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Using Environmental Sounds to Initiate Receptive Language Training for Children with Autism

Woan Tian Chow
Western Michigan University

USING ENVIRONMENTAL SOUNDS TO INITIATE RECEPTIVE LANGUAGE TRAINING FOR CHILDREN WITH AUTISM

by

Woan Tian Chow

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A pre-test showed that three pre-school children with autism had difficulty learning to match spoken words to objects (receptive identification). Therefore, they were first taught to match environmental sounds to objects (e.g., to touch a tambourine, when they heard the sound of the tambourine) and then to match spoken words to other objects while continuing to match the mastered environmental sounds to the original objects.

For all three children, simply learning the environmental-sound/object matching did not facilitate learning spoken-word/object matching; however intermixing the training of spoken-word/object matching with the previously mastered environmental-sound/object matching did result in the mastery of those intermixed spoken-word/object matches, which, in turn, led to the mastery of additional spoken-word/object matches without further involvement of environmental-sound/object matching. Incidentally, for the environmental-sound/object matching, the objects had been modified to produce no auditory feedback when touched by the children, demonstrating that auditory feedback was not needed to learn the environmental-sound/object matching.

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INTRODUCTION

Most normally developing children, as young as 1 to 2 years old, can readily respond to their names, follow simple instructions (e.g., "push the car"), and point to pictures or a few body parts when asked to (Bowen, 1998). However these skills often do not come easily and naturally for children with autism. Understanding spoken words is commonly referred to as receptive language and is a core deficit for children with autism; therefore training receptive language skills is often an important part of early intensive behavioral intervention programs.

Receptive identification of objects (and pictures) is commonly used to teach receptive language. Typically, this task involves the presentation of an array of two or three objects with the tutor asking the child to identify one of the objects by saying, for example, "touch car". This receptive identification can be more precisely described as matching of auditory stimuli to visual stimuli, which requires the child to perform a cross-modal matching of the auditory sample stimulus (e.g., the spoken word "car") to the visual comparison stimulus (e.g., a car). For some children, learning to match auditory stimuli to visual stimuli is particularly challenging, even when they have acquired the repertoire of matching visual stimuli to visual stimuli.

The Assessment of Basic Learning Abilities (ABLA) test (Kerr, Meyerson, & Flora, 1977) is used to assess the learner's ability to acquire basic discrimination and matching skills. From a series of studies conducted to examine the ranking of task difficulty using the ABLA test, it was consistently found that the visual to visual matching skill (which involved putting a red block into a red box, or a yellow cylinder into a yellow can) was ranked as an easier task than the auditory to visual matching skill (which involved putting an irregular foam into a red box when the tester said "red box", or into a yellow can when the tester said "yellow can") (Martin, Thorsteinsson, Yu, Martin, & Vause, 2008; Martin & Yu, 2000). In other words, those who succeeded in matching auditory stimuli to visual stimuli also succeeded in matching visual stimuli to visual stimuli, but not all who succeeded in matching visual stimuli to visual stimuli could match auditory stimuli to visual stimuli. Further, for those who failed to match auditory stimuli to visual stimuli in the ABLA test, it was very difficult to teach auditory to visual matching using standard prompting and reinforcement procedures even after hundreds of training trials (Martin & Yu, 2000; Meyerson, 1977).

These findings point to a gap between matching visual stimuli to visual stimuli and matching auditory stimuli to visual stimuli involving spoken words. This raises the question, is there an intermediate step that would bridge this gap and facilitate the acquisition of matching spoken words to visual stimuli? Walker, Lin, and Martin (1994) developed a task involving the matching of environmental sounds to visual stimuli (objects) that produce those sounds (sound/object matching); they then examined the ability to perform this task as a prerequisite skill for matching spoken words to visual stimuli (word/object matching). In the study, a bell and a tambourine were placed on the table in front of the testee, and another bell and tambourine were placed out of sight of the testee. During the testing session, the experimenter would present a continuous sound with the hidden bell or tambourine, and upon hearing the sound (i.e., the auditory sample stimulus), a correct response would be choosing the correct object on the table and manipulating that object to produce the identical sounds. The study involved 31 participants with developmental disabilities from 8 to 32 years of age and found that all participants who were able to perform word/object matching could also perform sound/object matching. On the other hand, of the eight participants who failed to perform word/object matching, only three of them could perform sound/object matching, indicating that the difficulty in matching environmental sounds to objects with auditory feedback ranks between matching visual stimuli to visual stimuli and matching spoken words to visual stimuli. This ranking suggests that the ability to perform sound/object matching could be an intermediate step before being able to perform word/object matching.

These results were replicated by Harapiak, Martin and Yu (1999) with 25 developmentally disabled participants, and Vause, Martin, and Yu (2000) with 40 developmentally disabled participants. In addition, Ward and Yu (2000) replicated these results using two different environmental-sound objects (a rice-shaker and a toy-squeaker) with 17 children, 13 diagnosed with autism spectrum disorder and 4 with developmental delays.

While those studies showed consistent results regarding the hierarchical order of task difficulty for visual and auditory matching, no published experimental study has been conducted to investigate the effects of actually training sound/object matching on the facilitation of word/object matching. The only experimental research to examine the effects of using environmental sounds was an unpublished study presented by Evan, Lewis, Levin, and Coyne (2009). In that study, training on sound/object matching was used to facilitate word/object matching for three children who showed difficulty in learning this skill. The authors used a step-by-step intervention that first began by teaching the children to perform sound/object matching with the same procedure described by Walker et al. (1994). Following the mastery of this procedure, they then intermixed the word/object matching with sound/object matching, and then gradually reduced the trials of sound/object matching until the children were only presented with trials of word/object matching. This intervention was successful, and all three children were able to acquire word/object matches.

Although Evan et al. (2009) showed that the step-by-step intervention package involving environmental sounds did facilitate word/object matching; the effect of training sound/object matching alone was not assessed. It was unclear whether training sound/object matching alone would suffice as an intermediate step to facilitate word/object matching or if it was crucial to intermix trials of word/object matching with trials of sound/object matching. In addition, Walker et al. (1994) required the children to manipulate the comparison object to produce the object's sound; therefore, they immediately received the auditory feedback after the selection of comparison object. However, it was also not clear whether it was crucial to have the auditory feedback. Furthermore, during the matching of spoken words to visual stimuli, selection of the visual comparison stimulus generally does not produce any auditory feedback. Therefore, instead of requiring the child to manipulate the object in a way that produces the auditory feedback, we may get more transfer of the auditory to visual matching skill by simply requiring the child to touch or point at the targeted object (without the auditory feedback), as this will more closely resemble the most common spoken-word to visual matching tasks. Further, this alternative may also be more efficient as it does not require an extra teaching step to teach the child to manipulate the environmental-sound objects in a way that will produce the auditory feedback, though these two issues will not be assessed in the current study.

The objective of the present study was to systematically evaluate the training of sound/object matching as an intermediate step to facilitate word/object matching (i.e., receptive identification). The study examined the effect of training sound/object matching alone. And it also examined the effect of intermixing word/object matching and sound/object matching if training with sound/object matching alone proved to be insufficient. In addition, the environmental-sounds procedure described by Walker et al. (1994) was also modified in the present study by removing the auditory feedback component.

METHOD

Setting

The current study took place in the Early Childhood Developmental Delay (ECDD) classroom at Croyden Avenue School, a public special education school in Kalamazoo Michigan. The classroom partnered with Western Michigan University's Psychology department to provide one-on-one discrete trial training for children 18 months to 5 years of age and, therefore, also serving as a practicum site for the university's graduate and undergraduate psychology students. All sessions in this study were conducted in the ECDD classroom and occurred in an instructional booth approximately 2 x 3 m and equipped with a child-sized table and chairs.

Children

This research included three children enrolled in the ECDD classroom: LaShanti (female, 2 years 9 months), Dawson (male, 5 years 2 months), and Nuri (male, 3 years 8 months). Both LaShanti and Nuri attended the school 6 hours per day, whereas Dawson attended 3 hours per day. Prerequisite criteria for participating in the present study included basic attending skills and mastery of objects and pictures matching. In addition, the children needed to have difficulty learning word/object matching (see the criterion in the pre-test section). Both LaShanti and Dawson could readily imitate sounds and Dawson could also imitate one-syllable words. However, Nuri's sounds imitation was at the emerging stage and did not occur reliably. All three children were able to use the Picture Exchange Communicative System (PECS) to mand for reinforcers. LaShanti and Nuri had not received any prior training with receptive-identification procedures.

Dawson, however, was unable to match auditory stimulus to visual stimulus, in learning receptive identification of objects, identification of classmates, and to put a block in the cup and take a block out of the cup following the tutor's instructions. In addition, the Vineland Adaptive Behavior Scale was used to assess the children prior to the study; this assessment was conducted by the experimenter, under the supervision of a school psychologist. Compared to their typically developing peers, all three children showed low adaptive levels in the receptive and expressive areas, with their age equivalent scores ranging below 1 year of age (Table 1).

Table 1: Results of Vineland Adaptive Behavior Scale for All Children in the Receptive and Expressive Area

Children	Age	Receptive		Expressive	
		Adaptive level	Age equivalent	Adaptive level	Age equivalent
LaShanti	3 years 2 months	Low	6 months	Low	7 months
Dawson	5 years 8 months	Low	9 months	Low	9 months
Nuri	3 years 7 months	Low	< 1 month	Low	4 months

Materials

The materials used for the sound/object matching procedure were two sets of environmental-sound objects, with each set consisting of a tambourine, a rice-shaker, a squeaky toy, and a clapper. One set produced those sounds, whereas one other set was modified so that the objects were muted and would not produce any sounds when manipulated. The materials used for the word/object matching procedure were four three dimensional objects: a cup, a mitten, a book, and a plastic apple. In addition, three separates sets of objects were used for pre-test and post-tests. Each of these three sets consisted of two targeted objects for training and one object as a distracter (see Table 2). While Set 1 was used in both pre-test and post-tests, Set 2 and Set 3 were only used for post-test purposes.

Table 2: Objects in Each of the Three Sets Used for Pre-tests and Post-tests

Set	Target Objects	Distracter
1	hat, glasses	Spoon
2	horse, plate	Shoe
3	banana, phone	Block

Overview

This section describes an overview of the experimental design used in the present study (Figure 1); a detailed description of each procedure is in the later sections. The study began with a pre-test for each of the three children to assess whether they could learn word/object matching using typical reinforcement and prompting procedures. The child was selected to participate in the study if he or she showed difficulty in learning word/object matching during the pre-test. Procedure 1, training sound/object matching followed the pretest. The objective was to train the child to match each of four environmental sounds to four corresponding objects. When the child met the mastery criteria for Procedure 1, Post-test 1 was conducted to evaluate the effect of the environmental sound to visual matching skill on acquisition of word/object matching. If the child was still unable to learn to match spoken words to visual stimuli, the experimenter implemented Procedure 2, which involved word/object matching intermixed with mastered sound/object matching. The author conducted all experimental sessions.

General Teaching Procedure

The following teaching procedure was used in all of the experimental conditions. All sessions began with a reinforcer assessment where the child was asked to select a preferred item from an array of five reinforcers consisting of edibles and toys. After the optimal reinforcers were selected and the child was quietly oriented toward the tutor or the comparison stimuli, the experimenter presented the auditory discriminative stimulus (S^D).

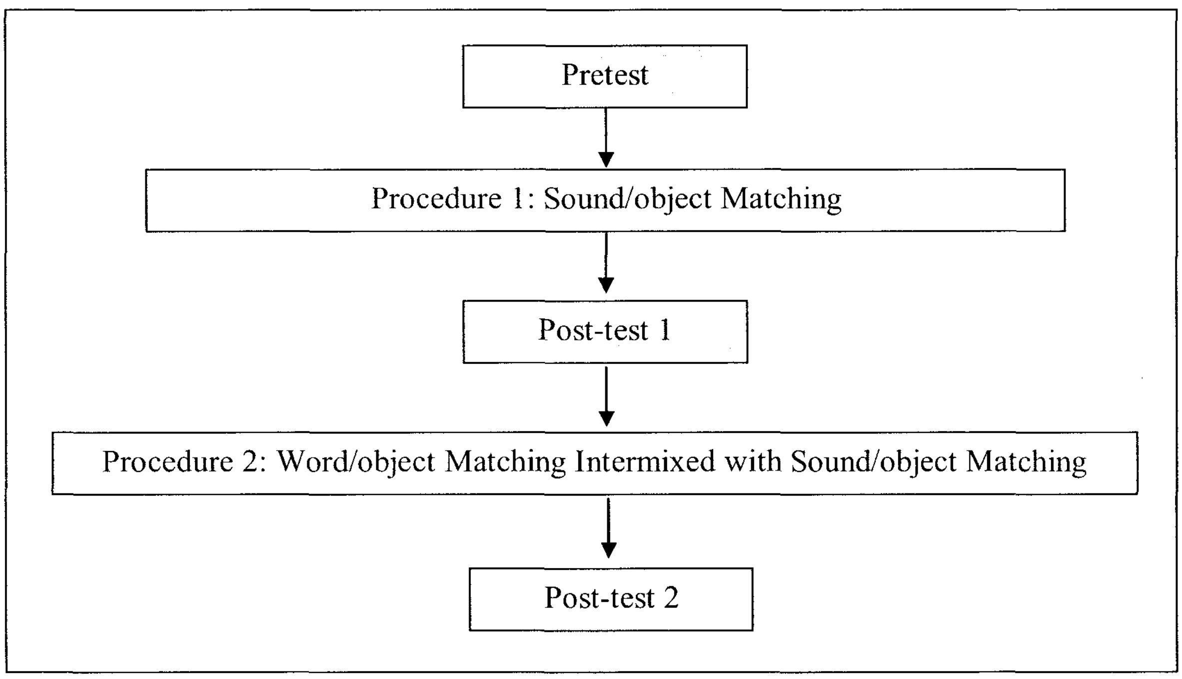


Figure 1. Overview of the Experimental Design.

The S^D consisted of either an environmental sound or a spoken word, and the experimenter repeated the sound or word for up to 8 s, allowing the child to respond independently during that time. Correct responses (touching the target object) were immediately followed by a reinforcer and verbal praise delivered in an enthusiastic manner. Incorrect responses (touching the wrong object) or no response after 8 s were followed by a correction procedure, consisting of the presentation of the S^D while simultaneously using least-to-most prompting to prompt the correct response, beginning with a gestural prompt and escalating to a partial and then a full physical prompt, as needed. All correct prompted responses were reinforced in the same way as correct unprompted responses. The sample stimuli were presented randomly, and the positions of the comparison stimuli were semi-randomly rotated throughout the session. The child qualified as having difficulty in acquiring word/object matching in the pre and post-tests if his or her matching accuracy was 50% or less for three of five test sessions. The mastery criterion for the intervention procedures were 80% or above for three consecutive sessions, or 90% or above for two consecutive sessions.

Details of the Procedure

Pre-test

The pre-test consisted of five training sessions with sound/object matching from Set 1. In each pre-test session, two targeted objects (hat and glasses) and a distracter (spoon) were placed in front of the child, with the verbal S^D: "item's name" (e.g., "hat"). The session consisted of ten trials, five for each targeted object. The child was included as a participant and proceeded to the training on sound/object matching if he or she performed below chance level (50% correct responding) for three out of five training sessions.

Procedure 1: Sound/Object Matching

The materials were the two sets of environmental-sound objects described earlier. During the training sessions, the set of "muted" environmental-sound objects was presented to the child as comparison stimuli, and the identical set that produced sample-stimulus sounds was hidden under the table. Each trial began with a presentation of the environmental sounds under the table (i.e., the auditory sample stimulus). A correct response was the child's independently selecting the matching object that corresponded to the sample sound. Procedure 1 included three training phases. The array of comparison stimuli started with two stimuli and increased by one with each phase, so that by Phase 3, there was an array of four environmental-sound objects (see Table 3). After Procedure 1, a post-test was given to determine if the children could now readily learn word/object matching. If the child could, the experiment would have terminated for that child. Otherwise, the children proceeded to Procedure 2. (The post-tests following Procedure 1 and Procedure 2 are described in the results section).

Table 3: Targeted Sounds and Mastered Sounds for Each Training Phase in the Sound/Object Matching Intervention

Phase	Targeted Sounds	Mastered Sounds
1	Tambourine, squeaky toy (20 trials)	n/a
2	Rice shaker (10 trials)	Tambourine, squeaky toy (10 trials)
3	Clapper (10 trials)	Tambourine, squeaky toy, rice shaker (10 trials)

Procedure 2: Word/Object Matching Intermixed with Mastered Sound/Object Matching

Phase 1 of this procedure began with the presentation of an array of four objects (comparison stimuli), consisting of three of the four objects that had previously been paired with environmental sounds and one new object (cup) to be paired with a spoken word. The particular combination of three of the four environmental-sounds objects presented in the array varied from trial to trial. During the training session, the experimenter presented the verbal S^D: "item's name" for the word/object matching trials and make the environmental sounds with the hidden environmental-sound objects during the sound/object matching trials.

Phase 2. Following mastery of the first spoken-word object (cup), another environmental-sound object was removed from the array and replaced with the second targeted spoken-word object (mitten). Thus the array of stimuli consisted of two mastered environmental-sound objects (rotated among the four mastered environmental-sound objects), one mastered spoken-word object (cup), and one new, targeted, spoken-word object (mitten).

Phases 3 and 4. Subsequently, an array of four stimuli similar to the preceding was also used when training the third and fourth spoken-word objects (book and apple). The only difference was that the mastered spoken-word object presented in the array was randomly rotated between all previously mastered spoken-word objects.

Phase 5. After the fourth spoken-word object match was mastered, the final step in Procedure 2 was to remove all environmental-sound objects from the array and replace them with the spoken-word objects, so that the array consisted of only the four mastered spoken-word object matches. Procedure 2 is summarized in Table 4. Following Procedure 2, a second post-test was given, as described in the results section.

Interobserver Agreement

Interobserver agreement data were collected for 40% of the pre-test and post-test sessions, and 35% of the training sessions for each of the three children. During the observation sessions, an independent observer and the experimenter simultaneously and independently record the responses of each child. The percentage of agreement was calculated by dividing the number of agreements by the sum of agreements and disagreements, and multiplying this number by 100%. The average percentages of agreement were: 99% for the pre and post test sessions, ranging from 96% to 100%, and 98% for the training sessions, ranging from 94% to 100%.

Table 4: The Number of Trials Presented During the Training Sessions of Procedure 2

Phase	Targeted Spoken Word	Mastered Spoken Word	Mastered Environmental-Sounds
1	10 (cup)	n/a	10
2	10 (mitten)	4 (cup)	6
3	10 (book)	3 for each object (cup, mitten)	4
4	10 (apple)	2 for each object (cup, mitten, book)	4
5	n/a	5 for each object (cup, mitten, book, and apple)	n/a

RESULTS AND DISCUSSION

Pre-test

During the pretest, none of the three children performed above 50% correct in any of the five training sessions, with a range from 10% to 50% correct (first panel of Figure 2). In other words, all the children had difficulty learning word/object matching; therefore they met the criterion to be participants and to begin Procedure 1, sound/object matching.

Procedure 1: Sound/Object Matching

Both LaShanti and Dawson needed only nine sessions to master the matching of four environmental sounds to their corresponding objects, though Dawson's accuracy was much lower than Lashanti's for the first three sessions (Figure 3, top and middle graphs). However, Nuri needed 21 sessions to master the first three sound/object matches; though like the other two children, he only needed two sessions to master the final sound/object match (Figure 3, bottom graph). In other words, the three children differed in the rate of acquisition of the first three sound/object matches; but by the fourth sound/object match, they all needed only the two-session minimum required to demonstrate mastery by our most stringent acquisition criterion (i.e., 90% correct for two consecutive sessions). Though not tested, this suggests that all three children might have needed, more or less, only the two sessions required to demonstrate mastery for future sound/object matching.

Post-test 1

The procedure used in the post-tests was identical to the pre-test. For all three children, the post-test began with training word/object matching for the two objects from

Set 1 (hat and glasses), which were also used in the pre-test. In this post-test, LaShanti and Dawson typically performed at or below 50% correct thus indicating that they continued to have difficulties with word/object matching even after they had mastered sound/object matching (top and middle graphs on the second panel of Figure 2). Therefore, they were included in training with Procedure 2.

On the other hand, Nuri's performance showed an increasing trend of performance during the five sessions and he achieved a 90% correct in the fifth session (bottom graph on the second panel of Figure 2). This indicated that he had successfully acquired word/object matching with Set 1. However, in order to ensure that the improvement displayed in Post-test 1 was not due to the exposure of the materials from the earlier training (i.e., the pre-test) and to ensure the generality of the skill of word/object matching, another five training sessions were conducted using a different set, Set 2 (horse and plate). Nuri's performance with Set 2 was below 50% correct in all five sessions, showing that he still had difficulty with word/object matching using new words and objects. Therefore, Nuri was also trained with Procedure 2.

Procedure 2: Word/Object Matching Mixed with Mastered Sound/Object Matching

Procedure 2 involved new word/object matching intermixed with previously mastered sound/object matches. Note that although the acquisition criteria were based on the children's overall performance in each session (i.e., performance on both spoken-word trials and environmental-sound trials), Figure 4 (to be discussed) only displays the children's performance on the spoken-word trials, in order to focus on the acquisition of the matching of the new spoken words to their corresponding objects (the graph with the children's overall performance is in Appendix A).

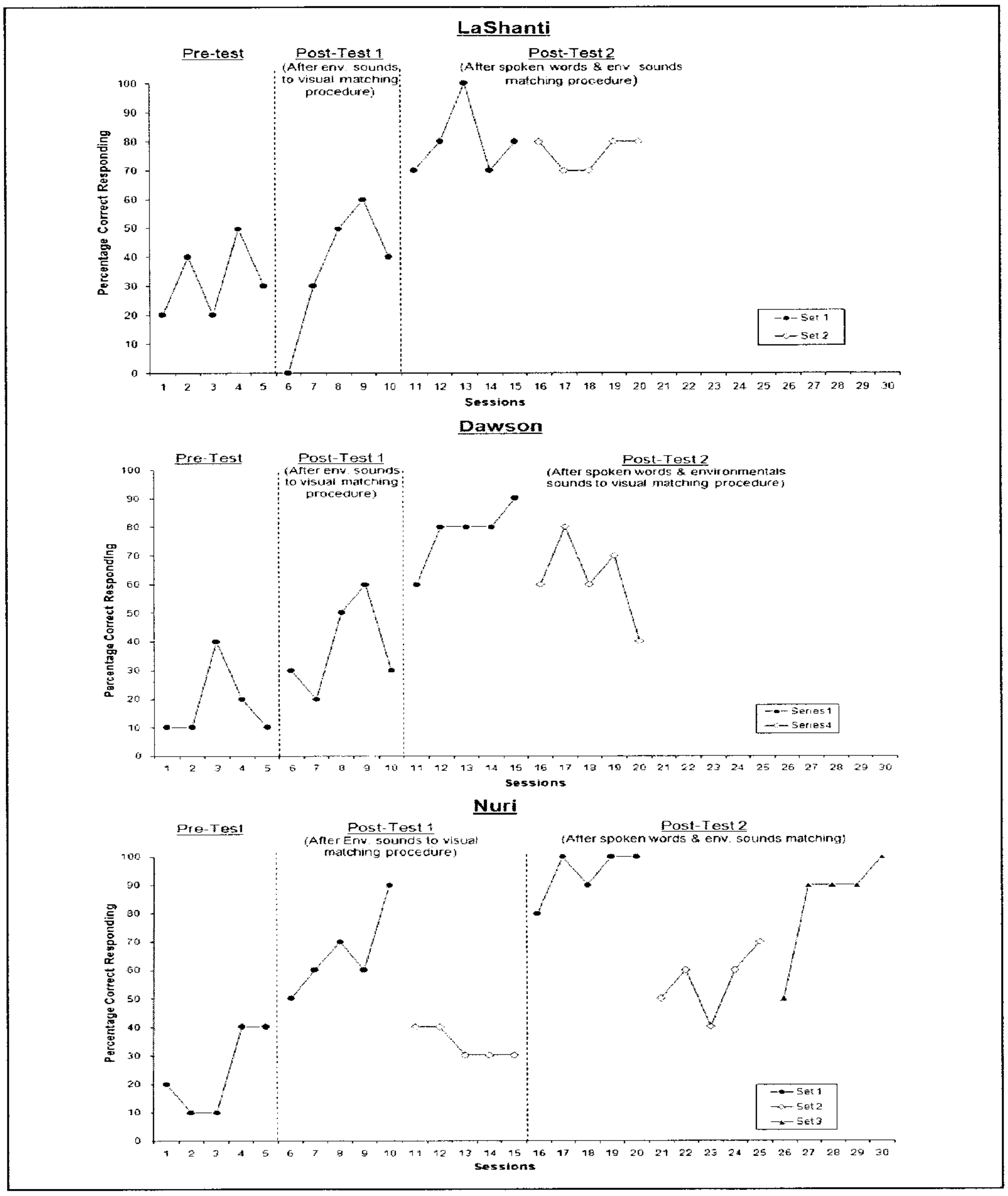


Figure 2. Percentage Correct Responding During Pre-test, Post-test 1, and Post-test 2.

The top graph shows LaShanti's performance, the middle graph shows Dawson's performance, and the bottom graph show Nuri's performance.

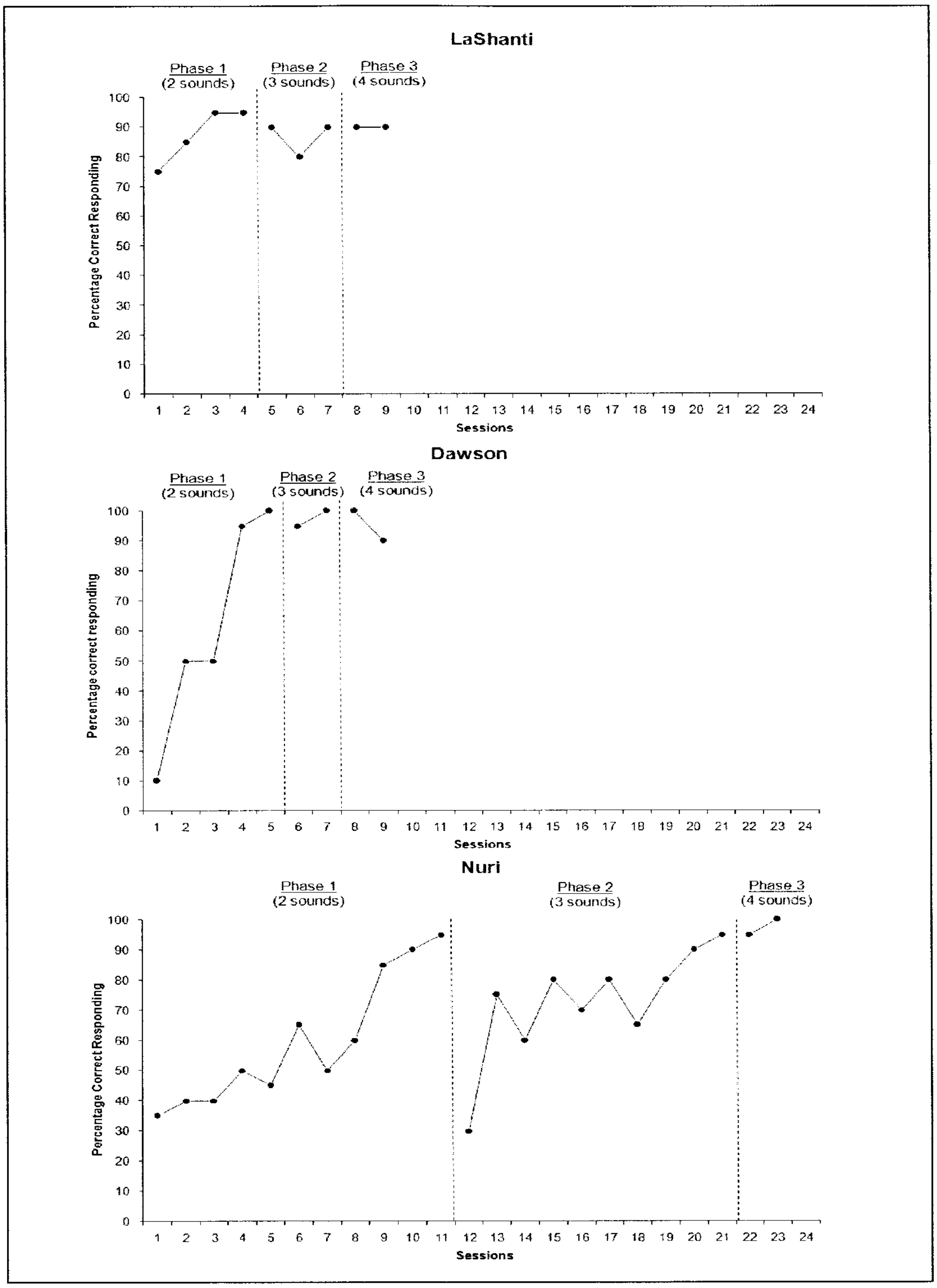


Figure 3. Percentage Correct Responding During Procedure 1, Sound/Object Matching.

The top graph shows LaShanti's performance, the middle graph shows Dawson's performance, and the bottom graph show Nuri's performance.

Compared to their earlier performance in acquiring the first sound/object matching (Procedure 1, Phase 1), LaShanti and Dawson had more difficulty in acquiring the first word/object matching (Procedure 2, Phase 1). LaShanti needed eight sessions and Dawson needed ten sessions to master Phase 1. Following the mastery of the first spoken word, LaShanti and Dawson progressed from Phase 2 to Phase 4 rapidly, acquiring a new spoken word to object match in each phase. After they mastered the four spoken words, Phase 5 involved the removal of the environmental sounds so that the trials consisted of only the four previously mastered word/object matching. Their performance decreased immediately following the removal of sound/object matching. Although LaShanti eventually mastered Phase 5, Dawson showed no progress and he also began to respond emotionally (e.g., fist clenching, whining, and facial muscle tensing) during the training sessions (Figure 4, top and bottom graphs).

After 10 sessions with Dawson making no progress, a supplementary procedure, Phase 5a, was added. In this phase, two previously mastered environmental-sound objects were added to the array of four spoken-word objects (similar to Phase 5), thus establishing an array of six objects (the two environmental-sound objects were semi-randomly rotated among the four mastered environmental-sound objects). Each session consisted of five trials for each of the four spoken-word objects (20 trials total), intermixed with 13 to 15 environmental-sound trials. In this phase, only the spoken-word trials were included for the calculation of percentage of correct responding and for determining mastery. Immediately after the start of Phase 5a, Dawson's performance improved sharply: 85% correct in the first session and successfully meeting an acquisition criterion within three sessions (Figure 4, middle graph). In addition, his emotional responding during the training sessions quickly and almost completely disappeared. Ideally, another phase should have been included to gradually remove the environmental-sound trials so that Dawson could become fluent at matching spoken words to visual stimuli without intermixing with environmental-sound trials. However, because of his age, Dawson had to transfer out of the preschool classroom. Therefore we had to stop the training sessions to ensure enough time to implement the second post-test.

LaShanti and Dawson's decreased accuracy with previously mastered objects suggests that, a more gradual removal of environmental sounds may have been needed in Phase 5. Perhaps this was due to an increase in response effort needed to identify the targeted comparison object that matched the spoken-word sample stimulus. In the previous phases, the array of comparison stimuli had consisted of two environmental-sound objects and two spoken-word objects. Thus, for any given spoken-word trial, the children had only to select one of the two spoken-word objects (anecdotal data suggest that they rarely selected an environmental-sound object when a spoken word was presented). However, in Phase 5, the array of comparison stimuli consisted of four spoken-word objects and no environmental-sound objects. Thus the effort to select the object that matched the spoken-word sample stimulus increased because the child was then required to discriminate between four spoken-word comparison objects instead of only two.

Or, perhaps the environmental-sound trials were easier and, when intermixed with the potentially more difficult spoken-word trials, the aversiveness of the procedure was less than when the procedure involved all spoken-word trials with no easier

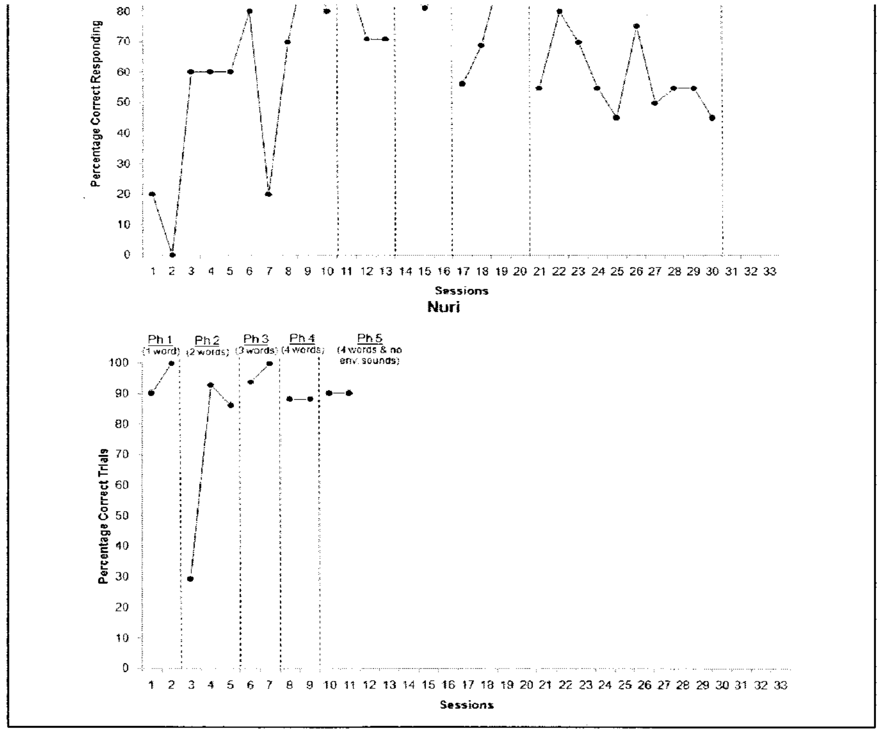
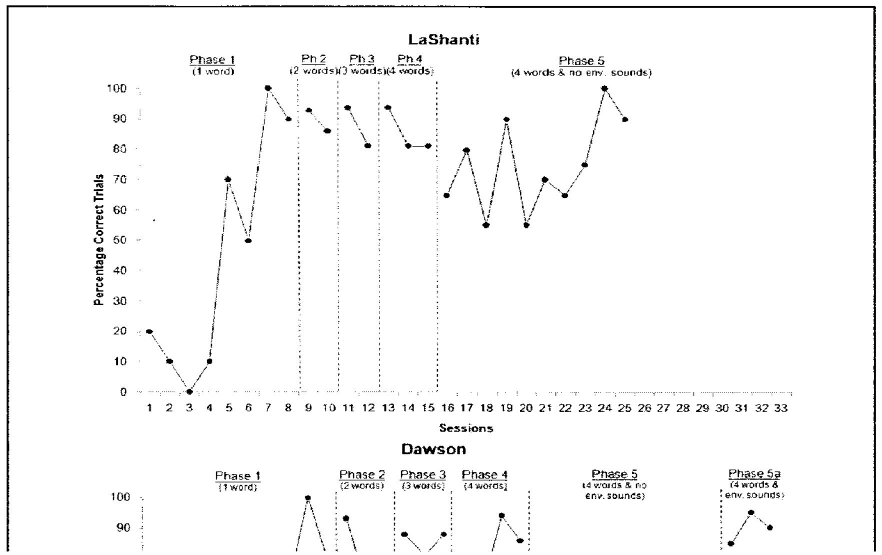


Figure 4. Percentage Correct Responding for Spoken-word Trials During Procedure 2, Sound/Object Matching Intermixed with Word/Object Matching.

The top graph shows LaShanti's performance, the middle graph shows Dawson's performance, and the bottom graph show Nuri's performance.

environmental-sounds trials. And perhaps this decrease in aversiveness increased compliance and accuracy in responding to the more difficult spoken-word trials.



This is suggested by Dawson's performance in Phase 5a, where his performance on word/object matching task improved sharply following the reintroduction of environmental-sound trials, even though the array presented was increased to six comparison objects and the total number of trials presented was also increased.

On the other hand, though Nuri experienced more difficulty than the other children in acquiring sound/object matching, he had little problem acquiring word/object matching. He performed at a high level of accuracy in all five phases, except the first session of Phase 2 where he was required to discriminate between two spoken-word sample stimuli for the first time. Nuri only needed 11 sessions to master Procedure 2; and unlike LaShanti and Dawson who struggled with the removal of environmental sounds in Phase 5, Nuri's performance remained unaffected (Figure 4, bottom graph).

Post-test 2

Post-test 2 was conducted in the same manner as Post-test 1. All three children first received training sessions using the objects from Set 1, and when they showed that they were able to learn word/object matching with Set 1 (third panel of Figure 2), another five sessions were conducted with Set 2 (again, to eliminate the confound with previous training). LaShanti's accuracy with Set 2 varied between 70% and 80% correct, showing she could readily learn word/object matching of novel objects (Figure 2, top graph). Dawson's accuracy in the first four sessions ranged between 60% and 80% correct, however it dropped to 40% in the fifth session (Figure 2, middle graph). This suggests that although he was generally performing above chance, indicating he was improving in his ability to learn word/object matches, more practice would be for him to acquire the undetermined skills needed to reliably rapidly learn future word/object matches.

Nuri's performance with Set 2 improved from Post-test 1, but he continued to have difficulty in mastering Set 2, as the highest performance he achieved was 70% correct, with an average of 56%. Because, Set 2 was used in Post-test 1 for Nuri and he performed above 50% correct in three of the five sessions, another five post-test sessions were conducted with a novel set, Set 3 (banana and phone). Here his performance was only 50% correct in the first session but improved sharply to 90% in the second session. He maintained this high level of accurate performance for the remaining sessions, scoring 100% correct on the fifth session (Figure 2, bottom graph). Therefore, despite his mediocre performance with Set 2, he was able to master word/object matching with novel objects in Set 3, thus suggesting that there may have been other factors affecting his performance with Set 2, though it is not clear what those other factors might have been.

GENERAL DISCUSSION

Training sound/object matching clearly facilitated the acquisition of matching auditory to visual stimulus for these children with autism, as all three were able to master the environmental-sounds procedure successfully (four sound/object matches), with two rapidly mastering the four matches (Figure 3). However, training with environmental sounds alone was not sufficient to facilitate word/object matching (second panel of Figure 2). The subsequent intermixing of spoken-word and environmental-sounds object matching was crucial to their eventually mastering new spoken-word/object matches. Furthermore, all three children could eventually master novel word/object matches without the intermixing of environmental-sound/object matching (third panel of Figure 2). It may be easier for children with autism to discriminate between environmental sounds than between novel spoken words; and if so, that might explain why matching environmental sounds to visual stimuli was much easier than matching spoken words to visual stimuli.

Also the auditory feedback produced by manipulating the targeted comparison object, as was done by Walker et al. (1994), was not needed for the children to acquire environmental sounds to visual matching, because all three children were able to match the environmental sounds to the muted comparison environmental-sound objects. However, it is not clear whether auditory feedback from the environmental-sound objects might have increased the speed of acquisition, especially for Nuri who had more difficulty than the others in mastering the first three sound-object matches (Figure 3, bottom graph). Future research might clarify this.

Interestingly, all three children showed "learning-to-learn" with both environmental sounds and spoken words. Once the children mastered one or two initial sound/object matching, they were able to master subsequent sound/object matching rapidly (Figure 3 and 4). And upon mastering the first four word/object matches, they were able to master subsequent new word/object matches much more rapidly (Figure 2, third panel). Therefore all three children are now set to rapidly acquire a large receptive-identification repertoire (word/object matching).

CONCLUSION

Three children with autism who were unable to respond discriminatively to spoken words at the beginning of the study, quickly learned to acquire matches of environmental sounds to objects, even when the objects themselves produced no environmental sounds. However, this alone did not prepare them to learn to respond discriminatively to spoken words. But when the spoken-word training trials were intermixed with the environmental-sound trials, they did learn to respond discriminatively to new spoken words. And then, they were able to learn to respond discriminatively to another set of new spoken words without the intermixing of environmental sounds. Furthermore, their speed of learning increased as they progressed through both new environmental sounds and new spoken words.

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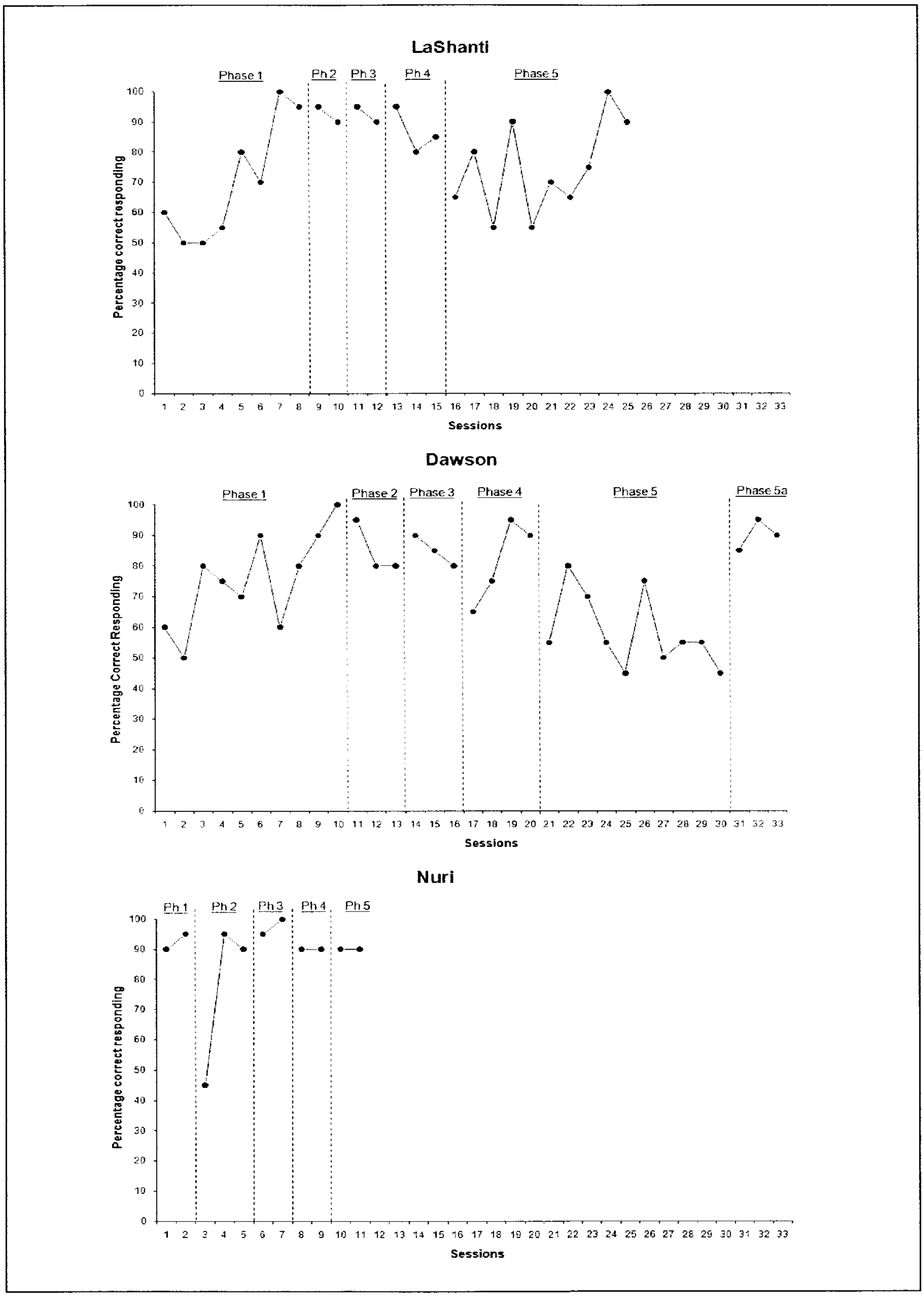
Appendix A

Overall Performance of All Three Children during Procedure 2: Sound/Object Matching Intermixed with Word/Object Matching


LaShanti
Phase 1
Ph 2
Ph 3
Ph 4
Phase 5
Percentage correct responding
Sessions
Dawson
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5
Phase 5a
Percentage Correct Responding
Sessions
Nuri
Ph 1
Ph 2
Ph 3
Ph 4
Ph 5
Percentage correct responding
Sessions

Appendix B

HSIRB Approval Letter and Proposal (Project Description)

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: November 26, 2008

To: Richard Malott, Principal Investigator
Breanne Hartley, Student Investigator

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number: 08-11-28

This letter will serve as confirmation that your research project entitled "Croyden Avenue School Practica: Continuous Quality Improvement" 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 that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. 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.

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

Approval Termination: November 26, 2009

Walwood Hall, Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276

Protocol Outline

Project Title:

Croyden Avenue School Practica: Continuous Quality Improvement

Abstract

The purpose of this study will be (1) to evaluate an intensive behavioral treatment provided in a preschool for children diagnosed with autism and, based on these evaluations, (2) to continuously improve aspects of the treatment and assessment procedures provided to the children. This program evaluation and treatment/assessment adjustments are part of the standard continuous quality improvement efforts of the classroom where the study will be conducted. The study will be documented through direct observation and video recordings, which will capture the children's behavior. The study will take place in the Early Childhood Developmental Delay (ECDD) preschool classroom at Croyden Avenue School, where the treatment is provided by undergraduate and graduate practicum students. We are asking permission to use these evaluation, training, and assessment data in Master's theses, presentations, and publications to document the effectiveness of this continuous quality improvement effort.

Purpose/Background Information

I (Richard Malott) am training BA, MA, and PhD students to be human-service practitioners, generally with a specialty in preschool autism and early childhood developmental delays, not to be either basic or applied researchers. I am not using the researcher/practitioner model. However, I am training my students to continuously evaluate the effects of their work with the children and to modify their treatment/training procedures accordingly. So our first criterion in any practicum, thesis, or dissertation is that the children directly involved in those projects will immediately benefit from their involvement, not just that their involvement will contribute to the long-term betterment of the treatment of subsequent children, though we also have that as a goal, of course.

The current project will involve a case study objectively evaluating the performance of children diagnosed with autism. The study will examine the background of the children (e.g., pre-intervention assessments, medical conditions, behavioral history), the behavioral treatment provided to the children, the measurement and data collection process, performance results, and problem behavior.

Participant Recruitment

All participants will be preschool-aged children who are currently enrolled in the Early Childhood Developmental Delay (ECDD) Classroom at Croyden Avenue School. As part of the continuous quality improvement standard within the classroom, all the children will be involved in the evaluation and improvement process. The students whose parents decide not to provide permission for Dr. Malott's graduate students to use their data will not have their data included, however they will still be part of all evaluation and training improvements. The student age range in the classroom is from 12 months to 5 years of age. Before data are presented, used in publications, or used in theses an informed consent form will be sent home to the parents asking for permission to use their child's data. The parents will be assured that neither names nor any other identifying information will be used in publications, presentations, or in the theses. Whether or not the parents consent for our use of the data for the theses, publications, and presentations their children's performance will still be closely monitored and their children will receive any improved training programs that are developed. Undergraduate and graduate student tutors record daily perfomance data for each child and will not be asked to perform any additional tasks not included as a regular part of their practica.

Informed Consent Process

All data collection methods that involve the children participating in this study are used as a regular part of the undergraduate and graduate practica during which this study will take place. All parents participating in the use of their child's data will receive two copies of an informed consent document asking permission for their data to be used confidentially for theses, publications, and/or presentations. They will have the opportunity to sign and return one copy and keep the other copy for their records. As stated earlier, all results will be displayed confidentially for each participant. The consent forms will be returned to Dr. Richard Malott. The focus of our data collection process will be the performance of the children, not the performance of the tutors. The tutors and classroom teacher will only be asked to perform the duties already required as part of their regular obligations. For HSIRB protocols concerning the practicum students, see the section below, though data concerning their performance will not be part of this study.

Research Procedure

As part of standard classroom procedure Richard Malott, his graduate students, and the Early Childhood Developmental Delay (ECDD) classroom staff are constantly working to improve all aspects of the treatment provided to the children to improve each individual child's performance. This standard procedure involves an initial Pre-primary Evaluation Team assessment (PET), yearly IEP goal-setting meetings between Croyden staff and parents, parent meetings, data collection, data analysis, changes made to the training system based on the data analyses, and continuous quality improvement of all procedures, data collection methods, and treatment methods. Specifically, data collected include the percentage of correct responses for each child for the procedures assigned to him or her as part of enrollment in Croyden Avenue School, the occurrence of problem behaviors, and skills obtained throughout their time at Croyden Avenue School. Examples of areas that may be addressed in this study include prompting strategies, skill maintenance, generalization, transfer of training, and revisions of skill acquisition procedures. All improvements made to classroom training procedures are part of standard continuous quality improvement designed to constantly improve the service provided to the children in the classroom. All data sources are already part of the undergraduate and graduate practica through Western Michigan University. These projects and their approved HSIRB Project Number are as followed:

- Pre-Practicum: 06-12-12
- Intermediate/Advanced Practicum: 08-11-15
- Language Facilitation Training System: 06-12-09

Methodology

The model for this study will be an intensive case study model (Green, Brennan, & Fein, 2002) that includes continuous empirical assessment and improvements made based on these assessments, as well as based on the goals of the parents and the classroom teacher. Performance data for the children involved in the study are collected and evaluated as part of the normal duties of the Croyden Avenue Early Childhood Developmental Delay (ECDD) preschool classroom.

Risks and Costs to and Protections for Participants

There are no known risks to the participants.

Benefits of Research

A primary objective of this study is to thoroughly evaluate the performance of the children involved in this study and work to continuously improve their instructional procedures and their skill acquisition as well as the other children in the classroom.

Confidentiality of Data

The data collected will be stored on a computer disk for at least three years. The computer disk will be filed and locked in Richard Malott's lab. Once all paper data have been analyzed and compiled for presentation, the original copies of the data will be stored in a box, and locked in a psychology lab at Western Michigan University. The only people who will have access to the disk and paper data will be Nicholas Weatherly and Richard Malott.

References

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