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Prediction of Auditory Matching
Performance of
Developmentally Handicapped Individuals

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A Thesis Submitted
in Partial fulfillment of the Master of Arts degree
at the University of Manitoba

1995



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PREDICTION OF AUDITORY MATCHING PERFORMANCE OF
DEVELOPMENTALLY HANDICAPPED INDIVIDUALS

BY

YI H. LIN

A Thesis submitted to the Faculty of Graduate Studies of the University of Manitoba
in partial fulfillment of the requirements of the degree of

MASTER OF ARTS

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Results of Highest ABLA Level Passed, Auditory Matching, Matching
Common Sounds, Live-to-Taped Speech Sound Matching and Live-to-Live
Speech Sound Matching

Table 2 26

A Behavioral Analysis of the Antecedents, Behavior, and Consequences on a
Reinforced Trial of ABLA and Auditory Matching tasks.

Abstract

A test called the Assessment of Basic Learning Abilities (ABLA) has proven to be a useful tool for teaching developmentally disabled persons. The ABLA test assesses the ease or difficulty that developmentally disabled persons experience in learning to imitate and perform two-choice discriminations. Walker, Lin and Martin (in press) have suggested that a test of auditory matching may be a worthwhile addition to the ABLA test. As a step towards evaluating their suggestion, the present experiment examined the predictive validity of their auditory matching test. Three groups of subjects were selected, including a group that passed level 4 of the ABLA test but failed the test of auditory matching, a group that passed level 4 of the ABLA test and the auditory matching test, and a group that passed level 6 of the ABLA test and the auditory matching test. All subjects were then assessed for their ability to: a) match common sounds (sounds made by objects); b) match live-to-taped speech sounds; c) match live-to-live speech sounds. The results showed that those who failed the auditory matching test also failed to perform other auditory matching tasks. Those who passed the auditory matching test but failed level 6 of the ABLA test were also able to match common sounds and live-to-taped speech sounds, but were unable to match live-to-live speech sounds. Those who passed level 6 of the ABLA test were able to perform all of the auditory

matching tasks. These results demonstrate that the ABLA test has considerable predictive validity. The results were discussed in terms of a behavioral analysis of characteristics of the various tasks.

Prediction of Auditory Matching Performance of
Developmentally Handicapped Individuals

Professionals working with developmentally handicapped persons frequently encounter problems in teaching those individuals to perform vocational or educational tasks. For example, some severely developmentally handicapped persons might attend to only one aspect of a complex cue, but fail to show generalization to other aspects of the complex cue (Bickel, Richmond, Bell & Brown, 1986; Koegel & Wilhelm, 1973; Lovaas, Koegel & Schreibman, 1979). Other handicapped persons may continue to respond inconsistently to simple discriminations even after extensive training trials (Koegel, Egel, & Dunlap, 1980). Still other handicapped persons may learn to perform certain tasks within a few trials, but learn other seemingly similar tasks only with great difficulty (McDonald & Martin, 1991; Wacker, Steil, & Greenebaum, 1983). Problems such as these make it extremely difficult for training staff to decide what kinds of learning tasks should be taught to which developmentally handicapped individuals.

Some research suggests that many of the difficulties encountered by persons with developmental disabilities in learning certain tasks may be functions of deficits in making the prerequisite auditory, visual, and motor discriminations necessary to perform those tasks (Kerr, Meyerson & Flora,

1977; Yu, Martin, & Williams, 1989). In order to determine the ease with which developmentally handicapped individuals are able to learn basic discriminations, Kerr et al. (1977) developed a diagnostic test called the Assessment of Basic Learning Abilities (ABLA; formerly called the AVC test).

The ABLA Test

The ABLA test consists of six diagnostic tasks which assess an individual's ability to imitate and to perform five basic two-choice discriminations. In level 1 (imitation), the tester puts an object into a container and the subject is required to do likewise. In level 2 (position discrimination), two different containers (e.g., a yellow can and a red box) are placed in unchanging right-left positions, and the subject is required to put an object consistently into one of them.

In level 3 (visual discrimination), the subject is required to put an object into one of two containers (e.g., a red box vs. a yellow can) while the positions of the two containers are randomly switched. In level 4 (visual match-to-sample discrimination), two stimuli (e.g., a red box and a yellow can) are presented, and the subject is required to make a match by putting a yellow cylinder into the yellow can or putting a red block into the red box.

In level 5 (auditory discrimination), two different auditory cues (e.g., "red box" spoken rapidly in a high tone vs. "yellow can" spoken slowly in a low

tone) are randomly presented, and the subject is required to put an object (a piece of sponge) into one of the containers according to the given cue. In level 6 (auditory-visual combined discrimination), the stimuli and the requirements are the same as in level 5, but the positions of the two containers are switched randomly.

Levels 5 and 6 are not meant to assess a subject's ability to understand the words "red box" or "yellow can". Rather, they are used to assess a subject's ability to respond differentially to two different sounds, that is, to make an auditory discrimination. Level 5 requires subjects to distinguish two different tones and to match them with objects kept in fixed positions. Level 6, however, requires subjects to distinguish two different tones and to match them with objects regardless of their positions.

The ABLA test can be administered in approximately 30 minutes with an individual subject. For each task, a demonstration, a guided trial, and a practice trial are presented to ensure that a subject is capable of responding to the task. In the demonstration trial, the tester presents the stimulus and shows the correct response. In the guided trial, the tester presents the stimulus and physically guides the subject to make the correct response. In the practice trial, the subject is required to make an independent correct response after the tester presents the stimulus.

Scoring begins after the subject has made a correct response on the practice trial. On test trials, correct responses are followed by praise and intermittently presented reinforcers (e.g., popcorn). Incorrect responses are followed by an error correction procedure (including a demonstration, guided trial and a practice trial). Trials on a particular task continue until the subject meets either a passing criterion or a failure criterion, whichever comes first.

The passing criterion is eight consecutive correct responses and the failure criterion is eight cumulative incorrect responses. A failure to respond on a current trial is not counted towards a scoring criterion. Statistically, only four times in 1,000 trials will eight consecutive correct responses occur by chance in a two-choice situation (Kerr et al., 1977). Thus, meeting the failure criterion can be interpreted as demonstrating genuine difficulty to learn, rather than chance responding or failure to respond.

Research on the ABLA Test

Research has indicated that the ABLA test has considerable potential as a diagnostic and training tool for those faced with the task of teaching developmentally disabled persons. Specifically, research indicates: (a) The ABLA tasks are hierarchically ordered as stated above, such that individuals who pass a certain level also pass at lower levels of the hierarchy, and those who fail a certain level of discrimination also fail at higher levels (Martin, Yu,

Quinn, & Patterson, 1983; Yu, et al., 1989); (b) At a given ABLA level (such as visual discrimination, level 3), subjects either learn the task readily or with great difficulty. The pass (or fail) criterion is typically met within 30 trials or less. If a subject fails an ABLA level, then that level is very difficult to teach, often requiring hundreds of training trials before the discrimination level is acquired, if it is acquired at all, and despite the use of standard prompting and reinforcement procedures (Meyerson, 1977; Stubbings & Martin, 1994; Witt & Wacker, 1981; Yu & Martin, 1986); (c) The performance on the ABLA is highly predictive of the ease or difficulty with which subjects will learn certain educational and vocational analogue tasks (Yu et al., 1989; Wacker, 1981; Tharinger, Schallert, & Kerr, 1977).

Auditory Discriminations and Auditory Matching

While all levels of the ABLA are important, the ability to make auditory discriminations may be the most important of all. For example, auditory discrimination skill is required in order for individuals to learn to attend when their name is spoken, to learn to stop or go when directed, and to learn to follow instructions in the variety of training programs to which they might be exposed. The ability to make auditory discriminations is also prerequisite to learning more complex language discriminations such as those involved in receptive and expressive speech (Casey & Kerr, 1977; Meyerson, 1977).

Children who fail the auditory discrimination level of the ABLA also fail a reading readiness test (Meyerson, 1977). The acquisition of auditory discrimination skills, therefore, is of great importance to the developmentally disabled learners if they are to interact competently and independently with their environment, and in order for staff to go beyond the reliance on imitation and physical guidance as primary instruction tactics (Hupp, Mervis, & Conroy-Gunter, 1986; Witt & Wacker, 1981).

Why is it that it takes hundreds of training trials, using standard prompting and reinforcement procedures, for clients to master failed auditory discriminations on the ABLA, if they master them at all (Meyerson, 1977; Witt & Wacker, 1981; Yu et al., 1989)? One possibility is that the ABLA test, as currently structured, is missing a critical skill between level 4, visual match-to-sample, and level 5, auditory discrimination. The missing level may be that of auditory match to sample (Walker, Lin & Martin, in press).

A Test of Auditory Matching

Walker et al. (in press) devised a test to assess a subject's ability to readily learn an auditory match-to-sample discrimination. In their procedure, two bells and two tambourines are used with one of each placed on a table in front of a subject and the other two placed under the table. A subject is given a demonstration of the required response, a guided trial and a practice trial for

each stimulus. Test trials and scoring then begin.

On each test trial, the tester gives the verbal prompt ("make the same sound") while presenting the auditory stimulus by ringing the bell or hitting the tambourine (that are hidden under the table) continuously for about 10 seconds (with each sound about 3 seconds apart). A response is defined as correct if the subject makes the matching sound during the period in which the verbal prompt and the auditory stimulus are presented. A response is defined as incorrect if the subject makes the incorrect sound (e.g., the tester hits the tambourine under the table and the subject rings the bell on the table). If the subject does not respond within 10 seconds, the tester discontinues the trial by moving the stimuli away from the table and turning away from the subject for a few seconds. Then a new trial begins. The identity of the correct stimulus is randomly alternated across trials.

Following correct responses, praise and other intermittent reinforcers (e.g., popcorn) are provided. Incorrect responses are followed by the error correction procedure as in the ABLA test (Kerr et al., 1977). A failure to respond is not scored. These procedures continue until either eight consecutive correct responses occur (passing criterion) or eight cumulative errors occur (failure criterion). These scoring, passing, and failure criteria are those used in the ABLA test.

Research by Walker et al. (in press) suggests that the new auditory matching level falls between levels 4 and 5 on the ABLA test. In their study, all of the 16 subjects who passed the auditory discriminations (levels 5 & 6) also passed the auditory matching test. All of the seven subjects who passed only the visual discrimination test (level 3) or lower failed the auditory matching test. Of the eight subjects whose highest ABLA level passed was the visual match-to-sample test (level 4), five failed the new auditory matching level, and the other three passed the new level.

In a second experiment, Walker et al. (in press) identified eight subjects who passed levels 1 through 4 of the ABLA test, but failed levels 5 and 6. Of these subjects, four passed and four failed the test of auditory matching. All eight were then assessed for their ability to match five pairs of common sounds. The four subjects who passed the test of auditory matching were all able to match common sounds, while the four subjects who failed the test of auditory matching were unable to match the common sounds. These results suggest that the test of auditory matching may have predictive validity comparable to the other ABLA levels.

The addition of auditory matching to the ABLA test may have important implications in two areas. First, it might increase the predictive validity and diagnostic value of the ABLA test. Second, auditory matching skills may be

an important prerequisite in making it easier for subjects to learn auditory discrimination skills. Additional research is needed to examine these possibilities.

One additional study provided further information concerning the predictive validity of the auditory matching test. Barker (1993) studied three subjects whose highest ABLA was level 4. Two of these subjects failed the test of auditory matching, and one subject passed the test. These three subjects were then assessed for their ability to match speech sounds. In one assessment, the experimenter spoke a word rapidly in a high tone (e.g., "pen") and a subject was given the opportunity to press a button connected to a tape recorder that repeated the same word, or to press a different button connected to a second tape recorder that presented a different word spoken slowly in a low tone (e.g., "b-l-o-c-k"). The subject who passed the test of auditory matching learned to correctly match live-to-taped speech sounds, while the two subjects who failed the test of auditory matching were unable to learn this task.

In a second assessment of ability to match speech sounds, an item was placed in front of the subject. Barker then spoke the name of the item rapidly in a high tone for several times (e.g., "hat, hat, hat"). A second tester repeated the same auditory cue (e.g., "hat, hat, hat"), while a third tester repeated the name of a different object slowly and in a low tone (e.g., "s-p-o-o-n, s-p-o-o-n,

s-p-o-o-n"). The subject was required to demonstrate an ability to match live speech sounds to live speech sounds by handing the object named by the tester to the person who repeated the name of that object. Interestingly, the subjects who passed level 4 but failed levels 5 and 6 on the ABLA test, the auditory matching test, and live-to-taped speech sound test were unable to pass the live-to-live speech matching test. Moreover, of seven subjects who passed levels 5 or 6 of the ABLA as well as the test of auditory matching, all of them were able to match live-to-taped speech sounds, but only two of them were able to match live-to-live speech sounds, and those were two of the subjects who passed level 6.

Considering the experiments that assessed the predictive validity of auditory matching, Walker et al. (in press) only assessed the predictive validity of the test for auditory matching on the ability of subjects to match pairs of common sounds. The ability to match speech sounds was not assessed. Moreover, in their second experiment, subjects were assessed who had passed up to level 4 only. Subjects who had passed levels 5 and 6 on the ABLA were not included in their experiment. In the study by Barker (1993), subjects were assessed for their ability to match live-to-taped speech sounds or live-to-live speech sounds, but they were not assessed for their ability to match common sounds. Moreover, Barker included only three subjects who had passed levels

1 through 4, but failed levels 5 and 6 of the ABLA. Only one of these three subjects passed the test of auditory matching. Thus, while research to date suggests that the test for auditory matching may have some predictive validity, additional research in this area is needed.

Statement of the Problem

The purpose of the current research was to use multiple measures with subjects of varied abilities to further examine the predictive validity of the auditory matching discrimination test that has been proposed by Walker et al. (in press) as an addition to the ABLA test.

As indicated previously, research on the other levels of the ABLA indicates that clients will learn with relative ease behaviors that require a discrimination level that has been passed, but experience great difficulty in learning a task that requires a discrimination level that was failed (Yu et al., 1989). If the test of auditory matching skills is a worthwhile addition to the ABLA levels, it must be demonstrated that these generalizations hold for the auditory matching level.

It was hypothesized that the pass or fail performance of subjects on the auditory matching test would predict their performance on several other auditory matching tasks (matching common sounds and speech sounds). This finding would pave the way for further research to determine if the test of auditory matching is a worthwhile addition to the ABLA hierarchy.

In addition, assessments were also conducted within speech sound matching tests and the possibility of requirement of different functioning abilities to perform live-to-taped speech matching and live-to-live speech matching tests was explored.

Method

Subjects and Setting

Moderately and severely developmentally disabled residents from the St. Amant Center were assessed on the ABLA test and the test of auditory matching until three groups, with four subjects in each group, were identified.

Group 1 was composed of those who passed levels 1 through 4 of the ABLA test, but failed levels 5 and 6 as well as the test of auditory matching. Group 2 was composed of those who passed levels 1 through 4 of the ABLA test and the auditory matching test, but failed levels 5 and 6 of the ABLA test. Group 3 was composed of those who passed all the levels on the ABLA as well as the auditory matching test. These groups were then assessed for their abilities to match common sounds, live-to-taped speech sounds and live-to-live speech sounds.

All sessions were conducted at the St. Amant Centre. During sessions a subject was seated either across from or beside the tester, and one or two research assistants were seated beside the subject.

Materials

The materials used for the ABLA test consisted of a yellow can measuring 13 cm in diameter and 16.5 cm in height, a red box measuring 15 cm x 15 cm x 10 cm, a small piece of irregularly shaped green sponge, a small yellow wooden cylinder and a small red block.

The materials for the auditory-matching test consisted of two tambourines and two bells.

The materials for matching common sounds were arranged in three pairs. Pair 1 consisted of two squeaky toys and two sets of keys. Pair 2 consisted of two cups with three wooden balls in each and two noise making boxes. Pair 3 consisted of two tambourines and two wooden toy bells.

The materials for matching live-to-taped speech sounds included two identical tape recorders whose electrical source consisted of four AA batteries. A wooden button was connected to each tape recorder. The circuit formed between the batteries and the battery housing of each tape recorder could be altered to form a broken circuit. The play button on each tape recorder remained pressed throughout testing, so that depression of the wooden button would allow the recorder to play. The speech stimuli for matching assessments were tapes recorded before the test. To aid discrimination between the two buttons, one button was colored red and the other yellow.

Auditory matching during the first live-to-taped test involved the words "pen" (said rapidly in a high voice) and "b-l-o-c-k" (said slowly in a low voice). Auditory matching during the second live-to-taped test involved the words "spoon" and "hat". Auditory matching during the third live-to-taped test involved the words "cup" and "glass".

The words used for matching live-to-live speech sounds were the same as those used to match live-to-taped speech sounds. The materials for matching live-to-live speech sounds were arranged in three pairs. Pair 1 included a black pen and a red block. Pair 2 included a baseball hat and a metal spoon. Pair 3 included a red cup and a blue glass.

Data sheets designed for the ABLA test (see Appendix A), for the auditory matching test (see Appendix B), for matching common sounds (see Appendix C), for matching live-to-taped speech sounds (see Appendix D) and for matching live-to-live speech sounds (see Appendix E) were used for scoring subjects' pass or fail performance on each task.

Procedure

Following subject selection as described previously, all subjects were assessed for their ability to match common sounds, live-to-taped speech sounds, and live-to-live speech sounds.

Assessment of ability to match common sounds. A subject was seated

across from the tester in a session room. A pair of objects (such as a tambourine and a bell) was placed on the table in front of the subject, and a duplicate pair was placed under the table out of sight of the subject.

The tester provided a demonstration trial by making the sound of one of the stimuli (e.g., shaking the bell) under the table for about 10 seconds (with each sound about 3 seconds apart) while saying, "make the same sound" and then shaking the bell on the table to make the matching sound.

Following the demonstration trial a guided trial was presented, in which the tester shook the bell under the table while saying, "make the same sound", and then guided the subject to shake the bell on the table to match the sound.

Following the guided trial a practice trial was presented in which the tester shook the bell under the table while saying "make the same sound". The subject was required to make an independent response by shaking the bell on the table. The demonstration, guided and practice trials were then conducted with the other stimulus (tambourine). All correct responses were reinforced with praise.

If the subject made a correct response on the practice trial for each stimulus, the test trials and scoring would begin. A correct response occurred when the subject made the sound which matched the stimulus presented by the tester. Each correct response was reinforced by praise. During some sessions

other intermittent reinforcers (e.g., popcorn) were presented on approximately a variable ratio 4 schedule (e.g., presenting a reinforcer following 3-5 correct responses).

If some subjects had difficulty in moving their fingers or shaking the objects, touching or hitting the objects for several seconds instead of shaking the objects were counted as responses.

An incorrect response occurred when the subject made the sound which did not match the stimulus presented by the tester. For each incorrect response during practice and test trials, a correction procedure was conducted by presenting a demonstration, a guided trial and then a practice trial. Testing continued until a passing criterion (eight consecutive correct responses) or failure criterion (eight cumulative incorrect responses) was met.

On correction trials, errors were counted towards the failure criterion but correct responses were not counted towards the passing criterion. A failure to respond on a trial was not counted in the scoring criteria because such an outcome did not provide information on the subject's ability to make a correct response.

If the subject made no response during the period in which the stimuli were presented, or emitted other undesirable behaviors during testing, an extinction procedure was conducted in which the tester moved the stimuli away

from the table and turned away from the subject for a few seconds, and then started a new trial. If the subject refused to make any responses over several trials, the test was discontinued and rescheduled.

The scoring, and pass/fail criteria were the same as those used for testing the six levels on the ABLA test mentioned previously.

Assessment of matching live-to-taped speech sounds. The procedure used was that described by Barker (1993). The tester was seated across from the subject. Two wooden buttons (each of a different color) were placed 25 cm apart on a table top and remained in a stable position throughout testing. Each button was connected to a tape recorder placed under the table out of the sight of the subject.

The test of matching live-to-taped speech sounds involved three pairs of sounds. Pair 1 was "pen" and "block". Pair 2 was "spoon" and "hat". Pair 3 was "cup" and "glass". For a test tried on each pair of the sounds, the tester presented either one sound rapidly in a high tone (e.g., "pen") or the other slowly in a low tone (e.g., "b-l-o-c-k"). In each task, the tester produced an auditory cue for approximately 10 seconds with each sound 3 seconds apart, and then instructed the subject to "make the same sound". The subject was required to respond by pressing one of the two buttons.

A correct response occurred if the subject pressed the button which

produced the sound matching the cue presented by the tester. For example, if the tester said pen, pen, pen, the subject was said to respond correctly by pressing the button which played the same sound presented by the tester. An incorrect response occurred if the subject pressed the button which produced a sound that did not match the cue presented by the tester.

A demonstration, a guided trial and a practice trial were performed at the beginning of each task. The scoring, pass/fail criteria, reinforcement, extinction and correction procedures were the same as those used in the ABLA and auditory matching tests.

Matching live-to-live speech sounds. The procedure used was that described by Barker (1993). A subject was seated adjacent to the tester. Two research assistants were seated in a fixed position across from and within easy reach of the subject while keeping their palms open throughout the test.

The tester presented a stimulus object and corresponding auditory cue either rapidly in a high tone (e.g., "pen, pen, pen") or slowly in a low tone (e.g., "b-l-o-c-k, b-l-o-c-k, b-l-o-c-k"). The two research assistants would produce auditory cues in a randomized fashion such that assistant A produced a cue matching that of the tester on some trials and assistant B produced the cue matching that of the tester on the remaining trials.

A correct response was scored if the stimulus object was placed into the

open palm of the assistant who produced an auditory cue matching that of the tester. For example, if the tester said pen, pen, pen, the subject responded correctly if he/she placed the pen into the palm of the assistant who also said pen, pen, pen rather than the assistant who said b-l-o-c-k, b-l-o-c-k, b-l-o-c-k. An incorrect response was scored if the subject put the stimulus object into the palm of the assistant who produced an auditory cue which did not match that of the tester.

The demonstration, guided trial, practice trial, scoring and fail/pass criteria, reinforcement, extinction, and correction procedures were the same as those used in the ABLA and the auditory matching tests.

Interobserver Reliability Assessments

Interobserver reliability data were collected for 35% of the test sessions, during which one or two research assistant independently recorded subjects' responses concurrently with the tester. The scoring criteria and the data sheets used by the observer were identical to those used by the tester. Results obtained by the tester and the research assistant were compared to obtain a measure of interobserver agreement. The interobserver agreement score was determined by dividing the number of the agreements between the tester and observer by the total number of agreements plus disagreements, and multiplying by 100%. (Martin & Pear, 1992). The interobverser reliability

agreement was 100% in all sessions.

Results

The results are presented in Table 1. As can be seen in Table 1, Group 1 subjects, who passed level 4 on the ABLA test but failed the auditory matching level, failed to perform any of the other auditory matching tasks; Group 2 subjects, who passed level 4 on the ABLA test and the auditory matching test, were able to learn readily to match common sounds and live-to-taped speech sounds but unable to match live-to-live speech sounds; Group 3 subjects, who passed all levels on the ABLA and the auditory matching tests, were able to match common sounds, live-to-taped speech sounds and live-to-live speech sounds.

Kerr et al. (1977) indicated that only four times in 1,000 trials will eight consecutive responses occur by chance in a two-choice discrimination. Since the pass/fail criteria used were the same as those used by Kerr et al, it was highly unlikely that the results obtained could occur by chance.

Discussion

The results of the current study support four generalizations. First, the results confirm the findings of Walker et al. (in press) that their auditory matching test was positioned between level 4 and level 5 on the ABLA hierarchy. That is, considering the subjects in the present study who passed

Table 1

Scores of Subjects on the ABLA Test, Auditory Matching TestMatching Common Sounds, Live-to-Taped Matching Test, and Live-to-LiveMatching Test

Subject	Highest ABLA Level Passed	Auditory Matching Test	Matching Common Sounds	Live-to-Taped Matching	Live-to-Live Matching
Group 1					
1	4	F	F	F	F
2	4	F	F	F	F
3	4	F	F	F	F
4	4	F	F	F	F
Group 2					
5	4	P	P	P	F
6	4	P	P	P	F
7	4	P	P	P	F
8	4	P	P	P	F
Group 3					
9	6	P	p	p	p
10	6	P	p	p	p
11	6	P	p	p	p
12	6	P	p	p	p

Note. F = fail; P = pass.

level 4 but failed levels 5 and 6 on the ABLA test, some of them failed the auditory matching test, while the others passed the auditory matching test.

The second generalization is that the results extend the predictive validity of the auditory matching test beyond the results reported by Walker et al. (in press). The subjects in Group 1 who failed the auditory matching test also failed to match common sounds and live-to-taped speech sounds. The subjects in Groups 2 and 3 who passed the auditory matching test were also able to match common sounds and live-to-taped speech sounds.

The third generalization is that live-to-taped speech sound matching appears to be easier than both auditory discriminations (levels 5 & 6) and live-to-live speech sound matching. That is, the subjects in Group 2 who passed the auditory matching test but failed levels 5 and 6 on the ABLA test were able to pass common sound matching and live-to-taped speech matching, but were unable to pass live-to-live speech matching. However the subjects in Group 3 who passed the auditory matching test and levels 5 and 6 on the ABLA test passed both the live-to-taped speech matching and the live-to-live speech matching.

The fourth generalization is that the live-to-live speech matching is at least as difficult as levels 5 and 6 on the ABLA test. That is, the subjects in Groups 1 and 2 who failed the levels 5 and 6 on the ABLA test also failed to match live-to-live speech sounds even though the subjects in Group 2 were able to match live-to-taped speech sounds. The subjects in Group 3 who passed levels 5 and 6 on the ABLA test were

also able to pass live-to-live speech matching.

The finding that all the subjects in Group 3 who passed levels 5 and 6 on the ABLA test also passed live-to-live speech sound matching is not completely consistent with the results reported by Barker (1993). In her study, of five subjects who passed levels 5 and 6 on the ABLA test, only two of them passed the live-to-live speech sound matching, while the other three subjects failed the live-to-live speech sound matching. Since only nine subjects (across this study and Barker's study) who passed levels 5 and 6 on the ABLA test have been assessed on live-to-live speech sound matching, more research needs to be undertaken to decide if live-to-live speech sound matching is clearly more difficult than levels 5 and 6 on the ABLA test.

How might we explain the first three generalizations described above? That is: (a) Why is the auditory matching test more difficult than the visual discrimination task of level 4 on the ABLA test? (b) Why are both the auditory matching test and live-to-taped speech sound matching easier than the auditory discrimination of level 5 on the ABLA test? (c) Why are the auditory matching test and live-to-taped speech sound matching easier than live-to-live speech sound matching (which is at least as difficult as level 6 on the ABLA test)?

The behavioral analysis of the antecedents, behavior and consequences on a reinforced trial of ABLA and auditory matching tasks shown in Table 2 may help to answer these questions. In Table 2, the responses appear to be of equal difficulty. But there are some clear differences in antecedents and consequences between some of

Table 2

A Behavioral Analysis of the Antecedents, Behavior, and Consequences
on a Reinforced Trial of ABLA and Auditory Matching Tasks

Type of Discrimination	Antecedents	Behavior	Consequences
simple visual	<i>Visual Discrimination, ABLA Level 3</i> Yellow Can and Red Box	Put foam in yellow can	Praise
conditional, simultaneous, within-modality (visual), identity match	<i>Visual Match-to-Sample, ABLA Level 4</i> <i>Sample: Red Cube</i> <i>Comparisons: Yellow Can, Red box</i>	Put red cube in red box	Praise
conditional, simultaneous, across-modality (simple sound, visual), non-identity match	<i>Walker et al. Auditory Matching Task</i> <i>Sample: Bell sound</i> <i>Comparisons: Bell, Tambourine</i>	Hit bell	A natural matching sound Praise
conditional, simultaneous, across-modality (speech sound, visual), non-identity match	<i>Live-to-Taped Speech Sound Matching</i> <i>Sample: "pen" (spoken)</i> <i>Comparisons: Yellow Button, Red Button</i>	Hit yellow button	A tape-recorded matching sound Praise
conditional, delayed, across-modality (speech sound, visual), non-identity match	<i>Auditory Discrimination, ABLA Level 5</i> <i>Sample: "red box" (spoken)</i> <i>Comparisons: Red Box, Yellow Can</i>	Put foam in red box	Praise
conditional, delayed, within-modality (speech sound, speech sound), identity match	<i>Live-to-Live Speech Sound Matching</i> <i>Sample: "pen, pen, pen" (spoken by tester)</i> <i>Comparisons: "pen, pen, pen" (spoken by Individual A); "block, block block" (spoken by Individual B)</i>	Give pen to person saying "pen, pen, pen"	Praise

the tasks.

Regarding the first question of why the auditory matching test is more difficult than level 4 on the ABLA test, we can see from Table 2 that these two tasks have different antecedent requirements. In level 4 on the ABLA test, subjects had to respond to two items of the same color and shape (a visual identity match). In the auditory matching test, the subject had to listen to the sound, then look at and hit the bell, and there was no physical similarity between the bell sound and the sight of the bell (an across-modality, non-identity match). Thus, the auditory matching test appears to be a more complex discrimination than level 4 of the ABLA test.

Regarding the second question, why are both auditory matching and live-to-taped matching tests easier than the auditory discrimination at level 5 on the ABLA test? In Table 2 we see differences in both antecedents and consequences between these tasks. At the antecedent level, the auditory matching (both the auditory and live-to-taped matching) tests and level 5 are identical except that level 5 is a delayed discrimination and the matching tasks are simultaneous (or at least less delayed). Delayed discriminations are likely to be more difficult for mentally retarded persons (Bonta & Watters, 1983). The consequences of a correct response also differed between level 5 and the matching tasks. In level 5, a correct response was only reinforced by praise. However, in the auditory matching and live-to-taped matching tests, in addition to praise, a matching sound was produced by the subjects' banging the appropriate object (e.g., bell) or pressing the appropriate button (which activated the tape recorder).

That this "extra" consequence may be important can be seen by examining the response-reinforcer relationship in terms of functionality involved in these tests. When a reinforcer is simply delivered following a correct response, the response-reinforcer relationship is said to be arbitrary. But when a response leads to discovering or producing a reinforcer, then the response-reinforcer relationship is said to be functional. Switching from an arbitrary response-reinforcer relationship to a functional response-reinforcer relationship may lead to a more rapid response acquisition (Williams, Koegel & Egel, 1981). For example, in a study conducted by Williams et al. (1981), an autistic child was required to discriminate a pink box from a green box. During the arbitrary condition, the therapist placed a candy in the child's mouth each time the child responded correctly (e.g., by picking up the pink box when instructed to "Pick up pink"). After many trials, the child did not acquire the correct discrimination. But when the condition changed to a functional response-reinforcer relationship (i.e., a candy was placed under the pink box and picking up the box led to obtaining the candy), the child's correct responses increased rapidly. In levels 5 and 6 on the ABLA test, the response-reinforcer relationship is arbitrary in that a correct response (e.g., to put the foam in the red box following the auditory cue "red box") is simply followed by praise. While in the auditory matching test and live-to-taped matching test, the response-reinforcer relationship is functional in that the behavior, for example, of hitting the bell, also produced a matching sound (which is likely a conditioned reinforcer), and this difference may have made the discrimination in the

auditory matching tests easier to learn than levels 5 and 6 on the ABLA test.

Regarding the third question, why are the auditory matching and live-to-taped speech matching tests easier than the live-to-live speech matching test? In terms of antecedents, there are two differences between these discriminations. First, the live-to-live test is a delayed discrimination while the auditory matching and live-to-taped tests are simultaneous (or at least less delayed) discriminations. Second, in the auditory matching and live-to-taped tests, the subject hears a single sound and then matches it to a visual stimulus. However, in the live-to-live test, the subject hears a spoken word and must then match it to that sound spoken by a different person. Perhaps this latter type of discrimination is more difficult. In terms of consequences, live-to-live matching leads to praise, an arbitrary response-reinforcer relationship. However the other matching tasks, as described previously lead to both praise and the matching sound. The latter is a functional response-reinforcer relationship. This difference might explain why the auditory matching and live-to-taped matching are easier than live-to-live matching.

Considering the potential benefits of mastering all levels on the ABLA test including the auditory matching test, future research might focus on three areas. First, studies might examine ways to program generalization of auditory matching ability across a variety of auditory matching tasks. Second, research is needed to assess the value of testing auditory matching as a prerequisite to teaching levels 5 and 6 on the ABLA test to subjects who have failed these levels. Third, the possibility that the

live-to-live speech sound matching may be more difficult than level 6 on the ABLA test might be further explored.

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Appendix A

Data Sheet For ABLA Test

Subject _____ Tester _____ Observer _____ Date _____

Level 1 (imitation)

Yellow Can: 1 2 3 4 5 6 7 8 9 10 11 12 13 14
 Red Box: 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Level 2 (position discrimination)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

Level 3 (Visual)

L R L L R L R R R L L R L R R L L
 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

L R L R R R L R L L R L L R R L
 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33

Level 4 (Match to Sample)

R R L R L L R L L L R R R L C
 B B C C B B C B C B C B B 1 2
 3 4 5 6 7 8 9 10 11 12 13 14
 L R L R R L R L R L L R R L C
 C C B C B B B B C C C B B 15 16
 17 18 19 20 21 22 23 24 25 26 27

Level 5 (Auditory)

B B C B C C B C C B C C B C B C B B 1
 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
 C B B C B B C B C C B C C B C B B C
 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37

Level 6 (AVC)

R R L L R R L L L L R R L L R R L L R B
 C C B C B C B C C B C B B B C C C B 1 2
 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

L L R L R R L L R R L L R L L R R L C
 B B C B B C C B C C B B C C B B C
 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37

Appendix B

Data Sheet For Auditory Matching Test

Name: _____

Tester: _____

Observer: _____

Date: _____

T B B T B T B T

T B T B B T B B

T B T T B T T B

T T B T B B T B

B T B B T B T T

T = tambourine sound

B = bell sound

Appendix C

Data Sheet For Matching Common SoundsSubject _____
Observer _____Tester _____
Date: _____

Pair 1

S	K	K	S	K	S	K	S	S	K	S	K	K	S	K	K	S	K	S	S
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
K	S	S	K	S	S	K	S	K	K	S	K	K	S	K	K	S	K	S	
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	

Pair 2

C	B	B	C	B	C	B	C	C	B	C	B	B	C	B	B	C	B	C	C
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
B	C	C	B	C	C	B	C	B	B	C	B	B	C	B	B	C	B	C	
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	

Pair 3

T	B	B	T	B	T	B	T	T	B	T	B	B	T	B	B	T	B	T	T
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
B	T	T	B	T	T	B	T	B	B	T	B	B	T	B	B	T	B	T	
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	

Pairs of Stimuli:

Pair 1: a Squeaky toy and a set of Keys.Pair 2: a Cup with balls and a noise making Box.Pair 3: a Tambourine and a wooden Bell.

Appendix D

Data Sheet For Matching Live-to-Taped Speech SoundsName: _____
Tester: _____Date: _____
Observer: _____

Pair 1 (pen and block)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
P	B	B	P	B	P	B	P	P	B	P	B	B	P	B	B	P	B	P	B
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
P	P	B	P	P	B	P	P	B	P	B	B	P	B	B	P	B	B	P	P

Pair 2 (spoon and hat)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
S	H	H	S	H	S	H	S	S	H	S	H	H	S	H	H	S	H	S	H
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
S	S	H	S	S	H	S	S	H	S	H	H	S	H	H	S	H	H	S	S

Pair 3 (cup and glass)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	G	G	C	G	C	G	C	C	G	C	G	G	C	G	G	C	G	C	G
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
C	C	G	C	C	G	C	C	G	C	G	G	C	G	G	C	G	G	C	C

Notes:

In Pair 1, P= pen , B= block;

In Pair 2, S= spoon, H= hat;

In Pair 3, C= cup, G= glass.

Appendix E

Data Sheet For Matching Live-to-Live Speech Sounds

Name: _____ Date: _____ Tester: _____ Observer: _____

Pair 1 (pen and block)

#:1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
T:P	B	B	P	P	B	B	P	B	P	B	P	B	B	P	B	B	P
A:P	P	B	P	B	B	P	B	B	B	P	P	P	B	B	P	B	B
B:B	B	P	B	P	P	B	P	P	P	B	B	B	P	P	B	P	P

#:19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
T:P	P	B	P	B	B	B	B	P	P	P	B	B	P	B	B	P	P	P	B	B
A:P	B	P	P	B	P	B	P	B	B	P	P	B	B	B	P	B	B	P	P	B
B:B	P	B	B	P	B	P	B	P	P	B	B	P	P	P	B	P	P	B	B	P

Pair 2 (spoon and hat)

#:1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
T:H	S	S	H	H	S	S	H	S	H	S	H	S	S	H	S	S	H
A:H	H	S	H	S	S	H	S	S	S	H	H	S	S	S	H	S	S
B:S	S	H	S	H	H	S	H	H	H	S	S	S	H	H	S	H	H

#:19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
T:H	H	S	H	S	S	S	S	H	H	H	S	S	H	S	S	H	H	H	S	S
A:H	S	H	H	S	H	S	H	S	S	H	H	S	S	S	H	S	S	H	H	S
B:S	H	S	S	H	S	H	S	H	H	S	S	H	H	H	S	H	H	S	S	H

Pair 3 (cup and glass)

#:1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
T:G	C	C	G	G	C	C	G	C	G	C	G	C	C	G	C	C	G
A:G	G	C	G	C	C	G	C	C	C	G	G	G	C	C	G	C	C
B:C	C	G	C	G	G	C	G	G	G	C	C	C	G	G	C	G	G

#:19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
T:G	G	C	G	C	C	C	C	G	G	G	C	C	G	C	C	G	G	G	C	C
A:G	C	G	G	C	G	C	G	C	C	G	G	C	C	C	G	C	C	G	G	C
B:C	G	C	C	G	C	G	C	G	G	C	C	G	G	G	C	G	G	C	C	G

Note:

T=tester; A=assistant A; B=assistant B;
 In Pair 1, P=pen, B=block;
 In Pair 2, S=spoon, H=hat;
 In Pair 3, G=glass, C=cup.