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The Hierarchical Relationship Between Several Visual and Auditory Discriminations and Three Verbal Operants among Individuals with Developmental Disabilities

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This study examined the relationship between performance on the Assessment of Basic Learning Abilities test (ABLA), two auditory matching tasks, and a test of echoics, tacts, and mands with persons with developmental disabilities. It was found that discrimination skill (visual, auditory–visual, and auditory–auditory discriminations) was a better predictor of performance on verbal operant assessments than level of functioning based on diagnosis. The results showed high test–retest reliability for the test of verbal operants and no hierarchical relationship was found among the three verbal operants. The results suggest that the ABLA Level 6 might be a possible bridging task for teaching echoics, tacts, and mands. Further research is needed to ascertain the relation between the auditory matching tasks and the verbal operants.

During the 1970s, a number of behavioral language programs were developed for persons with autism or mental retardation that incorporated vocal imitation as the first step, followed shortly by tact training (Drash & Leibowitz, 1973; Guess, Sailor, & Baier, 1976; Kent, 1974; Lovaas, 1977). More recently, there have been suggestions and some supportive research that such programs might more successfully begin with mand training (Drash, High, & Tudor, 1999; Sundberg & Michael, 2001). However, before attempting to teach such verbal operants to individuals with autism or developmental disabilities, it may be beneficial to teach some auditory discriminations as bridging skills. As a first step to identifying potential bridging skills, we examined the pass-fail performance on the Assessment of Basic Learning Abilities (ABLA) test (Kerr, Meyerson, & Flora, 1977), two prototype auditory matching tasks, and a test of echoics, tacts, and mands with a sample of persons with developmental disabilities. We also assessed the test-retest reliability of the test of the three verbal operants.

Kerr et al. (1977) developed the ABLA test to assess the ability of persons with developmental disabilities to learn the basic discriminations that appear to underlie many training tasks. When administering the ABLA test, the tester attempts to teach a client to perform a simple imitation task, a two-choice position discrimination, two two-choice visual discriminations, and two two-choice auditory–visual discriminations. A description of the ABLA tasks (referred to as levels) is presented in Table 1. When testing a level, a client is first given a demonstration followed by a guided trial, and an opportunity for an independent response. Formal testing of a level begins after an independent correct response occurs to the sample stimuli for that level. Across trials, correct responses are reinforced and errors are followed by an error-correction procedure (a demonstration, a guided trial, and an opportunity for an independent response). Testing on a level continues until a client achieves a pass criterion of eight consecutive correct responses, or a failure criterion of eight cumulative errors.

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Table 1

ABLA Levels	Type of Discriminations
1. *Imitation:* A tester puts an object into a container and asks the client to do likewise.	A simple imitation
2. *Position Discrimination:* When a red box and a yellow can are presented in a fixed position, a client is required to consistently place a piece of beige foam in the container on the left when the tester says, "Put it in."	A simultaneous visual discrimination with position, color, shape, and size as relevant cues
3. *Visual Discrimination:* When a red box and a yellow can are randomly presented in left–right positions, a client is required to consistently place a piece of beige foam in the yellow can when the tester says, "Put it in."	A simultaneous visual discrimination with color, shape, and size as relevant cues
4. *Match-to-Sample Discrimination:* A client demonstrates Level 4 if, when allowed to view a yellow can and a red box in randomly alternating left–right positions, and is presented randomly with a yellow cylinder and a red cube, he/she consistently places a yellow cylinder in the yellow can and red cube in the red box.	A conditional visual–visual quasi-identity discrimination with color, shape, and size as relevant cues
5. *Auditory Discrimination:* When presented with a yellow can and a red box (in fixed positions), a client is required to consistently place a piece of foam in the appropriate container when the tester randomly says, "red box" (in a high pitched rapid fashion) or "yellow can" in a low pitched drawn-out fashion).	A conditional auditory–visual nonidentity discrimination, with pitch, pronunciation, and duration as relevant auditory cues, and position, color, shape, and size as relevant visual cues
6. *Auditory Visual Discrimination:* The same as Level 5, except that the right–left position of the containers is randomly alternated.	A conditional auditory–visual nonidentity discrimination, with the same auditory cues as Level 5, and with only color, shape, and size as relevant cues

Note. From "Overview of Research on the Assessment of Basic Learning Abilities Test," by Martin, G. L., & Yu, D. C. T, 2000. *Journal on Developmental Disabilities, 7*, 14–15. Reprinted with permission.

Research on the ABLA test indicates that: (a) the test levels are hierarchically ordered in difficulty for persons with developmental disabilities (Kerr et al., 1977; Martin, Yu, Quinn, & Paterson, 1983), children with autistic spectrum disorders (Ward & Yu, 2000), hearing impaired, multiple handicapped persons (Wacker, 1981), and typically developing children (Casey & Kerr, 1977); (b) failed ABLA levels are difficult to teach using standard prompting and reinforcement procedures (Conyers, Martin, Yu, & Vause, 2000; Meyerson, 1977; Stubbings & Martin, 1995, 1998; Wacker, Kerr, & Carroll, 1983; Wacker, Steil, & Greenbaum, 1983; Witt & Wacker, 1981; Yu & Martin, 1986); (c) pass-fail performances on ABLA levels have high predictive validity for performances on other tasks (Stubbings & Martin, 1995, 1998; Tharinger, Schallert, & Kerr, 1977; Wacker, Kerr et al., 1983; Wacker, Steil et al., 1983); (d) the ABLA is a better predictor of a client's learning performance than experienced staff with direct knowledge of that client (Stubbings & Martin, 1998); (e) mismatching of ABLA test level of clients to ABLA difficulty of training tasks results in more aberrant behaviors (Vause, Martin, & Yu, 1999; Vause, Martin, Cornick et al., 2000); and (f) direct-care staff with no knowledge of the ABLA test often mismatch the

ABLA test level of clients and the ABLA difficulty level of training tasks (DeWiele & Martin, 1996; Vause, Martin, Cornick et al., 2000). The ABLA test has proven to be a valuable tool for matching the learning ability of clients to the difficulty of training tasks for individuals with developmental disabilities (Martin & Yu, 2000).

Research has also shown that performance on the ABLA test correlates with language assessments. In a study with 42 typically developing children (aged 13–35 months), children within matched age groups (five-month blocks) who passed ABLA level 6 performed significantly better on several measures of verbal skills than the age-matched children who failed ABLA level 6 (Casey & Kerr, 1977). In another study, individuals with developmental disabilities who passed ABLA levels 5 and 6 communicated using two or more words, while those classified as lower than ABLA levels 5 and 6 communicated using one word or less (Ward, 1996). In other studies with persons with developmental disabilities (Barker-Collo, Jamieson, & Boo, 1995), passing ABLA levels 5 and 6 was significantly correlated with scores on receptive and expressive communication subdomains of the Vineland Adaptive Behavior scales (Sparrow, Balla, & Cicchetti, 1984) and with the communication status survey (Barker-Collo, 1996). Recently, Richards, Williams, and Follette (2002) also reported significant and positive correlations between the ABLA test and Vineland communication, daily living, and social skills subdomains. Moreover, they found that neither the Vineland nor the WAIS-R was sensitive in differentiating individuals below ABLA level 6. All 12 participants who scored below ABLA Level 6 were untestable on the WAIS-R and showed low age equivalent scores on the Vineland with limited range.

Recently, we examined whether additional auditory discriminations may be worthwhile additions to the ABLA test. Considering that the ability to imitate sounds is one of the verbal operants typically taught in language training programs for children with autism and developmental disabilities, and considering that the ability to recognize that two sounds are the same is a part of accurate vocal imitation, we assessed two prototype auditory matching tasks for their relationship to each other and to the ABLA levels. An auditory–auditory identity matching (AAIM) prototype task requires a tester to say a word (e.g., "pen"), while one assistant says the same word ("pen") and a second assistant says a different word ("block"). The client must learn to point to the assistant who spoke the word that matched that of the tester. An auditory–auditory nonidentity matching (AANM) prototype task requires a tester to say "ball" on some trials and "ice" on other trials. Two assistants say either "field" or "rink." The client must learn to point to the assistant who says "rink" when the tester says "ice," and to point to the assistant who says "field," when the tester says "ball." Although both AAIM and AANM involved matching auditory stimuli, both tasks include auditory–visual discriminations. Our research (Harapiak, Martin, & Yu 1999; Harapiak, Yu, & Martin, 2001; Vause, Martin, & Yu, 2000) indicates that: (a) AAIM is more difficult than ABLA level 6; (b) AANM is more difficult than AAIM; (c) the AAIM and AANM prototype tasks have good predictive validity for similar tasks; and (d) the addition of AAIM and AANM to the ABLA test differentiates communication ability (as measured by the Vineland Communication subscale and the Communication Status Survey) to a greater extent than does pass–fail performance on levels 5 and 6 of the ABLA test alone.

Although research has demonstrated that performance of ABLA levels 5 and 6 and the auditory matching tasks are correlated with global measures of communication ability such as scores of receptive and expressive communication on the Vineland Adaptive Behavior scales, no one has yet examined the relationship between performance on the ABLA test or the auditory matching tasks and the ability to perform specific verbal operants. The present research is a step in that direction. Specifically, we examined performance of a sample of persons with developmental disabilities on the ABLA test, the prototype tests for AAIM and AANM, and a test of echoics, tacts, and mands. We also examined one-month test–retest reliability of the test of the three verbal operants.

Method

Participants and Setting

Participants were recruited from the St. Amant Centre, a community and residential

training facility for persons with developmental disabilities, and community homes operated by the Centre. Characteristics of the 38 participants are presented in Table 2. They included (a) 14 participants who passed up to and including either ABLA Levels 3 or 4, but failed ABLA Levels 5 and 6, AAIM and AANM (referred to as the Visual group); (b) 13 participants who passed up to and including ABLA Level 6, but failed AAIM and AANM (referred to as the Auditory–Visual group); and (c) 11 participants who passed all ABLA levels and the auditory matching tasks (referred to as the Auditory–Auditory group). Participants 29 and 31 (see Table 2) passed all ABLA levels and AAIM but failed AANM. These 2 participants are included in the Auditory–Auditory group. Client consent was obtained as approved by the Psychology/Sociology Research Ethics Board of the University of Manitoba.

Participants residing at the main residential program of the Centre were assessed in a testing room. Participants residing in community homes were assessed in a room in their respective homes. For the ABLA testing and verbal operant assessments, the tester sat across from the participant and the observers were seated either beside or behind the tester. During the auditory matching assessments, the tester was seated beside the participant, and the assistants were seated across from the participant and tester.

Materials

The ABLA tasks. The ABLA materials consisted of a red box with black diagonal stripes, a yellow can, a small red wooden cube with black diagonal strips, a small yellow wooden cylinder, and a small piece of irregularlyshaped white foam.

The auditory matching tasks. For the AAIM and the AANM tasks, no materials were required.

Verbal operant assessment materials. No materials were needed for assessing echoics. For the tact assessment, 11 objects were used: a soup bowl, a metal teaspoon, a cup of juice, a small three-piece puzzle of a bear, a piece of beige foam, a red box with black stripes, a yellow can, a pen, a small Styrofoam cup, a cup of pudding, and a piece of paper. The materials for the mand assessment consisted of juice, a Styrofoam cup, pudding, a metal teaspoon, a red box with black stripes, a yellow can, a piece of white foam, a small three-piece puzzle, a pen, and a 21 x 28 cm sheet of paper. A small blue ball was used during all three verbal operant assessments.

Procedure

Assessment on the ABLA test. The ABLA test was administered as described by Kerr et al. (1977). Prior to the assessment of each ABLA level, a demonstration, a guided trial, and an opportunity for an independent response were provided. The testing of a level commenced after an independent correct response occurred to the stimuli for that level.

Praise and an edible reinforcer were provided after each correct response (placing the item in the correct container). Following an incorrect response, an error correction procedure (demonstration, guided trial, and independent response) was provided. The pass criterion for a level on the ABLA test consisted of eight consecutive correct responses and the fail criterion for a level consisted of eight cumulative errors.

Assessment on the AAIM prototype task. The tester said "pen-pen" in a high fast tone or "b-l-o-c-k" in a slow low tone. One assistant said the same word as the tester, and the other assistant said the other word. After hearing all words, the participant was required to point to the assistant who said the same word as the tester. The words uttered by the tester and assistants, and the order of which assistant spoke first were randomized across trials. The tester and assistants did not cover their mouths when speaking. Prompts at the start of the session, consequences following a correct or incorrect response and the pass/fail criteria were the same as for the ABLA test.

Assessment of AANM prototype task. The procedure was the same as described in the AAIM prototype task except that the word given by the tester was either "ball-ball" in a high fast tone, or "i-c-e " in a low slow tone. The words spoken by the assistants were either "field-field" in a high fast tone, or "r-i-n-k" in a low, slow tone. A correct response was defined as the participant pointing to the assistant who said "field-field" when the tester said "ball-ball", or pointing to the assistant who said "r-i-n-k" when the tester said "i-c-e." As in the

Table 2. Characteristics of Participants.

Participant	Sex	Age	Level of Adaptive Behavior[a]	Diagnostic Level[b]	ABLA, AAIM, AANM Level[c]	Sensory Deficits[b]
1	F	25	N/A	Severe	3	None
2	F	41	N/A	Severe	3	Left eye ptosis and double elevator palsy
3	F	34	Severe	Severe	3	Keratoconus in both eyes, does not wear glasses
4	M	32	Severe	Severe	3	None
5	F	32	Severe	Severe	4	Myopic, astigmatism, no glasses needed
6	F	33	Severe	Severe	4	Myopic, astigmatism, has been prescribed glasses
7	M	35	Severe	Profound	4	Keratoconus in right eye, light perception only
8	M	47	Severe	Severe	4	Myopic, astigmatis, no glasses needed
9	M	32	Severe	Severe	4	None
10	M	26	N/A	N/A	4	Wears corrective lenses
11	M	25	Severe	Moderate	4	None
12	M	24	Severe	Moderate	4	None
13	F	22	Severe	Severe	4	None
14	M	41	N/A	Moderate	4	None
15	M	44	Severe	Moderate	6	Left eye's optic nerve glaucoma, vision limited
16	F	46	Not specified	Moderate	6	None
17	M	26	Severe	Severe	6	Vision slightly worse in right eye/no corrective lenses
18	M	31	Severe	Severe	6	None
19	F	34	Severe	Severe	6	Wears corrective lenses

(Continued, p. 96)

Table 2 (*continued*).

Participant	Sex	Age	Level of Adaptive Behavior[a]	Diagnostic Level[b]	ABLA, AAIM, AANM Level[c]	Sensory Deficits[b]
20	M	35	Severe	Moderate	6	Cataract in right eye
21	F	35	Severe	Severe	6	Wears corrective lenses
22	F	28	Severe	Moderate	6	None
23	F	28	Severe	Moderate	6	Wears corrective lenses
24	F	28	Severe	Severe	6	None
25	M	32	Severe	Moderate	6	Uses hearing aid
26	M	25	Severe	Severe	6	Nearsighted
27	F	38	Severe	Severe	6	Moderate hearing loss*
28	F	27	N/A	Mild	AAIM/AANM	None
29	F	39	N/A	N/A	AAIM	Some hearing loss*
30	F	31	N/A	N/A	AAIM/AANM	Wears corrective lenses
31	F	41	Severe	Mild	AAIM	Wears corrective lenses
32	F	46	Not specified	Mild	AAIM/AANM	Wears corrective lenses
33	F	35	Severe	Moderate	AAIM/AANM	None
34	M	33	Severe	Mild	AAIM/AANM	Wears corrective lenses
35	M	30	Severe	Mild	AAIM/AANM	None
36	M	35	Severe	Severe	AAIM/AANM	Wears corrective lenses
37	M	36	Severe	Mild	AAIM/AANM	None
38	M	41	N/A	Mild	AAIM/AANM	Wears corrective lenses

[a] Scales of Independent Behavior—Short Form (Bruininks, Woodcock, Weatherman, & Hill, 1984).

[b] From agency records.

[c] ABLA = Assessment of Basic Learning Abilities Test, Level 3 = visual discrimination, Level 4 = visual matching-to-sample, and Level 6 = auditory–visual discrimination, AAIM = auditory–auditory identity matching, and AANM = auditory–auditory nonidentity matching.

* These individuals did not wear hearing aids but were responsive to normal speech produced clearly and at a consistent volume. However, it was not possible to assess the degree to which hearing deficits may have affected performance on auditory discrimination tasks.

AAIM prototype assessment, the words that were given by the tester and assistants as well as the order of which assistant spoke first were randomized across trials. Prompts at the start of the session, consequences for incorrect and correct responses, and the pass/fail criteria were the same as for the ABLA assessment.

Assessment of echoics and tacts. Eleven words and items were used during the echoic and tact assessments. Ten of the words and items (cup, juice, bowl, spoon, pudding, puzzle, pen, paper, box, and can) were selected from a list of the first 240 words recommended for teaching to children with developmental disabilities provided by Sundberg and Partington (1998). The eleventh word used was foam, which was chosen because of the use of a piece of foam in the ABLA test.

The echoic assessment consisted of the tester saying to a participant "Say____" (e.g., "Say juice"). A participant was required to vocally imitate the same word that was vocalized by the tester. The tact assessment consisted of the tester placing an item on the table and saying "What's this?" Upon hearing the cue, a participant was required to name the item. For both assessments, the response given by a participant was recorded as either correct (pronouncing all syllables correctly), an approximation (vocalizing part of the word as previously deemed acceptable by the tester), incorrect (not pronouncing any part of the word correctly), or an omission (no response after 10 seconds).

If a participant said a word correctly or approximated the word, verbal praise was given (e.g., "good job"). If the response was incorrect, the tester said "Thank you". No consequences followed an omission. The tester waited approximately five seconds between trials. To maintain attention throughout testing, an easy task was presented to the participant, and praise was provided after the completion of the task. Specifically, a ball was rolled to a participant after every third trial. When the tester rolled the ball, she said "Pick it up," and verbal praise was given when the participant picked up the ball, the participant then rolled the ball back to the tester, and verbal praise was again given. For both echoic and tact assessments, the same list of words was used and repeated in the same order three times, for a total of 33 trials.

Assessment of mands. The mand assessment involved creating several establishing operations (Michaels, 1993) in order to observe whether a participant would mand for items. We assessed whether or not a participant would request five items: juice in the presence of a cup, pudding in the presence of a spoon, foam in the presence of a box and a can (similar to the ABLA Level 2), a puzzle piece in the presence of a partially completed puzzle with a missing piece, and paper in the presence of a pen. The assessment procedure of each task was broken down into four steps. Prior to implementing the steps, the tester asked the participant to consume a spoonful of an item (e.g., juice or pudding), or asked the participant to do an activity with the item (e.g., draw on paper, put the puzzle together, or place a piece of foam in the can), and this was repeated twice. The subsequent steps will be described with respect to the mand, "juice." On the first step, the tester hid the juice under the table and presented the participant with the empty cup and said, "Have some." If the participant requested the item by correctly saying or approximating the word "juice," juice was poured in the cup and given to the participant, and the trial was terminated. If the response was scored as incorrect or as an omission, step 2 began. On the second step, the tester hid the juice under the table and presented the participant with the empty cup and said, "Have some. What do you want?" If the participant requested the item by correctly saying or approximating the word "juice," juice was given to the participant and the trial was terminated. If the response was scored as incorrect or as an omission, step 3 began. On the third step, the tester would hold up the juice (out of reach for the participant), and say "Have some. What do you want?" If the participant requested the item by correctly saying or approximating the word "juice," juice was given to the participant and the trial was terminated. If the response was scored as incorrect or as an omission, step 4 began. On the fourth step, the tester held up the juice and said "Have some. What do you want? Say juice." If the participant requested the item by correctly saying or approximating the word "juice," juice was given to the participant and the trial was terminated. If the participant did not say "juice," the trial was terminated. The same steps were repeated with the four remaining manding tasks.

A correct (pronouncing all syllables), approximation (pronouncing a segment of the

word), incorrect (not pronouncing any segment of the word), or omission (no response) response was recorded for every step of the trial. As previously indicated, a correct or approximated response was followed by verbal praise and access to the desired item that was manded (juice, pudding, foam, paper, or puzzle); an incorrect response was followed by the verbal response "Thank you," and no consequences followed an omission. Similar to the echoic and tact assessments, a blue ball was rolled at the termination of each manding task.

Modifications to the tasks were made for a few of the participants. Based on preference assessments, for some participants, chocolate milk was substituted for juice, and either popcorn twists or yogurt were substituted for pudding. When modifications did occur the echoic and tact assessments were repeated with the new words before the manding assessment began so that the total number of trials for echoics and tacts remained at 33 for all participants. However, regardless of these modifications two of the participants chose not to consume one of the items. These tasks were excluded from analysis of mands on the assumption that an effective establishing operation had not been established. Therefore their score for the mand assessment was out of 12, not 15 trials (four tasks repeated three times).

Criteria for pass or fail. A participant received a pass for the echoic or tact assessments if he/she obtained 80% or more correct responses (Kozloff, 1973). A pass was given for manding if a participant responded correctly (Step 1) or with an approximation (Step 2) on 80% of the trials.

Test–retest reliability. One month after the initial verbal operant assessments, a retest was conducted for all three verbal assessments for 13 of the participants.

Interobserver and procedural reliability. For each verbal assessment the tester and an assistant sat in the same room and recorded each response of a participant. Once the assistant scored the response from the participant, the assistant would then say "Okay" to the tester. Upon hearing this cue from the assistant the tester then proceeded by delivering the appropriate consequence (praise, thank you, or saying nothing) to the participant. This ensured that the type of consequence delivered by the tester did not cue the assistant on how the tester had scored the response. The delay between response and consequence was brief (approximately 1 s).

Interobserver reliability checks were conducted for 63% of echoic, 50% of tact, and 37% of mand assessments. An interobserver agreement (IOA) score was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100% (Martin & Pear, 2003). The IOA scores averaged 91% (range: 70%–100%) for echoics, 94% (range: 70%–100%) for tacts, and 95% (range: 83%–100%) for mands. For the retest, reliability checks were conducted for 85%, 77% and 69% for echoic, tact, and mand assessments, respectively. The retest IOAs averaged 87% (range: 58%–100%) for echoics, 91% (range: 73%–100%) for tacts, and 97% (range: 92%–100%) for mands. IOA scores for the ABLA averaged 100%, and the IOA scores for both the AAIM and AANM assessments averaged 99%.

Procedural reliability (PR) was assessed using a procedural checklist of the steps for an assessment. A step was considered an agreement if the tester and an observer both recorded that it occurred correctly; otherwise, it was considered a disagreement. Reliability assessments were conducted for 45% of echoic, 37% of tact, and 37% of mand assessments. PR scores, calculated the same way as the IOA scores, averaged 99% (range: 97%–100%) for echoics, 98% (range: 96%–100%) for tacts, and 98% (range: 92%–100%) for mands. PR scores for the retest were calculated for 85%, 77%, and 69% of echoic, tact and mand assessments, respectively. PR scores averaged 100% for echoics, 99% (range: 96%–100%) for tacts, and 99% (range: 92–100%) for mands. PR scores for the ABLA and auditory matching tasks were 100%.

RESULTS

The pass/fail patterns on the ABLA test, the auditory matching tasks, and the three verbal operants are presented for each participant in Table 3. Of the 14 participants in the Visual group (participants 1 through 14, who passed only up to and including ABLA Levels 3 or 4), 13 failed the echoic assessment, and all 14 failed the tact and mand assessments. This group passed only 2% (1/42) of the verbal assessments. Of the 13 participants in the Auditory–Visual group (participants 15 through 27,

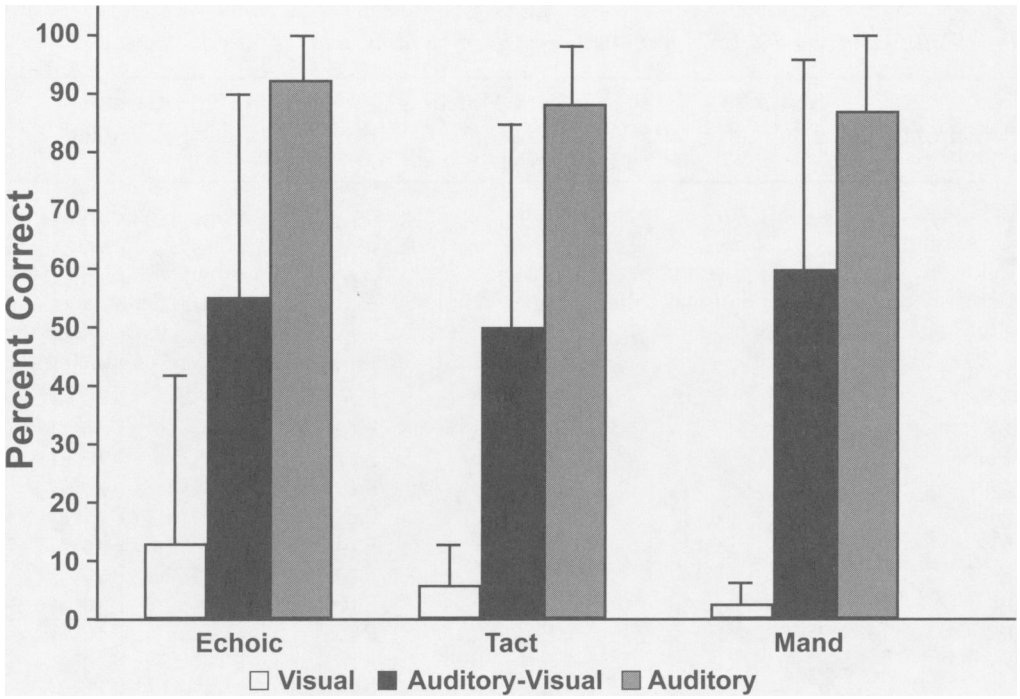

Figure 1. Mean percent correct on the test of verbal operants across discrimination groups. Error bars represent the standard deviation.

who passed only up to and including ABLA Level 6), six failed all three verbal assessments, two passed all three verbal assessments, two passed one verbal assessment, and three passed two verbal assessments. This group passed 36% (14/39) of the verbal assessments. Of the 11 remaining participants in the Auditory–Auditory group (who passed all ABLA levels and the auditory matching tasks), no one failed the echoic assessment, two failed the tact assessment, and two failed the mand assessment. This group passed 88% (29/33) of the verbal assessments.

The level of adaptive behavior as measured by the SIB-Short Form was not correlated with verbal operant assessments since all participants with an assigned level were severe (see Table 2). Both diagnositic level (profound/severe, moderate, and mild) and discrimination group (visual, auditory–visual, and auditory) were significantly and positively correlated with verbal operant assessments with the latter showing stronger correlations. Pearson correlations between diagnostic levels and verbal assessments were: .57 for echoics, .63 for tacts, and .57 for mands, respectively. Correlations between discrimination groups and verbal assessments were: .77 for echoics, .83 for tacts, and .83 for mands, respectively. All correlations were significant at $p < .001$. Multiple regression, with diagnostic level and discrimination group entered simultaneously as predictor variables and the verbal operant assessment as criterion variable, showed that the discrimination group was a significant predictor, accounting for 59% of the variance for echoics, 69% of the variance for tacts, and 65% of the variance in mands, respectively. Diagnostic level was not a significant predictor. That is, it did not account for any significant unique variance of the verbal assessments beyond discrimination group (see Table 4).

The means and standard deviations of the percent correct responses on verbal assessments across groups are presented in Figure 1. A one-way ANOVA was used to examine between group differences on each of the three verbal operant assessments, and a Tukey t-test was used for paired comparisons (alpha was set at .05). For echoics, there was a significant main group effect $F(2, 37) = 27.40$, $p < .001$. T-tests showed that the Auditory–Auditory group performed significantly better than both the Auditory–Visual group and the Visual

Table 3.
Pass/Fail Pattern on the ABLA test, Auditory Matching tasks, and the Verbal Operants.

Participant	ABLA Test		Auditory Matching	Verbal Operants		
	Level 3/4	Level 6	AAIM/ AANM	Echoic	Tact	Mand
1	P	F	F	F (0%*)	F (0%)	F (0%)
2	P	F	F	F (45%)	F (12%)	F (0%)
3	P	F	F	F (0%)	F (0%)	F (0%)
4	P	F	F	F (0%)	F (0%)	F (0%)
5	P	F	F	F (0%)	F (0%)	F (0%)
6	P	F	F	F (0%)	F (0%)	F (0%)
7	P	F	F	F (0%)	F (0%)	F (0%)
8	P	F	F	F (0%)	F (0%)	F (0%)
9	P	F	F	F (18%)	F (3%)	F (0%)
10	P	F	F	F (0%)	F (0%)	F (0%)
11	P	F	F	P (82%)	F (21%)	F (7%)
12	P	F	F	F (45%)	F (45%)	F (47%)
13	P	F	F	F (33%)	F (3%)	F (0%)
14	P	F	F	F (0%)	F (3%)	F (0%)
15	P	P	F	F (0%)	F (0%)	F (0%)
16	P	P	F	F (0%)	F (0%)	F (0%)
17	P	P	F	F (30%)	F (3%)	F (0%)
18	P	P	F	F (18%)	F (27%)	F (40%)
19	P	P	F	F (61%)	F (55%)	P (80%)
20	P	P	F	F (67%)	P (82%)	P (87%)
21	P	P	F	P (88%)	P (82%)	F (60%)
22	P	P	F	P (91%)	P (100%)	P (100%)
23	P	P	F	F (67%)	F (64%)	F (73%)
24	P	P	F	P (91%)	F (64%)	P (80%)
25	P	P	F	F (39%)	F (36%)	F (67%)
26	P	P	F	F (70%)	F (58%)	P (87%)
27	P	P	F	P (100%)	P (88%)	P (93%)
28	P	P	P	P (100%)	P (97%)	P (100%)
29**	P	P	P	P (82%)	P (91%)	F (60%)
30	P	P	P	P (82%)	F (70%)	F (67%)
31**	P	P	P	P (91%)	P (82%)	P (87%)
32	P	P	P	P (94%)	P (91%)	P (100%)
33	P	P	P	P (100%)	P (91%)	P (100%)
34	P	P	P	P (100%)	P (100%)	P (100%)
35	P	P	P	P (97%)	P (91%)	P (93%)
36	P	P	P	P (82%)	F (67%)	P (80%)
37	P	P	P	P (100%)	P (100%)	P (93%)
38	P	P	P	P (100%)	P (94%)	P (80%)

Note. ABLA Level 3 = visual discrimination, Level 4 = visual matching-to-sample, and Level 6 = auditory–visual discrimination, AAIM = auditory–auditory identity matching, and AANM = auditory–auditory nonidentity matching. Participants 1–14 made up the Visual group; 15–27, the Auditory–Visual group; and 28–38, the Auditory–Auditory group.

*The percent correct on the test. A pass (P) was > 80% correct.

**These participants passed only AAIM.

Table 4

Results of Standard Multiple Regression of Diagnostic Level and Discrimination Group (independent variables) Affecting Echoic, Tact, and Mand Assessments (dependent variables)

	B-weight	*Beta*	*t*-value	*p*	Adjusted R^2	*F* (*df*)	*p*
			Echoic Assessment				
Diagnostic Level	4.27	0.08	0.62	.542			
Discrimination Group	36.10	0.73	5.31	.000	0.59	27.87 (2,35)	.000
Constant	–28.78						
			Tact Assessment				
Diagnostic Level	5.85	0.12	0.98	.332			
Discrimination Group	37.61	0.76	6.44	.000	0.69	43.09 (2,35)	.000
Constant	–42.53						
			Mand Assessment				
Diagnostic Level	2.82	0.05	0.42	.675			
Discrimination Group	40.48	0.78	6.19	.000	0.65	35.60 (2,35)	.000
Constant	–38.40						

group, and the Auditory–Visual group performed significantly better than the Visual group. For tacts, there was a significant main group effect $F(2, 37) = 41.77$, $p < .001$. T-tests showed that the Auditory–Auditory group performed significantly better than the Auditory–Visual group and the Visual group, and the Auditory–Visual group performed significantly better than the Visual group. For mands, there was a significant main group effect $F(2, 37) = 39.31$, $p < .001$. T-tests showed that the Auditory–Auditory group performed significantly better than the Auditory–Visual group and the Visual group, and the Auditory–Visual group performed significantly better than the Visual group.

Order analysis (Kerr et al., 1977; Krus, 1977) was used to evaluate the hierarchical ordering between the ABLA levels, the auditory matching tasks, and the verbal assessments. Between any two tasks, a confirmation (C) occurs when the participant passes a hypothesized easier task and fails a hypothesized harder task. A disconfirmation (D) occurs when a participant passes a hypothesized harder task and fails a hypothesized easier task. A z-score was computed, where $z = (C - D)/(C + D)^{1/2}$, to assess significance. Data from individuals who pass or fail both tasks were not included because it does not provide information about the hierarchy of the tasks. The results indicated that the echoic, tact, and mand assessments were more difficult than ABLA Levels 3, 4 and 6 (Table 5). The hierarchy between the auditory matching tasks and among the three verbal operants was not significant.

Results from the initial test and the retest of the three verbal operants are shown in Table 6. Intraclass correlations were statistically significant for echoics ($r_{13} = .98$, $p < .01$), tacts ($r_{13} = .99$, $p < .01$), and mands ($r_{13} = .97$, $p < .01$).

DISCUSSION

Discrimination group was a significant predictor of performance on the echoic, tact, and mand assessments. Diagnostic level did not contribute any unique variance in predicting verbal assessment beyond what was accounted for by discrimination group. The Auditory–Auditory group scored significantly higher than the other two groups on all three verbal assessments, and the Auditory–Visual group scored significantly higher than the Visual group on the three verbal assessments.

Table 5

Participants who confirmed (C) or Disconfirmed (D) Ordering between Tasks

	Echoics		Tacts		Mands	
Tasks	C	D	C	D	C	D
ABLA Level 3/4	22*	0	25*	0	23*	0
ABLA Level 6	10**	1	10*	0	8*	0
AAIM/AANM	0	5	2	4	2	6
Echoics			4	1	4	3
Tacts					2	4

Note: ABLA test: Level 3 = visual discrimination, Level 4 = visual match-to-sample discrimination, and Level 6 = auditory–visual discrimination. Auditory matching tasks: AAIM = auditory–auditory identity matching, and AANM = auditory–auditory nonidentity matching.
*$p < .001$, **$p < .01$.

While echoics, tacts, and mands were harder than the ABLA tasks (Levels 3, 4 and 6), a hierarchical relationship between the auditory matching tasks and the three verbal operants was not established. Although not statistically significant, the results suggest that the auditory matching tasks (AAIM/AANM) may be more difficult than the echoics test (Table 6). Additional research with a larger sample is needed to clarify the hierarchical relationship among the auditory matching tasks and the verbal operants.

Similarly, the ordering between echoics, tacts and mands was inconclusive. Of the 38 participants, 20 failed all three verbal tasks and eight passed all three tasks. Of the remaining participants, three passed only echoics and two passed only mands. If the study were replicated with a larger sample, a hierarchy may emerge. When behavioural programs were first developed to teach verbal operants to individuals with developmental disabilities or autism, an attempt was made to teach vocal imitation first, then tacts, and then mands (Drash & Leibowitz, 1973; Guess, Sailor, & Baer, 1976; Lovaas, 1977). More recently, behavioral practitioners have argued that mands should be taught first (Drash et al., 1999; Sundberg & Michael, 2001). The main reason is that teaching mands first may be more functional for both staff and the target individuals themselves. Regardless of this reasoning, more research is needed to determine the optimal order for teaching the three verbal operants.

All three verbal assessments showed high test–retest reliability one month after the initial assessments. These results increase our confidence that the test has potential as a valid assessment of the three verbal operants for persons with developmental disabilities.

The present study has several limitations. First, the mand assessment was somewhat limited. According to Skinner's (1957) definition of a mand, if a child consistently emits a sound or gesture to request an item and does not use that sound or gesture to request other items, then that sound or gesture would be considered a mand. In the present study, the mand assessment was limited in that it focused only on vocal mands, and it considered only the correct word or an approximation to the word as being a mand. The present study did not take into account idiosyncratic sounds or gestures that the participant might have emitted to request various items. Inclusion of these responses may change the ordering among the verbal operants (i.e., resulting in higher scores on mand assessments). However, a consideration and justification for accepting only correct or approximations as correct vocal responses for mands is that, in order for a mand to be maximally functional for the speaker, it should be recognizable by different listeners in the general verbal community and not just

Table 6
Percent Correct Scores on the Initial Assessment and the Retest of the three Verbal Operants

Group	Participant	Echoics		Tacts		Mands	
		Initial	Retest	Initial	Retest	Initial	Retest
Visual	6	0%	0%	0%	0%	0%	0%
	7	0%	0%	0%	0%	0%	0%
	9	18%	30%	3%	6%	0%	0%
Auditory-Visual	15	0%	0%	0%	0%	0%	0%
	16	0%	0%	0%	0%	0%	0%
	18	18%	21%	27%	30%	40%	40%
	19	61%	48%	55%	55%	80%	93%
	20	67%	55%	82%	67%	87%	80%
	24	91%	88%	64%	70%	80%	100%
Auditory-Auditory	28	100%	100%	97%	100%	100%	100%
	29	82%	64%	91%	91%	60%	87%
	30	82%	82%	70%	67%	67%	87%
	31	91%	79%	82%	82%	87%	100%

Note. Visual = ABLA Levels 3 or 4, Auditory–Visual = ABLA Level 6, Auditory–Auditory = auditory–auditory identity matching and/or auditory–auditory nonidentity matching.

by one or two individuals who are aware of the idiosyncratic response.

A second limitation of the manding assessment is that just before assessment of each mand, we presented the participant with the task twice in order to provide a brief history of reinforcement, on the assumption that a state of deprivation would be created when the task was presented with a missing component. However, it was not really known whether the individual "wanted" the missing item. In order to prevent presenting a task that participants did not want to engage in during mand assessments, formal direct preference assessments could be done to determine which items or activities are the most preferred by participants. A mand assessment could then evaluate whether or not participants would request those items or activities.

Another limitation of the test of echoics, tacts, and mands is that the lists of words used for the assessments were limited to 11 words for echoics and tacts, and five words for mands. Future studies might examine the predictive validity of the test of vocal verbal operants used in this study using different and/or more words.

In summary the current study demonstrated that individuals who passed two auditory–auditory matching tasks performed better on a test of three verbal operants than those unable to pass auditory matching tasks, and that individuals who passed an auditory–visual discrimination (ABLA Level 6) performed better on a test of three verbal operants than those unable to perform this discrimination. Lastly, it was found that the test of verbal operants yielded strong test–retest reliability. These results suggest that further research is warranted to evaluate ABLA level 6 as a possible bridging task for teaching echoics, tacts, and mands to persons with developmental disabilities and to examine the hierarchical relationship among auditory matching and the verbal operants.

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