purposes, such as teaching children with less severe developmental or language delays to enunciate certain sounds more clearly, where it was found to be effective for most participants (Hawkins & Schuster, 2007). This approach seems to be most effective when used with individuals who already have emerging mand and echoic repertoires. If the range of possible reinforcers is relatively small, or if the participants are primarily non-vocal, this approach may take considerably longer.

Our Goal

However, none of the previously described approaches are effective with every child, especially lower-functioning children. The prerequisites may be difficult and time-consuming to teach, leaving children without effective means of communication.

A molecular approach to language instruction and other skills.

Our approach to teaching low-functioning children with autism has been to be as molecular in our analyses as possible. A molecular approach means keeping things as simple as possible, and isolating important discriminative stimuli to promote proper skill acquisition and stimulus control. In this project, we targeted echoic behavior, but other members of our research group have used this molecular approach to work on teaching visual discriminations, matching-to sample, auditory discriminations, and physical imitation to lower-functioning children in our classroom (Shane, Mrljak, Lichtenberger, Ouellette, & Malott, 2014).

Lower-functioning children tend to have very poor instructional stimulus control. They are not blind, they do not walk into door frames and they can easily pick out a piece of candy off the floor, but matching-to-sample is still difficult to teach. They are not deaf, they will approach the movie that is playing across the room out of sight when they hear it, but we still struggle to teach them to discriminate spoken instructions. Perhaps it is something about the way learning opportunities are structured that is not effective for these children. Previous research (Lovaas 1987) has shown that even traditional intensive behavioral intervention over several years is typically not enough to help this subset of children make significant progress. We are making modifications to the traditional approaches in an attempt to remediate that.

In this project, we attempted to establish auditory stimulus control in lower-functioning children with autism. This skill is essential both as a prerequisite for language acquisition, and also as a prerequisite for much of the instruction that happens during early intensive behavioral interventions. Language is important in its own right, and appears to be correlated with success in these programs.

Purpose.

Our purpose was to develop an approach we hoped would require very few prerequisites to be successful, and would teach some important skills. We developed and tested a multi-phase procedure to ultimately establish an echoic repertoire in lower-functioning children with ASD. The procedure we used most closely resembled the mand-model, with some key differences.

Methods (General)

Participants

Participants were selected from students in the early intensive behavioral intervention (EIBI) classroom at WoodsEdge Learning Center (WELC) in Portage, Michigan. This classroom was staffed by teachers from the school, and by undergraduate and graduate practicum students and graduate assistants from Western Michigan University (WMU). The children in this classroom received 15 hours of discrete-trail training (DTT) per week, implemented by the practicum students.

The classroom provided all incoming children with access to and training on how to use an icon-exchange system to request preferred items or activities (mand). This system was similar to the Picture-Exchange Communication System (PECS) (Bondy & Frost, 1994). Over the course of four phases, the children were taught to hand icons for preferred items or activities to communication partners (their tutors) who could provide access to those items or activities. Many children in the classroom were able to acquire the skills to use this system to mand, but often mands only occurred when prompted by the tutors, and not independently throughout the day.

The classroom also used standard verbal-behavior procedures, to which the children were exposed when appropriate. The echoic procedures in the curriculum were similar to the standard vocal-imitation training (echoic) procedures described previously. There was also a stimulus-stimulus pairing procedure available, which had been implemented with mixed results with other children.

Most of the children in the classroom also received supplementary services during the 15-hour week, such as occupational therapy, physical therapy, or speech therapy. The speech therapists primarily targeted icon-exchange skills, especially with children who were not vocal-verbal. Speech therapy was typically provided one or two times per week for 30 minutes at a time and the speech therapists worked with one to three children at a time.

Selection and Screening

Children were selected for this intervention based on their limited repertoires and lack of progress on relevant instructional procedures. Prior to selection for exposure to the pretest and ultimately the intervention, children were observed, tutors and case managers were interviewed, and curriculum progress was analyzed. Children who had acquired echoic responses from the existing vocal-verbal behavior curriculum in the classroom or entered the classroom with echoic repertoires were excluded from the study. Children who demonstrated strong receptive language skills (auditory discrimination/listener repertoires) were also excluded. A pretest was conducted with each potential participant to assess their existing echoic repertoire. To be included in the study, children could not demonstrate a strong echoic repertoire. A few correct echoic responses on the pretest, indicative of an emerging echoic repertoire, were considered acceptable.

We examined the list of children in the classroom, and based on familiarity with each child, excluded those who did not meet the inclusion criteria. The children on the focused list were observed more closely to determine if they were potential candidates.

Candidates were exposed to the echoic pretest. Poor performance on the pretest warranted inclusion in the study. Three children participated fully in this project. Layla, Lexie, and Ella will all be discussed in more detail in subsequent sections. Three other children were included briefly, but soon demonstrated more advanced skills than were observed during screening, and were excluded from further participation.

Setting and Materials

Sessions were conducted in the EIBI classroom at WELC. They took place in a standard instructional environment with a small table and chair. Some sessions were conducted in the children’s normal work spaces, some in similar available work spaces, and some in a quieter small room set up with the same furniture. Distractions were minimized by restricting the availability of tangible or edible reinforcers to only what we provided. Reinforcers included edibles such as Skittles® candy cut into quarters, gummy fruit snacks also cut into small pieces, mini M&M’S®, a variety of tangible toys, and a portable DVD player showing Disney® movies.

Dependent Variables

Dependent variables included performance on the echoic pre-test, echoic probes, and the echoic post-test. Data were also collected on rates of vocal behavior within session for early phases, and percentage of correct echoic responses for later phases.

Independent Variables

Overview.

The conceptual approach in this procedure was to first reinforce any vocalizations in a free-operant setting, and then to introduce vocal models resulting in echoic control.

Phase One (Free-operant reinforcement of all sounds).

The first phase was implemented to increase overall rates of vocalizations. Any vocalizations resulted in access to a preferred item or activity (presumed reinforcers). For certain participants, incremental shaping was required and began in some cases with reinforcing very subtle precursors to vocal behavior, such as audible breaths or even mouth movements.

Phase Two (Free-operant reinforcement of low-rate or novel sounds).

Once the participants were emitting acceptable vocal sounds at a high rate (two to three responses per minute) the goal shifted to increasing the variability and persistence of these sounds. Variability was important to allow success in the eventual echoic training. To achieve greater variability, dominant responses were placed on extinction throughout the sessions in Phase Two. Novel or low rate responses were continuously reinforced. These sessions were still free-operant in nature, with each acceptable vocalization resulting in access to the preferred item or activity.

Phase Three (Echoic training).

A crucial step in the intervention was the introduction of vocal models. We chose one high rate sound emitted by the child in Phase Two. The contingency was modified so that only the first instance of vocal behavior that matched (within acceptable limits) the

model was reinforced. In the initial sessions, only one sound was targeted. When the child was consistently making echoic responses to the first target sound, additional high-rate sounds were introduced (modeled). When every high-rate sound from Phases One and Two had been established as echoics, the goal then shifted to achieving echoic control with low rate and novel sounds. In this phase, we would make a novel or low rate sound, and would provide reinforcement for any vocal approximations or matches from the child.

Rationale

As was the case with Drash et al. (Drash, High, & Tudor, 1999), although we began by increasing vocalizations in a mand context, we did not particularly intend to establish manding (though we used it as a useful step towards echoics). This first phase of the procedure did not involve any discriminative stimuli or prompting from the tutor. On a free-operant, continuous-reinforcement schedule, we reinforced any vocal sounds the child made (aside from certain undesirable sounds, detailed later). If the child emitted only a few different sounds at high rates in and across these sessions, we implemented a similar phase in which previous high-rate sounds were placed on extinction, in order to increase the total number of sounds the child would reliably emit.

When we had identified a few high rate sounds in the child’s repertoire in this context, we introduced an echoic auditory discrimination procedure. We determined which sound was most common, and presented models of only that sound on a time-based schedule. The first matching sound emitted by the child following the tutor’s model was reinforced. Once the child was reliably responding to the single model, and not

engaging in high rates of unreinforced responses, we introduced models for other sounds the child had previously emitted. We continued in this manner until we had targeted all high-rate sounds from the free-operant phases, and then targeted echoic responses to novel models. Our ultimate goal was to work with each child until generalized echoic behavior was demonstrated, although in working with low-functioning children, we knew this may not have always been realistic.

Structurally, this procedure mirrored previous research which also used the mand-model to train echoic responding. However, there were some significant differences. Because we intended to use this procedure with low-functioning children who did not have any reliable echoic behavior or auditory discrimination, this informed many of our changes. Previous research (Drash et al., 1999) reported that at intake, their participants were already imitating vocal sounds with between 25-54% accuracy, and responding in manding conditions on between 47-95% of opportunities. The participants towards whom the current procedure was aimed were well below these levels of vocal-verbal skills. Eye contact was not considered to be a necessary prerequisite (though it was likely beneficial), but some basic attending skills were.

In the early phases, when increasing vocal behavior in a mand context, we did not provide any vocal prompts for the child to respond. Previous studies had incorporated vocal prompts such as “What do you want?” into these sessions. Given that our children did not have the sophisticated verbal repertoires necessary to make that complex language useful, we did not provide it. We also determined that including a prompt from the tutor in the initial manding sessions would add an unnecessary discriminative

stimulus. Therefore, we utilized a free-operant approach, in which the tutor's physical presence was the only possible S^D, and their only role was to provide reinforcement for appropriate vocal behavior.

Another characteristic that appears to be common (perhaps more common) in lower-functioning children with autism is that the array of consistent reinforcers is often small. In traditional mand-model training, specific reinforcers would be paired with specific sounds, leading to vocal behavior that more closely fits the Skinnerian definition of a mand. The goal would be to do this pairing with at least several sounds and reinforcers, to establish a variety of targets for echoic training. Being able to use the sight of the item as a prompt (and/or S^D) for the echoic response may be useful. However, the children we intended to work with had a limited array of consistently preferred items. Therefore, we chose to use non-specific reinforcement both in the manding and echoic phases of this procedure. We used whatever reinforcers we could identify as being at strength at any given time. We hoped to determine whether or not establishing sounds as specific mands was crucial for this type of intervention. Given that we were not pairing sounds with specific reinforcers, we had to utilize other methods to increase the total variety of sounds the children would emit (to eventually target as echoics). Therefore, our second phase involved manipulating reinforcement schedules to increase the variety of vocal responses.

Related to the topic of pairing specific reinforcers with specific sounds, we also did not attempt to reinforce or shape predetermined sounds. Any sounds the children made that were appropriate speech sounds or could be shaped into such sounds were

reinforced. We used any high rate sounds from the free-operant phases as targets for the subsequent echoic sessions.

The echoic procedure we used was similar to a standard vocal-imitation training procedure. We did deliberately train the first target in isolation, contrary to standard practice. We theorized that simplifying the first required echoic discrimination would be more important for the targeted population. We also did not use an error correction strategy during default echoic sessions. We provided reinforcement for imitating sounds even if it was delayed from the vocal model but still occurred prior to the next model. We also reinforced imitating sounds or making approximations even if they were not the first emitted sound following the model.

Research Design

This project was conducted both to contribute research to the field on establishing echoic behavior, and to increase the skills of the children who participated in the project. We did not conduct comparisons of different procedures, and the intervention was tailored to each child. We utilized differential reinforcement and shaping, and it was not always possible to carefully control every variable, as the primary goal was to help the children. As this was a teaching procedure involving skill acquisition, we would consider it to be a simple AB design, though the intervention consisted of three related phases. Skills were also assessed using a pre/post-test design.

Measurement

All sessions, including pre-tests, probes, post-tests, and experimental sessions were recorded on digital video. Sessions were coded live or afterwards, with data being

collected on relevant dependent variables for each phase. Sessions varied in length, as they depended on the motivation of the child, but typically lasted five minutes. For early phases, data were collected on the number of vocalizations per minute, to create a rate measure that could be compared across sessions of differing lengths. For later echoic phases, data were collected on accuracy of responses after each echoic prompt.

Interobserver Agreement

Interobserver agreement (IOA) was collected for approximately 33% of the sessions for each participant. Data we collected either during sessions or from coding video were compared to data collected by a graduate student who also coded the same videos. Interobserver agreement was 95% for Layla’s sessions, 97% for Lexie’s sessions, and 93% for Ella’s sessions.

Treatment Integrity

Since this procedure involved the shaping of vocal behavior, it contained some inherent subjectivity. Therefore, the author conducted all of the sessions with each participant, to ensure as much treatment integrity as possible. As interobserver agreement on the dependent variables was collected and analyzed, any potential concerns about treatment integrity would be discussed. However, no concerns were raised.

Layla

History

The PrePrimary Evaluation Team (PET) had evaluated Layla when she was 2.5 years old, after she was referred by her mother due to concerns regarding her communication skills. Her parents reported that she had fewer than ten words in her

vocabulary at the time, and many of those were words or phrases from favorite television shows and cartoons and were not used functionally. Layla was reported to have been acquiring language more rapidly up until she was about 1.5 years old, even counting up to 20 in both Spanish and English, but seemed to regress after that. Her mother relayed that she would sometimes say a word and then never use it again. During the observation, staff noted that she appeared to sing along with a Barney™ video that was playing, although she did not enunciate the actual words. Staff also observed her making a range of sounds with inflection. She did spontaneously echo the word "go," but she would not imitate any vocal behavior when requested to do so. Eye contact was inconsistent during this evaluation, but increased when playing peek-a-boo with a staff member. The evaluation team concluded that due to major delays in communication (receptive and expressive), social skills, and other areas, she met the criteria for an educational diagnosis of autism as defined by the state of Michigan.

Layla had been enrolled in the early intervention discrete-trial classroom at WoodsEdge Learning Center for four months before being selected as a potential participant in this project. She was three years old at the time. Along with the discrete-trial training, she received speech pathology services at WoodsEdge, typically for 30 minutes each week. The speech therapist primarily worked with Layla on manding (requesting) using an icon-exchange system similar to the Picture Exchange Communication System (PECS), and did not actively target echoics or other vocal behavior. Layla learned and used this icon-exchange system in the discrete-trial classroom as well.

When Layla was first considered as a potential participant, she was being trained on the second phase of this communication procedure, which involved closing the distance to a tutor, and persisting in a request until it was acknowledged. By the time she had started to regularly participate in our sessions, she had progressed to learning to discriminate between icons representing different preferred and non-preferred items or activities. Around the time she finished our procedure she also mastered this icon-exchange communication system, and could place an “I want” icon on a sentence strip along with the icon corresponding to the reinforcer desired. We and the tutors both observed that she could use this system fluently when prompted, but rarely engaged in spontaneous manding.

Reason for Inclusion

During her first four months at WoodsEdge, it became apparent that Layla was a potential candidate for this project. She had acceptable levels of in-seat behavior and some limited eye contact, and some consistent reinforcers. She also had not demonstrated reliable auditory stimulus control or echoic behavior.

Those who worked with Layla confirmed by anecdotal report that she did not demonstrate echoic behavior prior to the intervention. They also reported a lack of auditory stimulus control. One example of this was her responding on the “my turn” procedure. In this procedure, the tutor initially provides a physical prompt for the child to hand the tutor an item, and then the physical prompts are faded out until only a vocal SD is provided. Layla did well on the first few phases of this procedure which included physical prompting, but as soon as the prompt was completely removed, responding

immediately fell to near zero levels. After two additional months of working on this procedure with no progress, it was removed from her curriculum. This example illustrates the trouble some children in early intervention, including Layla, have with responding to auditory stimuli.

We also conducted direct observations, and reviewed performance on relevant instructional procedures. Layla had completed some procedures prior to being screened, during her first months in the classroom. These included programs targeting motor skills, cause-and-effect, and basic attending. She progressed quickly through visual discrimination procedures like matching-to-sample, before and during the intervention. She also worked on multiple imitation procedures during the intervention, though progress was slow. She had not completed any programs which targeted auditory discrimination skills or vocal-verbal behavior.

All sources of information and all observations indicated that Layla indeed did not demonstrate echoic behavior or auditory stimulus control. Therefore, she was determined to be a good potential candidate for the intervention, and was exposed to the pre-test.

Method and Results

Echoic pre-test.

Prior to the intervention, Layla was exposed to an echoic pre-test, conducted across two separate days. A total of 21 trials were presented, covering nine different early echoic targets. Targets were selected from those included in typical early echoic assessments (Esch, 2008). We conducted a preference assessment, waited for eye contact, and provided an S^D such as “say mmm.” If Layla responded correctly, she received the

reinforcer and social praise. If she did not respond, or responded incorrectly, we repeated the S^D (the sound alone, excluding the word "say") up to two more times (if needed). Extra learning opportunities targeting other mastered skills (such as gross motor imitation) were interspersed occasionally and correct responses were reinforced. Layla responded correctly on one trial, making the "shh" sound after the third repetition of the model. In total, Layla responded correctly to only 5% of the trials (1/21) during the pre-test sessions. This confirmed what the anecdotal reports and procedure data suggested, that she did not have an echoic repertoire, or at least not one under proper instructional control at WoodsEdge.

Phase One – Free-operant reinforcement of all vocal responses.

The first phase of this intervention used a free-operant condition in which any appropriate vocalizations were reinforced whenever they occurred, on a continuous reinforcement schedule. We sat in front of Layla and maintained eye contact, whenever possible, but did not provide any prompts or S^Ds. When Layla made an appropriate sound, we delivered an edible reinforcer and a praise statement (e.g. "good job"). A vocalization was only considered inappropriate for any participant (and not reinforced) if it was part of a behavior we did not want to increase (crying or whining) or if it would be difficult to shape into sounds often used in the English language (e.g., grunting or coughing). Sessions lasted between six and nine minutes, depending on the child's motivation. Edible reinforcers were used in sessions with Layla in all phases, and included pieces of crackers, Skittles, M&Ms, and Starbursts.

Figure 1 shows Layla’s performance during Phase One sessions. The most significant behavior change occurred during session four, where Layla made mand-like vocalizations. By mand-like, I mean that while all vocal responses were treated functionally as a generalized mand by the experimenter (i.e., they resulted in access to whatever edible was currently the most preferred), some were accompanied by pointing, reaching, and either eye contact with the experimenter or looking at the reinforcer. While the specific sounds emitted did not “match” the specific reinforcers received, and therefore do not fit the traditional definition for a mand, they were very similar in what may be considered the most relevant aspects. Such responses will be referred to as “mand-like” throughout this manuscript, in reference to this description.

During the first three sessions, Layla occasionally babbled and emitted a variety of single sounds, but mostly sat silently at the table. And while she did tend to show interest in the reinforcer which was often concealed in the experimenter’s hand, the majority of these sounds did not resemble a mand, though they were occasionally accompanied by actions such as pointing to or reaching for the hidden reinforcer.

Starting in the fourth session, the pattern of responding changed. Although there were still periods of silence as Layla consumed the edible reinforcers or engaged in stereotypy, her vocal responses and the accompanying behavior started to be consistently mand-like. The variety of sounds within sessions also greatly decreased from the first three sessions. From the fourth session onward, Layla would typically emit only one sound (the first was “whee”) over and over, gaining access to several small pieces of the edible reinforcers in the span of a few seconds. There was also less babbling and more

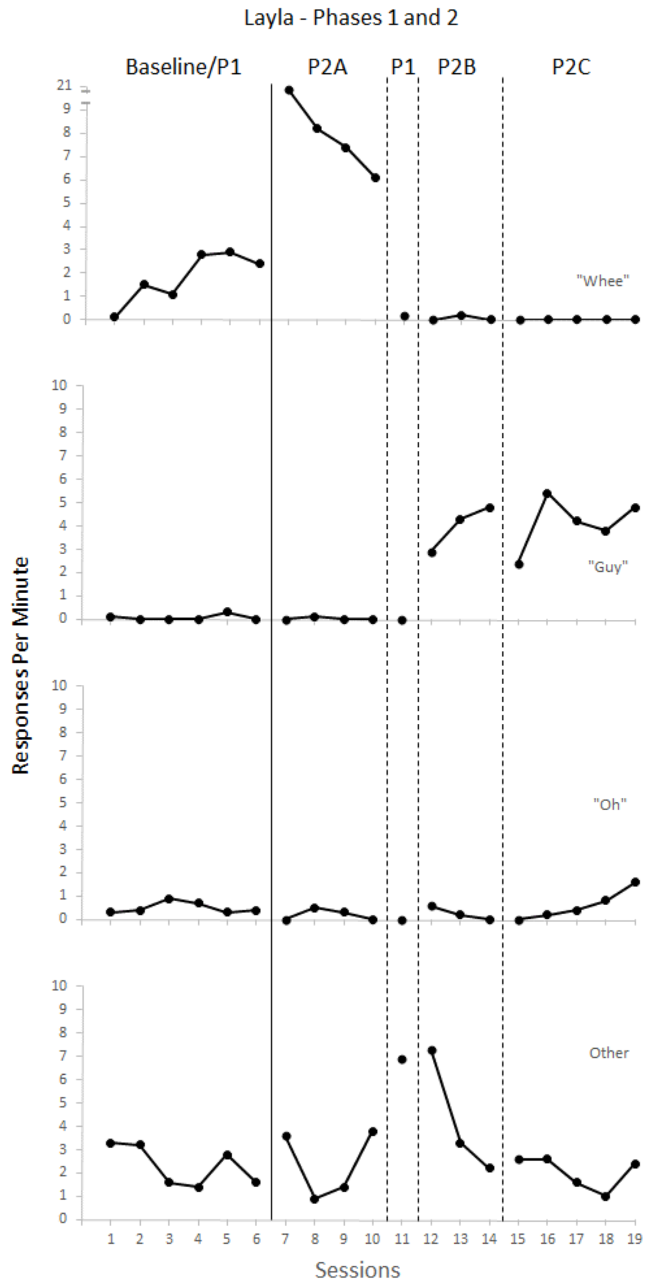

Figure 1. Layla – Rates of reinforced responses during Phases One (free-operant reinforcement of all acceptable vocal responses) and Two (increasing vocal variability). In P2A, "whee" was on extinction the entire session. In P2B, "guy" was on extinction the entire session. In P2C, a lag schedule was also in effect, as described in the section on Phase Two in this manuscript. Actual rates may be underrepresented, as sounds that were repeated quickly (e.g., "whee, whee, whee" in rapid succession) were counted as one utterance. The 'other' category includes babbling, vocal stereotypy, and low rate sounds (which were typically not mand-like).

vocalizations were mand-like and accompanied by pointing, eye contact, etc. Non-mand-like responses were still reinforced whenever they occurred, but were less common than the new dominant mand-like responses. This pattern of responding persisted for the fifth and sixth sessions. After six sessions in Phase One, vocalizations were occurring at a high rate (close to three utterances per minute or more), and often resembled a generalized mand.

Phase Two – Free-operant reinforcement of low-rate sounds.

The next goal was to increase the variety of sounds Layla would emit at a high rate, which could later be used as targets during echoic training. The sessions in the second phase of this intervention were similar to those in Phase One. The only difference between this phase and Phase One was that not every sound was reinforced in Phase Two (specific high rate sounds were placed on extinction).

In an attempt to increase vocal variability, the first method we used was to reinforce the dominant sound from Phase One ("whee") any time it occurred, during only the first minute of each session. After one minute had passed, that sound was placed on extinction. Any other sounds were reinforced any time they occurred during the session. This was implemented during sessions seven through 11. Starting in session 12, a new dominant sound emerged, and that sound ("guy") was placed on extinction after the first minute in sessions 12 through 14.

While the rates of reinforced sounds per minute remained relatively stable, we observed a much higher rate of non-reinforced sounds, as the dominant sound was often emitted even though it was on extinction. This increase was likely due to extinction

bursts, though another factor may have been that Layla was not receiving as many edible reinforcers, and was therefore spending less time chewing.

“Guy” became a dominant sound during this phase, and replaced “whee” as the most common sound after five sessions on Phase Two. Another variable contributing to the emergence of new dominant sounds could have been the temporal spacing of sessions. Early in the intervention, sessions were not yet run on a consistent schedule, and there were two breaks of a few weeks between sessions.

Layla was responding at high rates with dominant sounds, but often only one dominant sound was heard per session. Another method was used in an attempt to increase vocal variability and potentially increase the likelihood of multiple different dominant sounds occurring each session. During the last five sessions of Phase Two, no more than a specific number of dominant sounds in a row were reinforced, and then reinforcement was withheld until any non-dominant sound occurred. At that point the schedule reset, and again no more than the specific number of consecutive dominant sounds would be reinforced.

Specifically, in sessions 15 and 16, three dominant sounds in a row would be reinforced, and then one different sound was required before resetting. For example, if A and B were different sounds, then AAAA would result in reinforcers only on the first three occurrences, and not on the fourth. A response pattern of AAABA would result in reinforcement for every response. On sessions 17 and 18, the requirements were the same except for reinforcing only two dominant sounds in a row. Finally, on session 19, that criterion was reduced to only one dominant sound. During these five sessions, the rate of

a third sound ("oh") slowly increased, though it did not become as dominant and mand-like as either of the first two sounds.

Throughout Phase Two, specific vocal sounds were differentially reinforced and two different sounds increased to a high frequency, and a third occurred consistently at lower rates. However, there was very little vocal variability within sessions. While she had emitted three different sounds consistently across sessions (and many other less common sounds throughout), none of the reinforcement manipulations resulted in Layla reliably emitting all three dominant sounds in a single session. Figure 1 shows the rates of the three most common sounds during Phase Two. The different phases of this procedure have different goals and target different dependent variables, so data will be presented in separate graphs for each phase.

Phase Three – Establishing echoic stimulus control.

1 sound.

Having observed three different sounds occurring consistently throughout Phase Two, we then implemented echoic training with high-rate sounds. (What qualified as high-rate differed across children, but generally meant that the sound was emitted much more frequently and reliably than other sounds, often around 2-3 times per minute.) Layla (and many of the other children screened) had sometimes engaged in problem behavior when presented with echoic trials, such as "say mmm." Therefore, the goal was to introduce echoic models in a way that would not be aversive, and would have the best chance of gaining stimulus control.

We began by introducing an echoic prompt for only one sound. “Guy” was selected because it was occurring at the highest rates most often in Phase Two. A trial would begin when Layla had finished consuming the previous reinforcer. We waited between 15 and 30 seconds and then provided the model once (only the sound, we did not say “say ___”). The first time Layla made an approximation or matching sound following the model, a reinforcer was delivered, no matter the delay between the model and response. Only the first matching sound following the model was reinforced, and responses made prior to the model were not reinforced, even if they matched the target sound.

Data were collected on two additional variables in this phase. The latency of the first correct response from the time each model was provided was recorded. To supplement this, the number of target sounds Layla made following consumption of the reinforcer but prior to the next model was also recorded. A high rate of responding in this interim time would indicate that perhaps the model was not controlling behavior well, and the behavior was just being intermittently reinforced. But if responding during the interim was low, that would indicate better echoic stimulus control. The rate of non-target sounds during these sessions was very low.

Within two sessions, Layla was responding at mastery level (above 80%) to the model “guy.” She was reliably responding immediately to the models, which suggested good echoic stimulus control. Although she often remained oriented to the experimenter during the delay before the model, there were instances where the model was provided while she was turned away. In these instances, she would typically turn quickly back

toward the experimenter and emit a correct response, indicating that her response was under the control of the spoken model (even without visual cues). She continued to occasionally emit the target sound after consuming the reinforcer but before the model was given, which suggested that the echoic model and contingency was not yet exerting perfect stimulus control. However, performance was acceptable overall, therefore a second sound was introduced.

Figure 2 shows the percentage of correct responses for the first three targeted sounds. Sessions 1-5 in this phase targeted only “guy,” sessions 6-11 targeted “whee,” and sessions 12-20 targeted “oh.” Mastered targets were interspersed throughout each subsequent session, unless otherwise noted, and responding to previously mastered targets maintained at mastery levels in subsequent sessions.

2 sounds.

The next six sessions involved models for two sounds, “guy” and “whee.” Incorrect responses or non-responding did not result in any sort of correction procedure or programmed consequence. After an incorrect response or no response, we would wait approximately thirty seconds and provide the next model. The previously mastered sound (“guy”) was still targeted, and a new target (“whee”) was introduced. The new target sound had occurred at high levels in Phase One and Phase Two. The previously mastered sound continued to exert consistent stimulus control, and Layla responded correctly to it on 42 out of 43 opportunities across these six sessions.

Layla never responded correctly to the new target (“whee”) during the first two sessions it was introduced. She often responded with the previously mastered sound

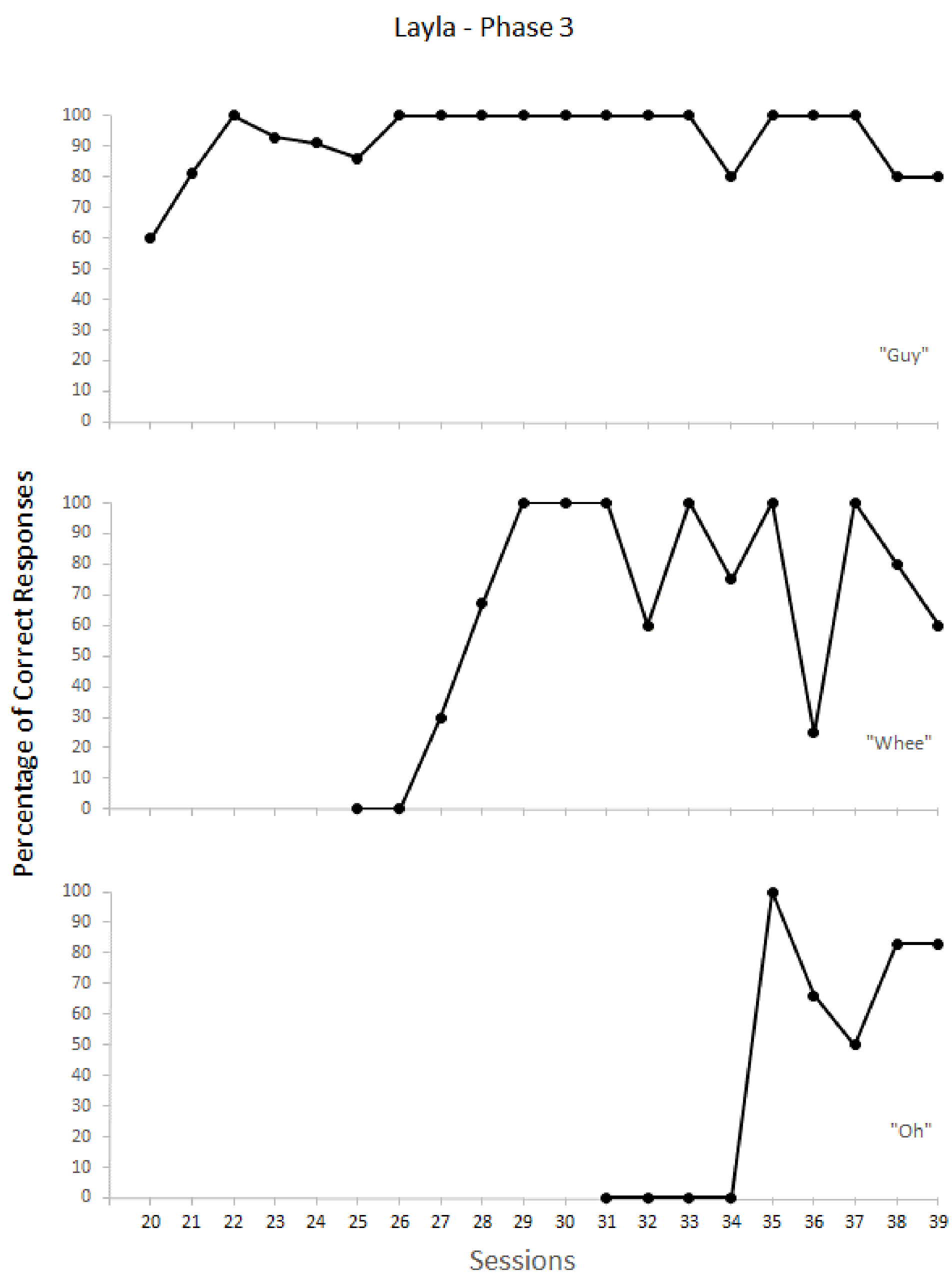

Figure 2. Layla – Percentage of correct echoic responses to the first three target sounds in Phase Three (establishing echoic stimulus control).

("guy"). We observed a steady increase in correct responding starting in the third session targeting "whee."

By the fifth session working on two targets, Layla was responding with 100% accuracy to both targets (as seen in Figure 2), and therefore we introduced another target.

3 sounds.

The third target sound was "oh," which had also occurred during Phases One and Two. During the first four sessions targeting this sound, Layla responded to the new model either with a previously established sound or crying. We were able to shape crying into an acceptable approximation of the target sound, and in the fifth session she emitted the acceptable approximation on 100% of those trials.

After five more sessions in this phase, Layla was reliably echoing all three targets (as seen in Figure 2). We then attempted to introduce a fourth target sound.

4 sounds.

Layla had only emitted three different sounds at high rates during the free-operant sessions of Phases One and Two. Echoic stimulus control with those three sounds was relatively easily established (with an average of seven sessions to mastery for each). Teaching an echoic response to a non-high-rate sound proved much less successful initially.

Twenty-five sessions were spent attempting to establish a fourth reliable echoic response, while continuing to intersperse trials for the three previously mastered sounds (which maintained at high accuracy). "Ah" was targeted in two sessions, but reliably elicited intense crying/yelling, and so we switched to "buh." While Layla did make a few approximations during the ten sessions in which "buh" was targeted, she mostly responded with one of the three previously mastered sounds. Following this, "ell" was

targeted in one session, because she had been reported to have been making that sound recently. She responded with the “oh” sound to every instance of the novel sound being modeled during that session. And finally, “mm” was targeted for 12 sessions. Layla would typically remain silent following that model, or respond with a previously mastered sound.

Return to Phase Two – Free-operant reinforcement of low-rate sounds.

Having failed to establish a fourth echoic response as easily as the first three, we theorized that an important variable might be how often each target sound was emitted during the free-operant portions of the intervention. Therefore, we returned to a modified Phase Two, in which the three established sounds were reinforced a total of once each per session (whenever they first occurred), and any other sounds were reinforced whenever they occurred. Ideally, we wanted to establish more high-rate sounds that we could target as echoics.

However, after nine sessions in this phase, Layla never emitted a single sound at high rates, contrary to the pattern of responding during the original Phases One and Two. Instead, Layla emitted a wide variety of different sounds at lower rates. These included phonemes that hadn’t yet been targeted, multiple-syllable sounds, and even words (including numbers). All sounds were reinforced, but no particular sound occurred significantly more often than others, and none appeared “mand-like.” Total rates of reinforced vocalizations were between 1 and 1.8 per minute, which was about 50% of her rate during the first exposures to Phase Two.

Back to Phase Three - Establishing echoic stimulus control.

A variety of other sounds had been observed during the return to the free-operant phase, so some of those sounds were selected as echoic targets. Even though they had not occurred at high rates, they were clearly in Layla's vocal repertoire, and had been emitted without any accompanying problem behavior. Over 21 sessions, Layla was exposed to a total of 24 new models. The list of targets was refined as sessions were conducted, and by the end of those sessions Layla had made correct responses to 13 new targets. Sessions targeted between four and ten of the new sounds each, in addition to the three previously mastered sounds. They varied depending on performance and motivation. Typically, only one trial was provided on each target in these sessions. As shown in Figure 3, correct responding to new targets steadily increased and maintained at high levels as the list of targets was refined and performance improved. During the few weeks in which these sessions were conducted, tutors also began reporting more spontaneous echoic approximations throughout the school day. These responses were especially likely to occur was when the tutor vocally labeled the item Layla requested using the icon exchange system. It was also reported that Layla began to engage in some spontaneous manding (e.g., saying "cookie" when she saw another child with one, and then getting access).

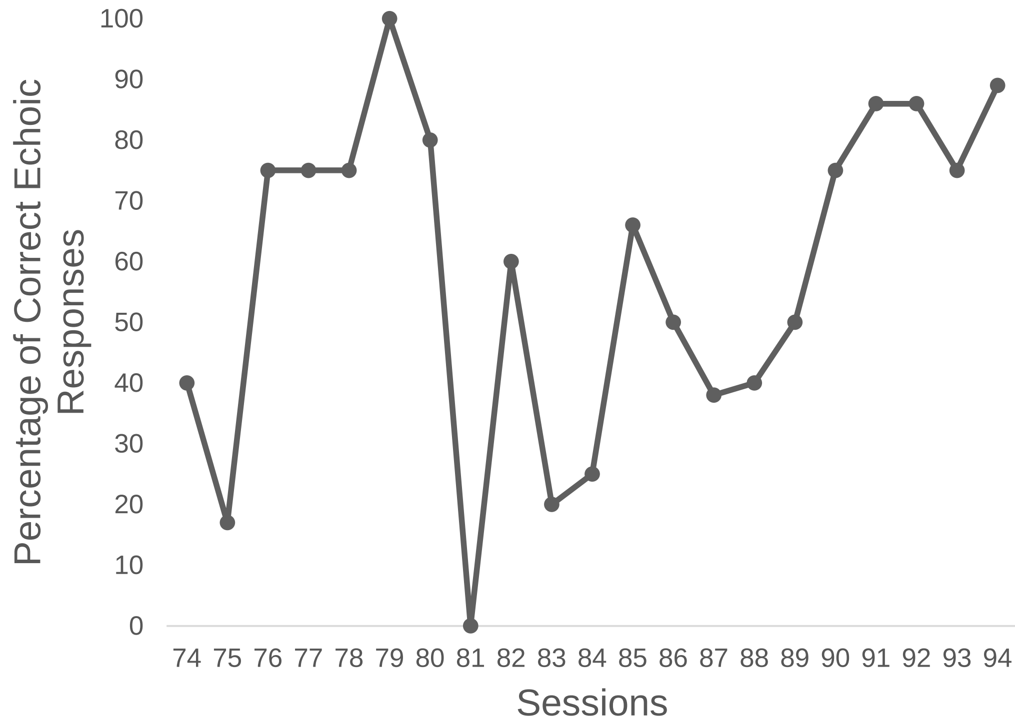

Figure 3. Layla – Percentage of correct echoic responses to novel targets in the final sessions in Phase Three (establishing echoic stimulus control).

Post-test and maintenance.

After observing the reliable high level of correct echoic responses to the targets in the last several sessions of Phase Three, we probed for generalized echoics. While attempts to test for echoics prior to the intervention (and early during the intervention) had typically resulted in problem behavior, Layla did very well on the post-test. She responded correctly (with a direct match or close approximation) to 61 out of 70 different echoic models in the post-test.

Layla clearly demonstrated a generalized echoic repertoire for vocalizations of up to two syllables. She would attempt to imitate longer utterances, and these attempts typically consisted of the right number of syllables but not the correct phonemes.

Shortly after this generalization test, Layla’s echoic repertoire was tested with her tutors providing the models, and she again demonstrated a generalized echoic repertoire with some of the same stimuli. This repertoire maintained as tested during a follow-up replication of the post-test two months later. The results of all follow-up testing are shown in Table 1.

Table 1

Pre- and Post-Test and Follow-up Testing Results for Layla

	Number Correct	Number Possible	Percentage Correct
Pre-test	1	21	2%
Post-test	61	70	87%
Tutor Follow-up	26	27	96%
Extended Follow-up	43	44	98%

After completing this procedure and demonstrating a generalized echoic repertoire, Layla continued her normal classroom curriculum, with an added emphasis on vocal-verbal behavior and auditory discrimination skills. She successfully completed multiple programs targeting echoic behavior with her normal tutors. At the time this was written, she was progressing through a more advanced direction-following program, and had nearly mastered an object-identifying procedure. She was engaging in more reliable independent vocal manding as well, to the point that her icon-communication system was removed. New mands were taught using an echoic-to-mand procedure. She also

continued to progress on programs from other skill areas, such as social play, imitation, and visual discrimination.

Eye contact and attending.

While eye contact, orienting towards the tutor, and generally attending to the source of the reinforcers were not considered necessary prerequisites, they may have been highly beneficial. These behaviors were not directly measured or recorded as the procedure was implemented. However, following completion of the study some session videos were coded for eye contact, in an effort to determine if there was a correlation between rates of eye contact and success in different phases. Layla made little eye contact during sessions in Phase One and Phase Two (free-operant sessions with no models), and when she did it was fleeting and did not seem “purposeful” (purposeful eye contact included looking at appropriate times and perhaps signified auditory attending as well, as opposed to random eye contact that may have been more stimulatory in nature). But eye contact was much more common and “purposeful” in echoic sessions, and at that time she would often turn to look at the experimenter after the model was provided. Eye contact was more sustained during these instances as well. When echoic models were not being provided, she would often look about the room, at her hands, etc., so it was clear that the models were exerting stimulus control and resulting in orienting and eye contact as well as correct responses. It was also often the case that an incorrect response or no response occurred when the echoic model did not result in immediate eye contact.

Table 2

Eye Contact Rates for Layla

Session #	4 (free-operant)	14 (free-operant)	22 (echoic)	29 (echoic)	36 (echoic)	56 (echoic)	70 (free-operant)	84 (echoic)
Percentage of 10-second intervals with eye contact	15%	15%	71%	73%	63%	82%	20%	65%
Percentage of echoic models involving eye contact	N/A (no echoic models provided)	N/A (no echoic models provided)	100%	100%	66%	87%	N/A (no models provided)	92%

Note. Edible reinforcers were used throughout, so in free-operant phases there were no relevant stimuli (such as the removal of a reinforcer).

Discussion (Layla)

Layla was our first and most successful participant, acquiring an emerging generalized echoic repertoire in only 94 sessions (approximately eight total hours of in-session time). Sounds that had occurred at high rates during the free-operant sessions in Phases One and Two could be brought under echoic stimulus control more easily than novel sounds. Within 30 total sessions, Layla was able to reliably respond to two echoic models; with ten additional sessions (40 total sessions) she was reliably responding to three echoic models.

Establishing a fourth reliable echoic response proved much more difficult. Providing models for novel sounds was much more likely to result in non-responding, refusals (yelling or turning away, with an “angry” affect), and crying (with a “sad” affect). This pattern of responding to novel discriminative stimuli was similar to the pattern on some occasions when responses did not produce reinforcement.

We observed a few notable instances of vocal behavior throughout our sessions. Layla would occasionally say things she had either heard many times at WoodsEdge, or likely heard at home. For instance, in Phase Two, when dominant responses were not producing reinforcement, she said what sounded like “please” once. During the same phase, and also while dominant responses were not producing reinforcement, she paused and began to clap while saying “yay” though she appeared more upset than happy. The tutors at WoodsEdge often provide this type of social praise following a correct response. Similarly, in the final phase, when presented with new models for low-rate sounds, Layla occasionally responded (immediately or after another attempt failed to produce reinforcement) by yelling “good job.” That is the most common tutor-provided vocal praise statement delivered after correct responses. At no point within our sessions did we target any of these responses, but they occurred in sort of loosely appropriate situations. “Good job” was something the tutor would often say immediately before delivering a tangible or edible reinforcer. So Layla spontaneously emitting this response when other responses were not producing reinforcers makes some sense. Perhaps a sort of delayed stimulus-stimulus pairing effect could explain it, but it may be more complicated than that.

Layla began demonstrating generalized echoic behavior sooner than anticipated based on her progress in the procedure. While performance in Phase Three with models of novel or low-rate sounds was steadily improving, it did not seem to be indicating a generalized echoic repertoire. But when we conducted an echoic probe (which turned into the post-test) she did very well. It is not clear if there was any influence from

uncontrolled variables (if there was, we cannot identify it) or if perhaps we reached a behavioral cusp without immediately realizing it.

Lexie

History

Lexie was evaluated by the PET when she was one year and three months old. She had been referred by a professional speech and language pathologist, and her parents had expressed concern about her limited communication. At this point, Lexie was reported to produce only vowel sounds (cooing), typically. Parents also had recently noted a regression in eye contact around one year of age, but said that it was improving again. Staff at the day care center she was attending noted that she did not talk or attempt to communicate, and that it was difficult to gain her attention. The evaluation team confirmed that eye contact was intermittent and vocal behavior was limited to vowel sounds. Although Lexie was quite young when this evaluation was conducted, she was found to have delays in communication, social, and other skills. This qualified her to receive special education services under the category of Early Childhood Developmental Delay, and she entered WoodsEdge at two-and-a-half years old.

Lexie had been attending the early intervention discrete-trial classroom for three months prior to being selected as a participant in this intervention. During this time, it became apparent to staff that Lexie had very little receptive and expressive language. Observations and staff reports revealed that she was very quiet, and the only time she made much noise was if she cried.

Like Layla, Lexie was also exposed to an icon-exchange communication system. She used this system in the discrete-trial classroom, and also during speech therapy. When she was first screened as a potential participant, she was working on moving to a communication partner and persisting in requests. When sessions began, she had progressed to discriminating between icons for different reinforcers and neutral items. She advanced to using a sentence strip and an "I want" icon around the time we moved into Phase Three of this intervention, and completed the icon-exchange procedure shortly afterward. Lexie was likely to use the communication book independently when it was available.

Reason for Inclusion

Lexie did not demonstrate either a strong auditory discrimination or echoic repertoire. In the month prior to being selected as a participant, she was exposed to a standard echoic (vocal imitation) training procedure. This procedure targeted the sounds "ah" and "mmm." In the first several sessions the data did indicate that Lexie made some correct responses to the "ah" prompt, up to a maximum of 40% correct responding in a session. However, responding on both sounds soon dropped to near zero levels, although the procedure had not changed. After 50 total sessions with no progress, the procedure was removed from her curriculum.

Lexie worked on a variety of programs prior to and during her time in this intervention. Before the intervention she was able to progress through a small number of procedures working on behaviors that were beneficial for discrete-trial training, including sitting, making eye contact, and giving up reinforcers when asked. All of these

procedures involved visual prompts or contextual cues, and Lexie did not master any programs that required strong auditory discrimination skills. She was also able to master programs addressing motor skills, attending, and matching-to-sample before beginning this intervention.

Lexie was also simultaneously participating in a thesis project targeting physical imitation. This project focused on shaping responses to gross motor movements, and progressed to fine motor skills. Vocal imitation was not targeted.

Method and Results

Echoic pre-test.

Given that Lexie had already been working on an echoic procedure prior to selection, we conducted only a simple pre-test to verify that she did not currently engage in echoics. Five simple sounds were targeted in the pre-test. Lexie did not make vocal responses to any of the models, aside from crying after the final two models. The pre-test was conducted in the same manner as described with Layla, with the only major difference being the reinforcers used. Lexie showed preference for watching movies on a portable DVD player, so correct echoic responses (of which there were none) and responses to extra learning opportunities were reinforced with a movie playing for several seconds.

Phase One – Free-operant reinforcement of all vocal responses.

Sessions on Phase One were conducted in the same manner as with Layla. Reinforcers used for Lexie typically included both a small piece of an edible (such as mini-M&M’s®) and access to 10-15 seconds of a movie playing on a portable DVD

player (we typically used *The Little Mermaid*). Lexie was normally able to sit in a small chair in the session room for the entire five-minute session with minimal problem behavior.

During the early sessions of Phase One, Lexie emitted a small variety of sounds. She was often silent for extended periods, especially during the first several sessions. But she occasionally babbled or made single syllable sounds, both of which were reinforced. One interesting behavior pattern we encountered was that coughing became a dominant (high-rate) response. As with Layla, Lexie quickly started emitting sounds in a mand-like manner. However, beginning in the second session and persisting for approximately the next twenty sessions, coughing was the response that most often occurred immediately following reinforcer removal. This response class was placed on extinction, but it proved quite resistant, even as we attempted to shape more appropriate vocal behavior.

It was not until the twenty-third session that this coughing greatly decreased and more appropriate speech sounds became more dominant. The most common sounds in Phase One aside from coughing were “ha/ah” (it was difficult to discriminate between these two sounds, so they were treated as the same) and “see.” There was not a large variety of sounds, as those two sounds became dominant, much like had been observed in this phase with Layla. In the twenty-fourth through twenty-ninth sessions on Phase One, rates of acceptable sounds averaged 3.4 per minute, as seen in Figure 4. These responses were occurring quickly after the removal of the reinforcer in most cases, and were generally mand-like. Therefore, we moved to Phase Two.

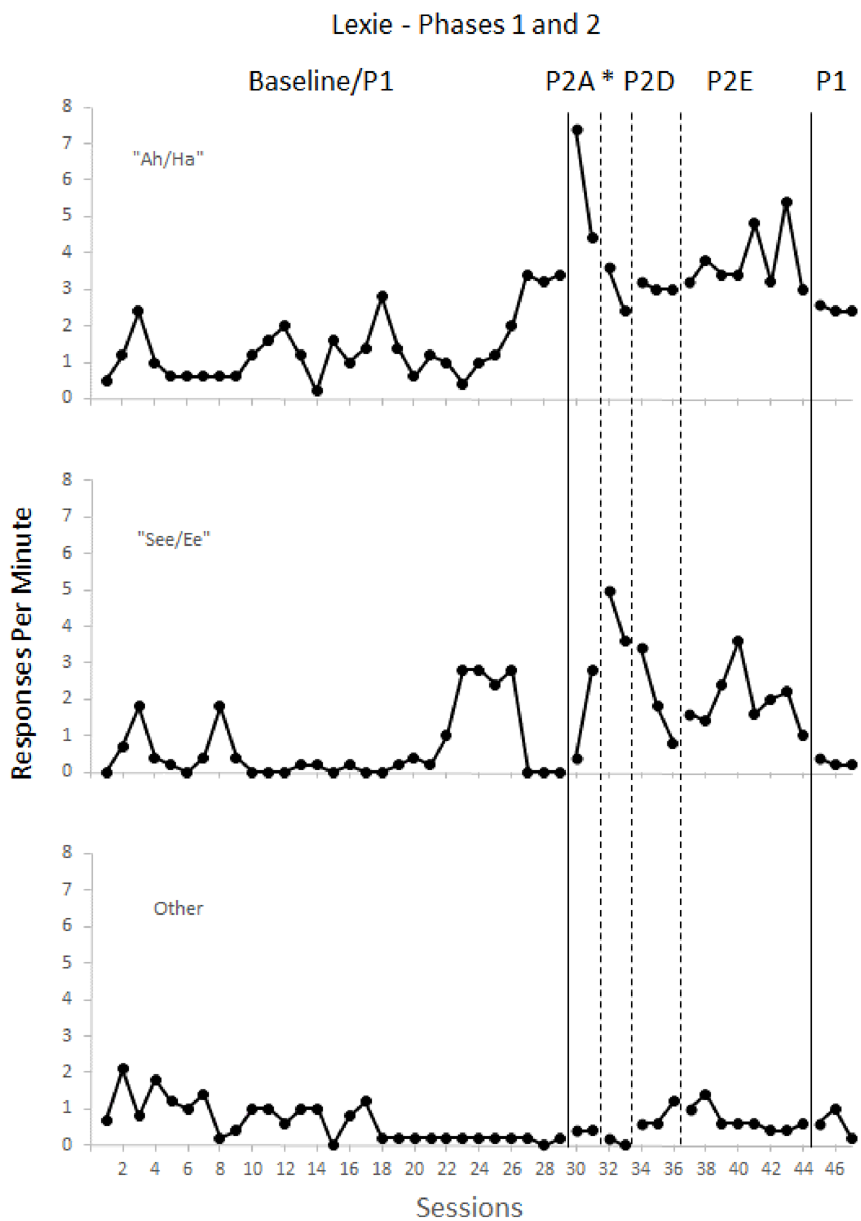

Figure 4. Lexie - Rates of reinforced responses during Phases One (free-operant reinforcement of all acceptable vocal responses) and Two (increasing vocal variability). In P2A, “Ah/Ha” was on extinction. *In session 32, “Ah/Ha” and “See/Ee” were on extinction after one minute, and in session 33 “See/Ee” was on extinction following the first two occurrences. In P2D, the dominant sounds were on extinction the entire session. And in P2E, each dominant sound was reinforced only once per session. Coughing and less clear versions of the dominant sounds are not included in this graph. The ‘other’ category includes less common sounds, grunts, and variations of the dominant sounds. Overall vocalization rates were likely to increase in Phase Two due to less time being spent watching the movie.

Phase Two – Free-operant reinforcement of low-rate sounds.

The dominant sounds from Phase One were “ha/ah” and “see.” The goal in Phase Two was to increase the variety of sounds Lexie would emit, to later be targeted in the echoic phase. Fifteen sessions were conducted in Phase Two. In the first two sessions, “ha/ah” was placed on extinction for the entire session, and Lexie began to emit “see” at increased rates. In the next five sessions, both of the dominant sounds were placed on extinction. In the final eight sessions, we reinforced “see,” “ah,” and “ha” only once each session. As seen in Figure 4, rates of “ha/ah” and “see” remained high throughout this phase, but there was not a clear increase in any third sound to the level of the first two sounds. The goal was to increase the variety of sounds that would occur at a high rate, but after 15 sessions this had not happened. Lexie often made strained (more effortful) versions of the dominant sounds, which showed sensitivity to extinction, but the variance was along an unwanted dimension. And Lexie also consistently made both dominant sounds in the same session. Given that Layla had performed well on Phase Three with only a few high-rate sounds in her repertoire, we progressed to the echoic phase.

Return to Phase One – Free-operant reinforcement of all vocal responses.

Phase One was re-implemented for three sessions. With the intention of moving into Phase Three soon, the goal was to get all of Lexie’s vocal behavior occurring at high rates again. Lexie made 2.8 reinforced sounds per minute across these three sessions. “Ha/ah” and “see” remained the most common sounds.

Phase Three – Establishing echoic stimulus control.

1 sound.

Although only two sounds had increased to high rates in Phases One and Two, the ultimate goal of the procedure was to establish echoic responses, and so Phase Three was implemented. As described with Layla, the sessions now had an echoic arrangement. We would remove the reinforcer, wait 10-15 seconds, and then provide a vocal model once. The first matching sound was reinforced. Thirteen sessions on Phase Three targeting only "ah" were conducted (see Figure 5). By the fourth session, Lexie was reliably responding almost immediately with an acceptable approximation of the "ah" model (the model was always "ah" but responses of "ha" or "ah" were accepted). Like Layla, Lexie would respond to the model even if she was not oriented toward the experimenter when it was provided. We continued sessions in this phase to see if responding during the interim would decrease. Unlike Layla, Lexie continued to make unreinforced "ah" sounds after the reinforcer was removed but before we provided the next model. Additional sessions in this phase did not cause the rates of unreinforced responses to noticeably decrease.

2 sounds.

Lexie was responding quickly and reliably with acceptable approximations of the first target sound, so a second sound was introduced. "See" was chosen because it was the second sound she emitted at relatively high rates during Phases One and Two. Trials targeting the mastered "ah" sound were interspersed with the new target, and Lexie continued to respond at mastery levels on those trials.

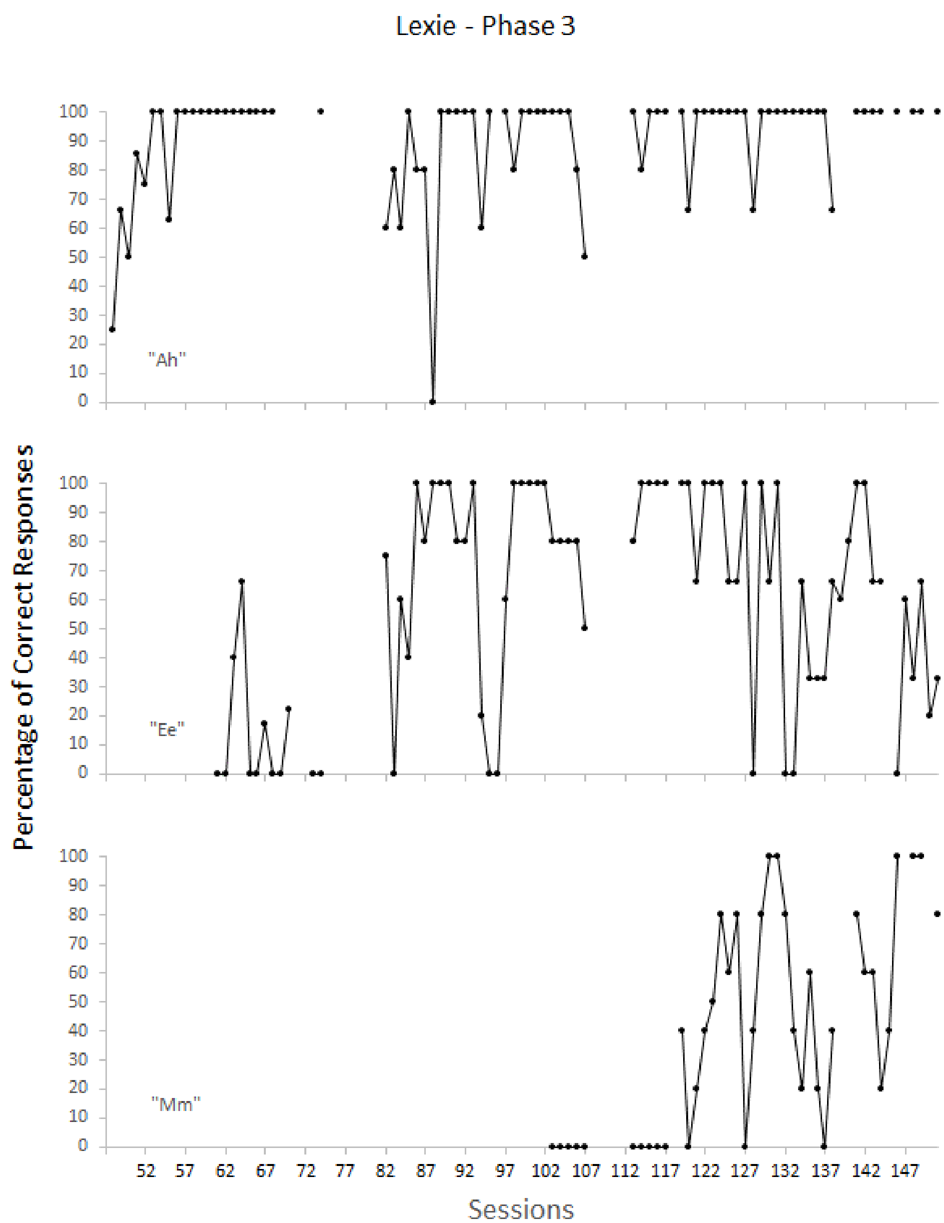

Figure 5. Lexie – Percentage of correct echoic responses during Phase Three (establishing echoic stimulus control). Gaps in plotted data indicate a return to previous phases, as described in detail in the manuscript.

During the first two sessions, Lexie did not make any correct responses or acceptable approximations to the new target. When the "see" model was provided, she often responded with "ah," the previously targeted sound which was still being

interspersed. Sometimes she persisted in making this sound when it was not reinforced. Starting in the third session in this phase, Lexie made two acceptable approximations to the new target sound, and did slightly better the next session. However, after that point, the majority of responses to “see” models were scrolled (she would emit an “ah” sound or another non-target sound first, and might eventually emit the target sound). Due to this pattern of scrolling, we returned to previous conditions in an attempt to increase stimulus control with the “see” response.

Establishing a consistent response to “ee.”

Over the next 13 sessions (69-81), Lexie was exposed to variations of Phase Two and Phase Three. Four sessions targeted “see” (which was modified to “ee” to match the approximations Lexie was making) in an echoic context, but scrolling was the most common response. Nine sessions were conducted in Phase Two, where only “see” or “ee” and approximations of those sounds were reinforced. Lexie emitted “ee” at low rates during these sessions.

2 sounds.

We returned to the standard two-target Phase Three, and performance on “ee” was variable but improved. “Ah” trials remained at acceptable (mastery) levels except for one outlier session. There was a shift in performance starting on the 13th session in this phase; Lexie grunted following every “ee” model, rather than making an acceptable approximation. This continued for the next three sessions before she spontaneously reverted to the previous correct responses. Both targets then consistently occurred at mastery levels for several sessions, prompting the introduction of a third sound.

3 sounds.

Lexie had only made two sounds reliably during Phases One and Two ("ah" and "ee"), so the third echoic target was a novel one. "Mm" was chosen because it is a common early sound in typical speech development. Lexie primarily emitted vowel sounds when babbling, and they were often difficult to discriminate among, so other vowel targets were avoided. When introducing the new target, we observed a marked shift in behavior. While "ah" and "ee" continued to be targeted and responded to at mastery levels, as soon as the new target model was provided, Lexie turned away and cried. It was clear she was discriminating between the three models that were being provided, because "mm" was the only sound she responded to with problem behavior.

Therefore, an alternate third sound was introduced to determine if there was something particularly aversive about "mm." The tutors who had been working with Lexie reported that she would occasionally make a sound resembling "hi," so that sound was selected. Lexie did not respond to this sound with problem behavior (except on one trial), and often responded with a vowel sound, but it was difficult to determine if she was making a distinct sound or a previously targeted sound. Therefore, we returned to "mm," which again resulted in problem behavior.

Pairing MM.

Presenting "mm" had consistently elicited problem behavior. It may be likely that other novel models would have had the same result. So rather than avoiding the problem behavior by not presenting that model, we attempted to reduce the aversiveness of "mm." We paired the model with the delivery of reinforcers without requiring a response from

Lexie. During the first two sessions we would say “mm” and simultaneously provide immediate access to edible and video reinforcers. During the next three sessions we incorporated a delay, working up to a three second pause between saying “mm” and providing free access to the reinforcers. Lexie stopped emitting problem behavior (crying and turning away) during these pairing sessions. She also began making sounds during the delay, though they did not match or approximate “mm.”

3 sounds.

Following the pairing sessions, we again implemented the echoic sessions using the previously established sounds “ah” and “ee,” and the new target “mm.” The next 39 sessions were devoted to establishing consistent echoic responses to all three models simultaneously (see Figure 5). “Ah” remained at mastery levels throughout these sessions. Trials of “ah” were reduced from five to three per session, in order to allow more trials on the other targets.

Responding to the “ee” model was initially at mastery levels during these sessions, and the number of trials per session for this target was also reduced. However, “ee” responses became less consistent over time. The response did not disappear entirely, and during some sessions Lexie responded at mastery levels to “ee.” But Lexie’s responses to this target became more varied, and she often responded with other targets or unacceptable approximations.

Responding to the newest target, “mm,” did consistently improve throughout these sessions, reaching mastery levels by session 132. However, performance on these

trails was also varied, and in some sessions was quite low. Responding became more consistently high in the last four sessions in this condition.

While most of these sessions included all three targets simultaneously, some concentrated on one target that Lexie was emitting less consistently. For these sessions, a sound that Lexie had been performing poorly on was presented in isolation for a greater number of trials.

Post-test and maintenance.

Although Lexie was not yet responding consistently at mastery level to the three existing targets, she was demonstrating an emerging echoic repertoire. She was not progressing as quickly as Layla had, so long-term follow-up and maintenance work was necessary. Therefore, we began to introduce other tutors who could run future sessions. Up until this point, the primary experimenter had conducted all sessions.

The first sessions conducted by novel tutors elicited consistent crying and attempts to leave the table. Therefore, rather than having novel tutors implement the current phase, a fading strategy was used. As the sessions started, the tutor would make a target sound and immediately provide reinforcers (edibles and video), regardless of Lexie’s behavior. A delay between the model and reinforcer delivery was then incorporated over the course of several trials, up to a five-second delay. If Lexie responded with anything other than crying, she received immediate reinforcement. On subsequent trials, the tutors would imitate any response Lexie made, and wait for her to emit that response again, and then provide reinforcement. Beginning each session with no response requirements helped avoid emotional responding. Within a few sessions with a

novel tutor, Lexie would perform comparably to how she did with the experimenter. The primary experimenter stopped conducting sessions with Lexie at this point, as the study was concluding. This method will be used with any of Lexie's future tutors, and will allow for a greater number of sessions to be conducted each day. The experimenter also conducted an echoic probe/post-test with Lexie at this time. She responded with acceptable approximations to the three sounds that had been targeted in the intervention, but did not show any generalized echoic responses to novel models (results shown in Table 3).

Table 3

Pre- and Post-Test Results for Lexie

	Number Correct	Number Possible	Percentage Correct
Pre-test	0	5	0%
Post-test	3	20	15%

Post-intervention status.

Lexie will continue to work on echoics with her tutors, although the study has concluded. Throughout the time she spent as a participant, she continued to make progress on other curriculum targets, including motor skills, social skills, and visual discriminations. Most did not rely on auditory discrimination skills, though she did acquire the ability to consistently respond to the vocal S^D "quiet hands." At the conclusion of this study, Lexie was working on matching, turn taking, attending, and appropriate play skills.

Eye contact and attending.

Lexie made more eye contact in the early free operant sessions than Layla did, and it was more sustained and "purposeful." She would often look at the experimenter after finishing an edible reinforcer, or immediately after the DVD player was paused, and then vocalize. Lexie also engaged in some bids for joint attention, as she would glance towards the experimenter and laugh when a funny part of the movie came on. Using a DVD player may have provided us with more natural opportunities for eye contact, because the movie being paused was a clear change in the environment (as opposed to an edible being gradually consumed). When certain sounds were on extinction in Phase Two, she commonly stared at the experimenter and repeated sounds more loudly or made new sounds. Once echoic models were introduced, she began to make more sustained eye

Table 4

Eye Contact Rates for Lexie

Session #	4 (free-operant)	24 (free-operant)	40 (free-operant)	54 (echoic)	66 (echoic)	86 (echoic)	120 (echoic)	142 (echoic)
Percentage of 10-second intervals with eye contact	63%	73% (remaining 27% of intervals spent watching movie)	70% (27% of intervals spent watching movie)	67% (27% of intervals spent engaging with toys or movie)	73% (17% of intervals spent watching movie)	50% (47% of intervals spent watching movie)	66% (31% of intervals spent watching movie)	67% (33% of intervals spent watching movie)
Percentage of echoic models or DVD pausing involving eye contact	N/A (no models provided, only edible reinforcers used)	100%	89%	93%	88%	84%	92%	100%

Note. Some intervals without eye contact were due to Lexie watching the movie on the DVD player, which was appropriate, and may underrepresent rates of appropriate eye contact, which was high at appropriate times.

contact, typically maintaining eye contact for most of the time between the reinforcer being removed and the next model presented. Eye contact was less likely when Lexie made an incorrect attempt after a model, as she would often turn away after that. Other than during those intervals spent watching the movie on the DVD player, Lexie had consistently high rates of purposeful eye contact.

Discussion (Lexie)

This approach to establishing echoic stimulus control was somewhat effective with Lexie. At the conclusion of the study, she was responding to three different targets, often at mastery levels. While reaching this point took 151 sessions (typically about three per day), this involved only a total of 13 hours in session for the entire intervention.

During the first 22 free-operant sessions, the most consistent sound Lexie made was a cough. We chose not to reinforce behaviors in this response class, for fear of reinforcing inappropriate sounds and interfering with acquisition of more acceptable sounds. While the coughing was mand-like, the specific sounds involved were inappropriate. Even though this response class was placed on extinction, it persisted for many sessions. If this response had not become so dominant, it is likely that Lexie would have been able to move out of Phase One much more quickly, and perhaps a greater variety of sounds would have been emitted. The lower variety of sounds during the free-operant phases (as compared to Layla) may be related to her relatively lower success during the echoic phase (this will be discussed further in the general discussion section).

Another behavior pattern that probably contributed to slower progress was emotional responding (crying and turning away) when Lexie was presented with novel

S^Ds. It is not clear why models for the two sounds Lexie had emitted in the free-operant conditions did not elicit emotional responding, while the first novel sound did. “Mm” had been a target in the original, unsuccessful vocal imitation training procedure, so perhaps repeated incorrect trials established “mm” as an aversive stimulus. However, “ah” had also been targeted in that procedure, and it did not elicit emotional responding in this intervention. Conducting pairing sessions in which no response was required did help to eliminate emotional responding. This tactic was also useful for introducing new tutors who conducted sessions.

It is also not clear why performance on two of the targets fluctuated so much. While performance on “ah” remained consistently high once it was established, responses for “ee” and “mm” were far more varied, even after they had occurred at mastery level for multiple consecutive sessions. Conducting echoic sessions to isolate the problematic targets did not seem to consistently produce clear improvements.

Ella

History

Ella was evaluated by the PET when she was just over two years old, at the suggestion of her pediatrician. Her parents’ primary concern was her limited communication development. Ella had been using three-to-five single words consistently when she was around one-year-old, but by one-and-a-half years of age, she was no longer talking. Her parents did report that her vocabulary was slowly expanding, but that words were not used consistently and often disappeared shortly after they were acquired. During the evaluation, the PET members confirmed that Ella did not demonstrate receptive or

expressive language skills, though she did make vowel and consonant sounds. Ella also made very little purposeful eye contact, and did not demonstrate joint attention. She qualified for an educational ASD diagnosis.

Ella first entered the EIBI classroom at WoodsEdge when she was two years and eight months old. She had been in the classroom for one month when her parents instead attempted a home-based intervention. Ella resumed attendance at WoodsEdge in the same classroom three months later. At the time she was initially screened for the present intervention, she was three years and three months old, and had been in the classroom for almost four consecutive months.

She received speech therapy services at WoodsEdge, and was exposed to the icon-exchange communication system. When she was selected for the present intervention, she was working on closing distance to a communication partner and persisting in requests with the icons. She remained in this phase of the icon-exchange procedure for almost six months before progressing to icon discrimination. She moved relatively quickly through the subsequent icon discrimination phase, and by the conclusion of the present study she was practicing putting together a sentence strip with an “I want” and a preferred icon. However, independent exchanges were rare, and often occurred only when prompted.

Ella’s school attendance was inconsistent, due partially to a recurring pattern of limited nighttime sleep. This may have affected her progress through this intervention and regular classroom procedures.

Reason for Inclusion

Ella was selected as a potential participant for this intervention because of to her observed and reported performance in the classroom. The PET report from when Ella was two years old also had suggested a need to work on functional language skills. She did not demonstrate any auditory discrimination skills at WoodsEdge. She did not orient to the sound of someone speaking her name or any voices in her environment. She occasionally babbled a variety of sounds, but most vocalizations consisted of crying and whining.

Prior to participating in this intervention, Ella worked on several different skills in the classroom curriculum. She mastered programs that targeted motor skills, cause-and-effect, visual discrimination, and matching-to-sample. However, she was unable to acquire eye contact and imitation, and did not demonstrate auditory discriminations. Furthermore, one-and-a-half months before Ella was selected as a participant, a standard echoic training procedure had been placed into her curriculum. Her tutors implemented this procedure with her for one month, and responding remained at zero or near zero levels for the duration. Due to her lack of appropriate and functional vocal behavior, poor receptive language, and the lack of success on the standard echoic (vocal imitation) procedure, she was considered an ideal candidate for this intervention.

Methods and Results

Echoic pre-test.

Due to the recent extended attempt to work on echoics using a standard procedure with Ella, a formal pre-test was not initially conducted. However, echoic probes were

interspersed throughout the intervention. After 34 sessions in Phase One, an echoic probe was conducted. Ella did not respond correctly to any of the targets.

Phase One – Free-operant reinforcement of all vocal responses.

Phase One sessions were conducted in the same manner as with Layla and Lexie, and a variety of stimuli were used as reinforcers for Ella throughout the sessions. Edibles such as crackers, candy, and frosting were used. She also showed preference for picture books, toys with letters or numbers on them, pop-up toys, and stuffed animals.

Ninety-two sessions were conducted in the first free-operant phase, during which all appropriate sounds were reinforced. During the first 42 sessions, closed mouth “mm” and “nn” sounds were not reinforced, due to concerns about increasing crying and whining (behaviors which these sounds often preceded or occurred simultaneously with). Rates of appropriate sounds averaged only 1.1 per minute. Significant portions of many of these sessions consisted of Ella crying, regardless of the lack of any demands being placed. During the remainder of the sessions in Phase One, all sounds, even “mm” and “nn” were reinforced. Rates of reinforced vocalizations increased slightly to 1.8 per minute, due to the new sound acceptance criteria.

Ella was exposed to far more sessions in Phase One than either Layla or Lexie. She remained in this phase due to low rates of appropriate sounds, and the lack of mand-like responding. Responses that were reinforced often seemed to be part of babbling or stereotypy, and were not mand-like. There was no increase of any specific sounds, which had occurred with both Layla and Lexie. Though Ella emitted a larger total variety of

sounds than either of the other two children, the rates of individual sounds remained low (as seen in Figure 6) and they did not appear to be mand-like.

Phase Two – Free-operant reinforcement of low-rate sounds.

The goal of Phase Two of this intervention was to increase the variety of sounds that a participant would make at high rates. In Ella's case, she was already making a variety of sounds during Phase One. While the overall vocalization rates remained low, variety was high, so it did not seem that exposure to Phase Two would have much benefit, and therefore Ella moved directly to Phase Three.

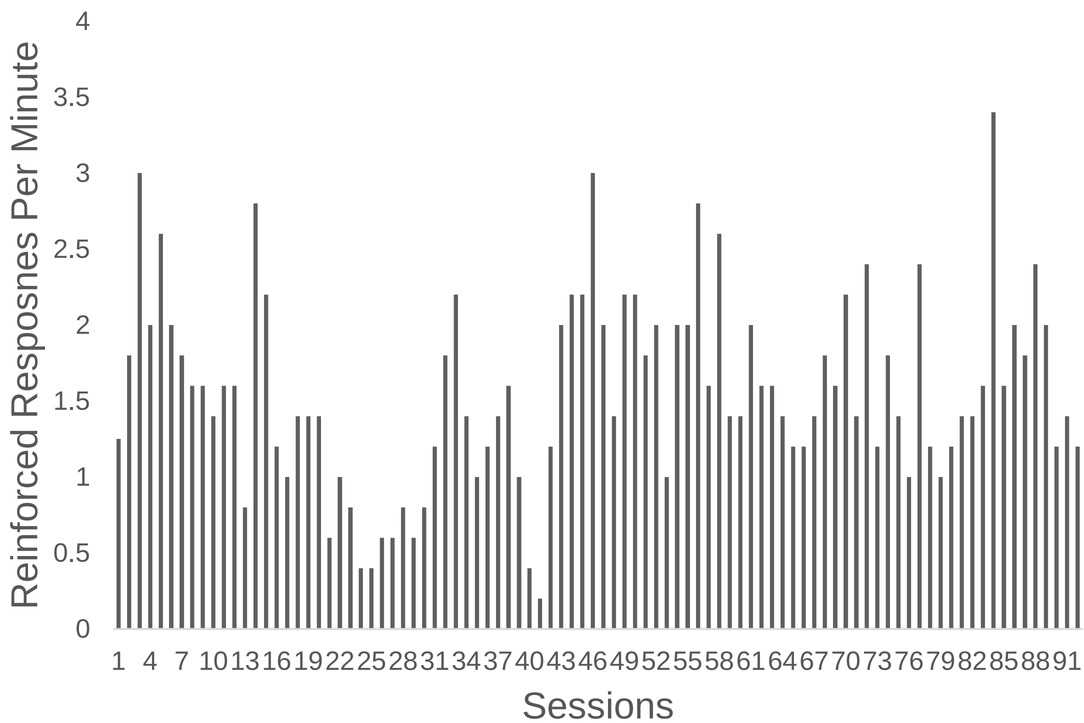

Figure 6. Ella – Rates of reinforced responses during Phase One (free-operant reinforcement of all acceptable vocal responses). Data is presented differently for Ella than the other two participants due to our lack of success in affecting her behavior (i.e., no specific sounds increased in frequency).

Phase Three – Establishing echoic stimulus control.

We implemented customized versions of Phase Three for 34 sessions in an attempt to establish some echoic control. The first nine echoic sessions used the sound "din" as the sole model. This sound had been heard at low rates throughout sessions in Phase One. In these sessions, we provided the model and reinforced the first matching sound. We also repeated the model every 30 seconds, if no correct response was made. Only the first correct sound following each model was reinforced. Sessions typically lasted five minutes, and included approximately ten models of the target sound. While Ella did make the "din" sound consistently at low rates throughout these sessions, the responses did not often closely follow a model, and she continued to make many other sounds.

Three free-operant sessions were interspersed throughout the echoic sessions after Ella returned from extended absences, to determine if "din" was still likely to be heard in those conditions. She made a variety of sounds in these three sessions, comparable to her performance in Phase One. "Din" was heard, but only at levels comparable to previous free-operant sessions. Then seven sessions of a modified echoic condition were conducted. These sessions were the same as previous echoic sessions; however, "din" was reinforced any time Ella said it. Rates of "din" did not increase noticeably, and few responses occurred soon after the model.

While Ella was not responding in a clearly echoic manner on most opportunities, there was some indication that her behavior was changing. She was starting to make the "din" sound or longer utterances involving that sound in her normal classroom, often

when she was upset. Both in and out of our sessions, the sound did not seem to be under any clear instructional stimulus control. To test the effect of these sessions, we changed the target sound to “see” for the next five sessions. “See” was a sound we had also heard occasionally during free-operant sessions. Ella did make the new target sound at least once in every session, but there was no increasing trend or echoic pattern. She also continued to emit “din” at consistent low rates, often when she was upset.

We then reverted to “din” for six sessions, the final five of which were pure echoic sessions (only the first matching response following a model was reinforced). Rates of “din” were not significantly higher than when it had been on extinction, and there were very few responses with low latencies from models.

Finally, we conducted four more sessions with “see” as the target sound, again using the modified echoic condition where any “see” sounds were reinforced, and the model was repeated every thirty seconds. Ella only made the “see” sound in two of these sessions, and only three times total over all four sessions. The results of all sessions in Phase Three are reported in Figure 7, which shows rates of reinforced vocalizations. Note that although most of these were echoic sessions, the responses rarely followed the model with low latency, and were often delayed by 10-20 seconds or more (indicating poor echoic stimulus control). In fact, the rates of the target sounds in these echoic sessions were likely near their operant levels. Also, Ella was not likely to orient toward the experimenter when a model was provided if she had been looking away.

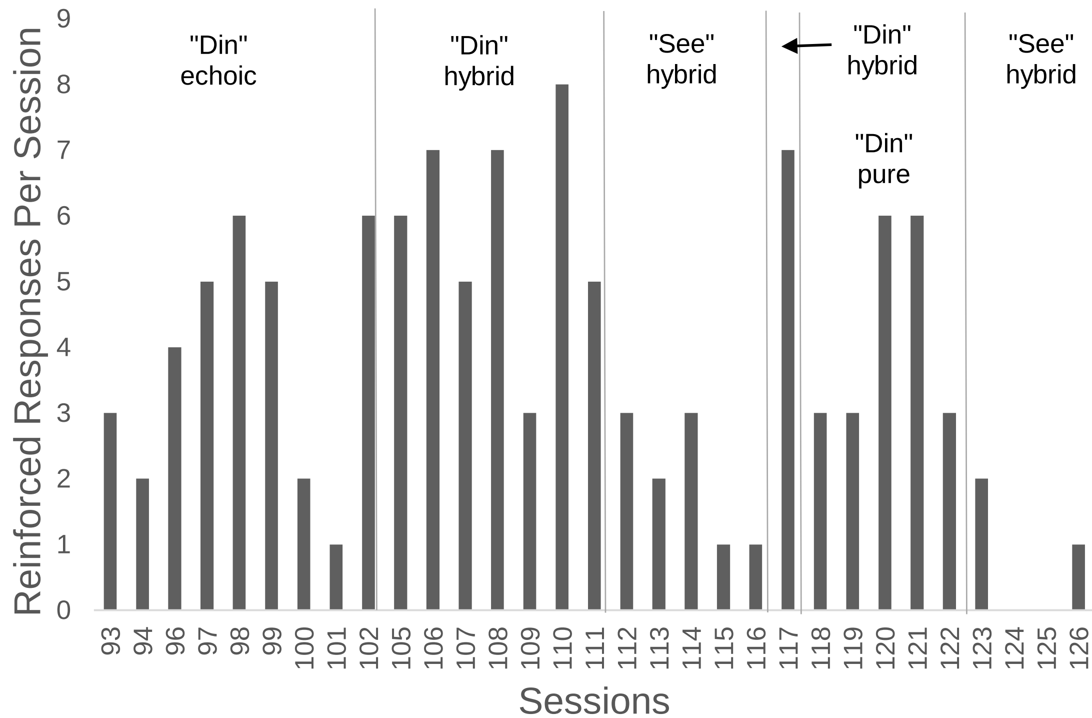

Figure 7. Ella – Reinforced responses per session in Phase Three (establishing echoic stimulus control). Note that although these were echoic sessions, the reinforced responses were almost always temporally delayed from the model.

Around the same time as we had moved out of Phase One (due to lack of progress), Ella's tutors had reported that she was spontaneously saying some words in a few different contexts. Most of these words appeared to occur in as a tact (label) of an item within sight. Her tutors recorded nine different animal names that she would occasionally (inconsistently) say when playing with animal toys, putting together animal puzzles, or looking at books with animals in them. The tutors attempted to reinforce this behavior, though it often seemed that the responses were somewhat automatically-maintained, and the tutor's attention and extra edible or tangible reinforcers were not what maintained the response.

Intervention status and maintenance.

It was clear that even after extended exposure to Phase One, the contingencies were not having a discernable effect on Ella's vocal behavior, at least in that context. Attempts to establish echoic stimulus control proved ineffective. While the sound that was targeted the most ("din") did appear to be occurring reliably at low rates, the goals of the intervention were not being met. Throughout the intervention, Ella had become generally happier at WoodsEdge, both in and out of sessions. It became easier to identify reinforcers, and she cried less. Her tutors also began to report some spontaneous tacting and language use, though most of it appeared non-functional. Therefore, we terminated the intervention with Ella, and supported her tutors in promoting vocal-verbal behavior in other ways.

Following cessation of echoic sessions, we and the tutors assessed Ella's tact repertoire using pictures of animals, toys, household objects, and other items. While responding was not consistent, and Ella did not respond to echoic prompts, she did label a number of pictures (mostly animals). Therefore, the classroom staff made plans to insert a tacting procedure into her curriculum.

Approximately three weeks after ending sessions with Ella, she spontaneously began to demonstrate strong emerging echoic behavior, repeating sounds and words the tutors said. It is not clear why this behavior suddenly appeared. When this happened, her tutors focused exclusively on reinforcing all functional vocal-verbal behavior, including echoics, tacts, and mands for the next several days. The new skills maintained, and at the time this was written, Ella continued to demonstrate an emerging generalized echoic

repertoire. An echoic post-test was conducted, and Ella correctly responded to 19 out of 20 simple single-syllable models. She made attempts to respond to ten two-syllable models (e.g., "mama" "dada"), but would typically only say the first syllable. She also responded correctly to 20 out of 40 intermediate sounds, again having more difficulty with multiple-syllable models. Table 5 shows the results from this post-test. Independent vocal manding was not occurring reliably, but she would echo vocal models for mands.

Table 5

Pre- and Post-Test Results for Ella

	Number Correct	Number Possible	Percentage Correct
Pre-test	0	5	0%
Delayed Post-test	41	70	59%

Ella continued to progress on standard classroom procedures during her time in this intervention. She was able to master procedures that targeted matching-to-sample, visual discrimination, motor imitation, and play skills. At the conclusion of this study, Ella was learning imitation, matching-to-sample, eye contact, and social play. With the emergence of an echoic and tacting repertoire, programs targeting those skills were also given a high priority.

Eye contact and attending.

Like Layla and Lexie, Ella also made some eye contact during the free-operant sessions of Phase One. Instances were typically brief, and often occurred simultaneously with physical scrolling, such as clapping her hands or raising her arms (she had been

working on motor imitation in other contexts). Eye contact also sometimes occurred during emotional responding, when she would cry or whine, bounce on her chair, or attempt to elope, and occasionally look at the experimenter. Ella also frequently turned around in her chair, oriented away from the experimenter, and appeared to scan the room. When reinforcers were removed, she did not consistently look at the experimenter. Eye contact reduced in frequency as more sessions in Phase One were conducted, and often only occurred as edible reinforcers were being delivered. The biggest difference between Ella and the other two participants regarding eye contact was that Ella rarely oriented towards the experimenter or made eye contact following an echoic model, and, even when she did, it did not result in an increase of correct responses or even attempts.

Table 6

Eye Contact Rates for Ella

Session #	7 (free-operant)	16 (free-operant)	34 (free-operant)	54 (free-operant)	84 (free-operant)	94 (echoic)	108 (echoic)	124 (echoic)
Percentage of 10-second intervals with eye contact	60%	60%	27% (20% of intervals spent engaging with toys)	10% (17% of intervals spent engaging with toys)	27% (7% of intervals spent engaging with toys)	20% (3% of intervals spent engaging with toys)	50% (3% of intervals spent engaging with toys)	43%
Percentage of echoic models or reinforcers removal involving eye contact	N/A (no models provided, only edible reinforcers used)	N/A (no models provided, only edible reinforcers used)	0%	20%	0%	0%	11%	56%

Note. Most sessions typically involved both edible and tangible reinforcers. In the free-operant sessions, removing the tangible items was considered a relevant stimulus. The higher score in session 124 was due to higher overall rates of “non-purposeful” eye contact throughout the session.

Discussion (Ella)

While the emergence of an echoic repertoire post-intervention was exciting and very good for Ella, it is not clear how much this intervention contributed to that emergence. Phase One had no clear effect on rates of vocalizations in session, and no mand-like behavior was observed. Attempts to establish echoic stimulus control also had no discernable effect while those sessions were being implemented. Ella spent approximately 11 hours in session, with nearly eight hours on Phase One with no success.

With both Layla and Lexie, mand-like vocal behavior emerged quickly, and both children progressed to Phase Two relatively quickly. However, even after extended time on Phase One, not only was Ella not engaging in mand-like behavior, but her overall rates of vocalizations in session had not increased. Determining why these free-operant sessions had no effect will be important for further research. It was more difficult to identify consistent and powerful reinforcers for Ella than for the other children. It may be that this played a large role in why mand-like behavior did not emerge. Ella also had less eye contact and more stereotypy. Perhaps the combination of some of these factors made the reinforcement contingencies less salient.

While the anticipated effects on mand-like and echoic behavior were not observed during our sessions, Ella did display some splinter skills, and eventually demonstrated an emerging echoic repertoire shortly after we stopped conducting sessions with her. Ella emitted the largest variety of sounds throughout her sessions. She would tact animal names quite clearly, with good pronunciation. The ability to say words clearly without a good echoic repertoire is unusual. We might theorize that technological advances in

children's toys (as well as electronic devices) have made it possible for words to be paired with visual stimuli very consistently and frequently. With enough repeated pairings, automatic reinforcement may explain the acquisition of clear words, but it does not seem likely. Again, further research is warranted.

Discussion (General)

Overview

This approach to developing echoic stimulus control was clearly effective for two of the three participants. Layla was able to acquire a generalized echoic repertoire in 94 sessions, while Lexie was able to acquire three reliable echoic responses in 131 sessions. This procedure did not appear to be successful at establishing either mand-like or echoic behavior (in the context of our sessions) with Ella after 126 sessions, however she did begin to exhibit a generalized echoic repertoire one month after we stopped conducting sessions with her.

Observations

The first two phases of this procedure were designed to increase vocal behavior in a non-specific manding context. And the third phase was designed to bring that vocal behavior under echoic stimulus control. The results of the first two phases appeared to greatly influence success in the third phase. Mand-like sounds established during Phases One and Two were generally easier to bring under echoic stimulus control in Phase Three than were low-rate sounds, even if the child had demonstrated the vocal ability to produce them (the targets had been emitted before, at lower rates not under stimulus control).

Providing models for novel sounds (and having novel people provide models, in Lexie's case) often elicited crying or other problem behavior. Ideally, novel models would elicit approximations, or at least vocal variability, following extinction of non-matching responses. But for both Layla and Lexie, problem behavior was more likely to occur than vocal variability.

Another observation was the difference in behavior patterns between initial exposure to the free-operant phases and any later returns to these phases. Layla in particular had engaged in very high rates of vocal behavior (over 20 vocalizations per minute, in some sessions) during the initial exposure to Phase Two. But when we returned to Phase Two (after 45 echoic sessions) in an attempt to increase rates of other potential echoic targets, vocal responding was very low, with fewer than two responses per minute in each session. The variety of responses did increase, but they ceased to have mand-like qualities. Determining whether reverting to previous phases will ever be an effective strategy is an important question for future research.

Both children who had success on the echoic phase also engaged in emotional responding when novel models were presented. For less intense emotional responses, simply ignoring and continuing the session was typically effective. However, for consistent strong emotional responses, an alternate strategy involving pairings of the novel sound with non-contingent access to preferred items was found to be more effective.

Implication of Results

This approach may not be effective for every child, but it may be a viable place to start with low-functioning children. We tried to ensure that the number of prerequisite skills was kept to a minimum, though the mixed results indicate that there may be some that lower-functioning children do not possess. The tutors must be able to identify and use powerful reinforcers. Ideally, the children should be able to sit appropriately for a period of several minutes. High rates of stereotypy seem to make this procedure less likely to be effective. Shaping can be used to increase volume and the variety of sounds in children who are mostly non-vocal, though it may be more difficult to implement with children who make almost no sounds.

Eye contact seems helpful for this procedure, as higher rates of eye contact were correlated with better overall results, but perhaps is not required. Layla exhibited low rates of eye contact during the free-operant sessions, but it was much more common in the echoic sessions, where she reliably made eye contact after echoic models. Lexie's eye contact was consistently high across all conditions. And Ella, who did not have good in-session results, made some eye contact, but it seemed more stereotypic in nature, and occurred less frequently than with the other two children. It may be that there is a correlation between visual stimulus control (eye contact or at least orienting towards the source of the echoic model) and auditory stimulus control. Our experiment did not allow us to draw any conclusions about a causational relationship, or a clear direction of any pre-requisites between these two skills, so further research could be conducted in this area. It is not clear if there is anything particularly unique about the ability to acquire

echoic behavior as it pertains to a child's success in early intervention programs. It may be that children who are able to rapidly acquire a complex skill such as echoic behavior would be likely to acquire other complex skills quickly. If teaching a child echoic behavior is difficult, it may be likely that teaching many other skills would also be difficult. However, targeting vocal behavior and vocal imitation early in a program may allow the child to learn subsequent vocal-verbal skills more quickly. Vocal imitation also involves receptive language skills, and learning to discriminate auditory stimuli (especially adult voices) should also help with skill acquisition. Number of phonemes and generalized echoic behavior – level 3?

The relationship between the total number of sounds (phonemes) that a child can produce and the ability to acquire a generalized echoic repertoire warrants further discussion and research. It may be that the total amount of sounds in a child's repertoire, even those not under any instructional stimulus control, is an important factor. For example, two of the children had a relatively large (though non-functional) vocal repertoire, and both of these children eventually demonstrated emerging generalized echoic behavior (they at least attempted to imitate novel sounds). However, Lexie, who had a very limited range of vocal sounds (and would typically only make vowel sounds), was not able to approximate novel sounds at first exposure. See Table 4 for a comparison of the children in regard to these variables. It may be that the combination of the ability to produce many sounds and the development of echoic stimulus control (demonstrated by attempted responses immediately after a model) is required before generalized echoic

behavior can occur. If so, targeting both components (either separately or simultaneously) may be necessary.

Table 7

Comparison of Repertoires and Results by Child

Child	Number of sounds in repertoire?	Acquired mand-like responding?	Echoic-stimulus control (vocal attempts following models)?*	Acquired generalized echoic repertoire?
Layla	Many	Yes	Yes	Yes
Lexie	Very few	Yes	Yes	No
Ella	Many	No	No	Yes

Note: *By echoic-stimulus control, we are referring to whether the child would consistently engage in vocal behavior immediately after a vocal model in the echoic training context, even if it was not always correct match.

Limitations

Confounding variables.

Given that all of our participants continued to attend school and had exposure to DTT and other services, it was impossible for us to control all potential confounding variables. However, the teachers and case managers ensured that no vocal-verbal procedures were included in the children's programming during this project. Tutors were also instructed not to target vocal-verbal behavior while the children were participants in this project, but we did not typically monitor compliance. It is quite possible that tutors would have reinforced any novel appropriate behavior, especially vocal behavior, as their primary goal is to help the children acquire and use skills functionally.

The icon-exchange manding system that is provided to all children in the classroom also introduced some possible confounds. When the child gives an icon to a tutor, that tutor provides the item while simultaneously labeling it and giving social praise. This may have a sort of stimulus-stimulus pairing effect. During the later phases of this icon-exchange procedure, the tutors are instructed to leave a brief pause between receiving the icon and providing the reinforcer. Sometimes children in our classroom will begin to make approximations of the reinforcer name during this pause, and those approximations would be reinforced with the delivery of the item. Therefore, some unaccounted learning opportunities may have been presented by the tutors. This may have been true for Layla as she reached the later phases of our procedure and her echoic skills improved, but likely was not relevant for Lexie or Ella. Each child also received services from a speech therapist. This may not be a significant confound, as speech therapy typically only occurred for 30 minutes each week, and speech therapists primarily worked on the icon-exchange manding system.

Subjective nature of shaping.

Teaching vocal behavior and using shaping and differential reinforcement inherently involves some difficult discriminations for the experimenter. Within sessions (and even when attempting to code videos), we had to make decisions about whether a sound was acceptable and should be reinforced, or whether it should be extinguished. If we had had access to sophisticated technology that could measure the dimensions of a vocal response and determine whether it was novel enough, or whether it matched the model closely enough, that would allow us more certainty. However, researchers and

practitioners alike almost always must rely on judgement calls for each decision. We tried to control for some of this subjectivity by having only one person conduct the sessions.

Future Directions

While the initial results of this procedure are promising, there remains much room for refinement, improvement, and standardization. One question about this procedure, and discrete-trial training and early intervention in general, is whether we could more efficiently teach a skill if we focused only on one procedure until it was complete. For example, Layla acquired a generalized echoic repertoire in 94 sessions, for a total in-session time of only eight hours, approximately; but it took four months to conduct those sessions. It would be interesting to see what would happen if we spent all three hours in session each day that Layla was at school. Would she have acquired a generalized echoic repertoire in three days (nine hours) if we have used that method?

Frost and Bondy, creators of PECS, suggest devoting all available time to PECS when first introducing the system, and not spending time on anything else during that period (Frost & Bondy, 2002). It would be valuable to see if taking the same approach for other skills, such as matching-to-sample, imitation, or this echoic procedure would result in much faster acquisition (less time in session). Lovaas also suggested targeting certain skills (such as imitation) exclusively over the course of at least hours if not days (Lovaas, 1981).

It would be useful to determine if there is a general rule for how many sounds should be established as mand-like in the first two phases to achieve the best results in the echoic phase. A general theme for our participants was that high-rate mand-like sounds

were relatively easy to bring under echoic stimulus control, and low-rate or novel sounds were much more difficult. Returning to free-operant phases often did not result in any mand-like responses. Therefore, establishing a certain number of different mand-like vocalizations before progressing to Phase Three may be important. For Layla, three sounds were insufficient to promote generalized echoic responding. And for Lexie, two sounds were also not enough. However, staying too long in the free-operant phases may occupy time better devoted to the echoic phase. We also did not identify reinforcement and extinction schedules that consistently and quickly increased vocal variability. Further manipulations of the schedules in Phase Two should be investigated.

Conclusion

This simplified approach to increasing vocal behavior and establishing echoic stimulus control was clearly effective with two lower functioning children, and may have had some effect with the third participant. Determining what variables affect its success should be pursued in future research.

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Appendix A

Procedure Write-Up

Procedure Write-Up

Increasing Vocalizations and Establishing Echoic Stimulus Control

Purpose: This is a multi-phase procedure with goals that build upon each other. The first goal is to increase the rate of any vocalizations (especially clear phonemes/speech sounds) within session. The second goal is to increase the variety of vocalizations within session. When this goal is met, the sessions shift to echoic training. Details included below.

Appropriate participants:

Beneficial repertoires: Strong consistent reinforcers available (edibles primarily used for pilot study). Ability to sit relatively still at the table for 5 minutes at a time. Eye contact not required but probably helpful.

Exclusionary repertoires: Children who already demonstrate echoic repertoires, auditory stimulus control, or high rates of speech sounds (phonemes) may not need this alternative procedure, and should instead be exposed to standard echoic training procedures.

NOTE: This procedure requires both the tutor and the child to be able to hear well with minimal distractions. Ideally sessions should be conducted in a quiet area.

Phase 1:

Tutor and child are in a quiet work area. The tutor should have a variety of effective reinforcers available, though switching between them is not required (the goal is to use the most effective reinforcer every time, so that may be the same reinforcer throughout the session). The tutor's only role in this phase is to provide a powerful

reinforcer every time the child makes an appropriate vocalization. What constitutes an appropriate vocalization will depend on the child's existing repertoire. Limit access to the reinforcer to approximately 10 seconds (or enough time to consume an edible). The tutor does not provide any S^Ds, this is a strictly free-operant phase. Session default length is five minutes, independent of levels of responding.

NOTES: It is probably beneficial for pairing purposes for the tutor to maintain eye contact with the child throughout the session. However, if eye contact is a powerful reinforcer already, it should be withheld and only provided contingent upon a vocalization. If the child is very quiet, reinforce any noises, maybe even starting with loud breathing, and shaping incrementally towards speech sounds. It is ok if the child makes the same sound every time for phase one. Ideally sounds will start to occur in a mand-like fashion, with the child making the sound as soon as the reinforcer is removed.

Criteria to move on: 3-4 reinforceable vocalizations per minute for 3 consecutive sessions. Responding must be strong, because Phase Two will include extinction of certain sounds.

Phase Two:

Tutor and child are in a quiet work area. The tutor should have a variety of effective reinforcers available, though switching between them is not required (the goal is to use the most effective reinforcer every time, so that may be the same reinforcer throughout the session). The tutor's only role in this phase is to provide a powerful reinforcer every time the child makes an appropriate vocalization. At this point the goal is to increase the variety of sounds the child will make. The best technique to do this may

vary from child to child. Options include lag schedules and simply placing certain sounds on extinction for periods of time. The tutor will have to make quick judgement calls on whether each sound is acceptable. The tutor still does not provide any S^Ds, this is a strictly free-operant phase. Session default length is five minutes, independent of levels of responding.

NOTES: It is probably beneficial for pairing purposes for the tutor to maintain eye contact with the child throughout the session. However, if eye contact is a powerful reinforcer already, it should be withheld and only provided contingent upon a vocalization. When encountering extinction for previously reinforced sounds, the child may exhibit some problem behavior. If the problem behavior happens to include appropriate speech sounds, the tutor should reinforce them. If the child stops responding altogether for more than one session, go back to Phase One.

Criteria to move on: three or more different consistent vocalizations demonstrated throughout Phase Two.

Phase Three:

Tutor and child are in a quiet work area. The tutor should have a variety of effective reinforcers available, though switching between them is not required (the goal is to use the most effective reinforcer every time, so that may be the same reinforcer throughout the session). At this point the procedure switches from a free-operant to a discrete trial format.

3.0 – The most common vocalization from Phase Two is determined. The tutor makes that sound once in a loud, clear voice and waits for the child to make the same

sound. The tutor reinforces the first matching sound from the child, regardless of delay or other sounds made between. The child is give 10 seconds to interact with or consume the reinforcer. The tutor then waits for approximately 10 more seconds and makes the same sound again (if the child responds during this time, it does not result in a reinforcer). Each time the tutor makes the sound counts as a trial. There is no correction procedure. Number of trials will vary, run sessions for five minutes total.

Criteria to move on: low responding in the delay conditions (fewer than 10 responses per session), low latency on correct responses (often responding within 2 seconds, and with no other non-reinforced responses in between).

3.01 – Same as above, but if worried about stimulus control, manipulate the schedule of tutor's S^Ds (different VI schedules) and observe if the child keeps responding in the interim. Only use if needed.

3.1 – The two most common vocalizations from Phase Two are determined. The tutor makes one of those sounds once in a loud, clear voice and waits for the child to make the same sound. The tutor reinforces the first matching sound from the child, regardless of delay or other sounds made between. The child is give 10 seconds to interact with or consume the reinforcer. The tutor then waits for approximately 10 more seconds and making the next sound. Randomize the order of the sounds presented in each trial. Each time the tutor makes a sound counts as a trial. There is no correction procedure. Number of trials will vary, run sessions for five minutes.

Criteria to move on: low responding in the delay conditions (fewer than 10 responses per session), low latency on correct responses (often responding within 2 seconds, and no other non-reinforced responses in between).

3.2 – same as previous phases, but with three sounds.

Criteria to move on: low responding in the delay conditions (fewer than 5 responses per session), low latency on correct responses (often responding within 2 seconds, and no other non-reinforced responses in between), and 80% or greater accuracy on both sounds for three consecutive sessions.

NOTE: Conduct echoic probes on a regular basis with the standard list of early sounds throughout Phase 3 (once a week).

Phase Three and beyond*: as when training an imitation skill, this procedure should not be considered mastered until the child demonstrates consistent generalized imitation. The number of trained sounds each child will need to reach this point will vary. Conduct generalization testing after each mastered sound. If the child starts to show generalized echoic responses, consider switching to standard echoic training. Otherwise, add another sound (if you run out of sounds they made during Phase Two, just pick simple early sounds) and continue this procedure.*

Appendix B

HSIRB Approval

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: March 4, 2015

To: Richard W. Malott, Principal Investigator
Joseph Shane, Student Investigator for dissertation

From: Amy Naugle, Ph.D., Chair Amy Naugle

Re: HSIRB Project Number 15-03-07

This letter will serve as confirmation that your research project titled "Shaping Vocal Mands and Developing Echoic Stimulus Control" has been **approved** under the **exempt** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may **only** be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., ***you must request a post approval change to enroll subjects beyond the number stated in your application under "Number of subjects you want to complete the study***)." Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: March 3, 2016

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