Examination of the relation between an assessment of skills and performance on auditory–visual conditional discriminations for...
EXAMINATION OF THE RELATION BETWEEN AN ASSESSMENT OF SKILLS AND PERFORMANCE ON AUDITORY–VISUAL CONDITIONAL DISCRIMINATIONS FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

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The current investigation evaluated repertoires that may be related to performance on auditory-to-visual conditional discrimination training with 9 students who had been diagnosed with autism spectrum disorder. The skills included in the assessment were matching, imitation, scanning, an auditory discrimination, and a visual discrimination. The results of the skills assessment showed that 4 participants failed to demonstrate mastery of at least 1 of the skills. We compared the outcomes of the assessment to the results of auditory–visual conditional discrimination training and found that training outcomes were related to the assessment outcomes for 7 of the 9 participants. One participant who did not demonstrate mastery of all assessment skills subsequently learned several conditional discriminations when blocked training trials were conducted. Another participant who did not demonstrate mastery of the auditory discrimination skill subsequently acquired conditional discriminations in 1 of the training conditions. We discuss the implications of the assessment for practice and suggest additional areas of research on this topic.

Key words: autism spectrum disorder, brief experimental analysis, conditional discrimination, skills assessment

A fundamental component of many types of tasks is engagement in discriminations among stimuli, and this is typically a high-priority goal in educational programs for individuals with autism spectrum disorder (ASD; Green, 1996). Teaching children with ASD to discriminate among stimuli is accomplished through training simple and conditional discrimination skills. A simple discrimination contains three elements: an antecedent, response, and consequence. Responses that occur in the presence of an antecedent stimulus...
are reinforced, but the response is not reinforced in the presence of different antecedent stimuli (Green, 2001). An example of a simple visual discrimination is opening the door to a house when the deadbolt is unlocked but not when the lock is engaged. Discrimination training with individuals with ASD may begin with a series of simple discriminations (e.g., following instructions) before training of more complex discriminations is initiated (Lovaas, 2003).

Establishment of more advanced discrimination skills is also important because many common educational tasks require a conditional discrimination. A conditional discrimination includes four components: a conditional or second-order discriminative stimulus, first-order discriminative stimulus, response, and consequence (Catania, 2012). Thus, a correct response in the presence of a particular first-order discriminative stimulus depends on the presence or absence of another (conditional) discriminative stimulus that may not have any physically distinguishing characteristics in common with the first-order stimulus. Matching and many listener responses are conditional discriminations that are frequently targeted in early intervention programs (Green, 1996, 2001). Some listener responses may require an auditory–visual (A-V) conditional discrimination because the child must respond to one antecedent stimulus in the presence of an auditory conditional discriminative stimulus. That is, the child engages in a nonvocal response (e.g., pointing to a picture of a dog in an array of three pictures) after presentation of an auditory conditional discriminative stimulus (e.g., “touch dog”).

Prior research on conditional discrimination training has evaluated whether establishing other simple discriminations might facilitate the acquisition of conditional discriminations (Grow, Carr, Kodak, Jostad, & Kisamore, 2011; Saunders & Spradlin, 1989, 1990). For example, Saunders and Spradlin (1989) examined the effects of teaching two-component simple discriminations on correct responding to visual–visual conditional discriminations (i.e., matching arbitrary symbols) during subsequent trial-and-error training. Before the component simple discriminations were taught, the participants did not demonstrate mastery on the matching task. First, the participants were taught the successive discrimination between the two sample stimuli. A successive discrimination involves differential responding between sample stimuli that are presented in succession (e.g., responding at differential rates between a picture of a bird and a picture of a dog presented sequentially). Next, the authors taught a simultaneous discrimination between two comparison stimuli by reinforcing differential responding to one of the two stimuli (e.g., a picture of a bird and a dog that are presented simultaneously) during each session. The participant’s mastery of both component discriminations (i.e., successive and simultaneous) was not sufficient to produce correct performance on the visual–visual conditional discrimination task during subsequent trial-and-error training. Therefore, Saunders and Spradlin (1989) modified the training format. Initially, trial-and-error training trials were intermixed so that two different conditional discrimination tasks were alternated across successive trials. They subsequently modified training trials so that trials were presented in blocks (i.e., the same sample stimulus and comparison stimuli were presented repeatedly with no alternation). When criterion performance was met with blocked trials, alternating trials were subsequently faded back in. The block-trials procedure and subsequent fading in of trial alternation resulted in acquisition of the two conditional discriminations.

Saunders and Spradlin (1989) showed that teaching simple component discriminations was insufficient to produce conditional discrimination, and the use of blocked training trials was necessary to promote acquisition of arbitrary visual-to-visual matching. However, this occurred only after participants had been taught simple discriminations. Therefore, it is unclear whether the blocked trials would have been
effective if participants had not previously been taught simple discriminations. Also, it is unclear what additional skills participants had in their repertoires before training. For example, both participants could engage in identity matching (e.g., matching identical pictures), and they exhibited “functional speech” (p. 2). Therefore, it is possible that participants would not have benefited from blocked training trials if they did not yet have these skills. In addition, the authors did not evaluate whether acquisition of the component discriminations or the blocking training procedure could facilitate acquisition of other types of conditional discrimination training (e.g., A-V conditional discriminations).

Additional skills might help to establish the necessary repertoires for learners to acquire A-V conditional discriminations. For instance, an A-V conditional discrimination requires an individual to attend to and engage in a discrimination between auditory stimuli (e.g., the spoken words “bird” and “dog”), scan an array of picture cards on the table, match an auditory stimulus to a visual stimulus, differentiate between important features of picture cards, and imitate the teacher’s model (if the teacher points to or indicates the correct picture in the array). Thus, skills such as auditory discrimination, scanning, matching, visual discrimination, and imitation may be related to the development of A-V conditional discriminations (Kerr et al., 1977; Mayville & Mulick, 2010).

Despite the importance of teaching A-V conditional discriminations and the large amount of time focused on teaching these skills during children’s special education and early intervention services, there are few assessment procedures that measure children’s specific skills that may be related to performance on A-V conditional discriminations. In a notable exception, the Assessment of Basic Learning Abilities (ABLA; Kerr et al., 1977) measures skills relevant to learning A-V conditional discriminations. The assessment includes six levels: Level 1 measures imitation, Levels 2 and 3 measure visual discriminations, Level 4 measures identity matching, and Levels 5 and 6 measure A-V conditional discriminations. Although studies on the ABLA show that this assessment can be used to identify important foundational skills for A-V conditional discrimination training (e.g., Stubbings & Martin, 1995; Wacker, Steil, & Greenebaum, 1983), this assessment tool may not be used frequently in classroom settings nor is it commercially available. Therefore, professionals may benefit from additional assessment tools that are more readily available for use with their clients or students.

The ABLA also does not include a measure of scanning. Scanning an array of stimuli may be a critical skill needed to benefit from A-V conditional discrimination training, because these discriminations are typically taught with table-top learning tasks. That is, the trainer presents objects or pictures in an array on the table in front of the participant, and the participant must scan each picture or object in this array. Looking at materials in an array has been shown to be a critical component of other types of instruction (e.g., discrete-trial training; Smith, 2001). Therefore, measurement of scanning may provide important information relevant to table-top instruction on A-V conditional discrimination tasks.

The purpose of the current study was to evaluate potential skills that may be correlated with accurate performance on A-V conditional discrimination training. We evaluated whether mastery-level responding on matching, visual discrimination, auditory discrimination, imitation of pointing, and scanning were related to outcomes on A-V conditional discrimination training.

**METHOD**

**Participants and Setting**

Participants included nine children who had been diagnosed with ASD. Seven of the participants had received their diagnosis from a
multidisciplinary team of professionals who specialized in the assessment and treatment of ASD or developmental disabilities. Two participants had received their diagnosis from an independent psychologist who was not associated with the study. Refer to Table 1 for each participant’s age, diagnosis, age-equivalence score on the Peabody Picture Vocabulary Test–4, and presence or absence of an echoic repertoire (defined as correctly repeating at least three sounds or words during early intervention programming or on the Early Echoic Skills Assessment developed by Barb Esch). All of the participants had at least one individual education plan goal related to learning A-V conditional discriminations, and five of them also had this goal as part of their early intervention programming.

All participants attended either a hospital-based early intervention program or a university-based research laboratory. We conducted sessions in a private therapy room that contained a table, chairs, data collectors, and all relevant session materials (e.g., picture cards, toys).

Response Measurement and Interobserver Agreement

The dependent variables included unprompted correct responses, prompted correct responses, and scanning. We scored an unprompted correct response if the participant touched the target picture card or placed a picture card on top of an identical picture card in an array within 5 s of the initiation of the trial. We scored a prompted correct response if the participant touched the target picture card or placed a picture card on top of an identical card in an array within 5 s of a model prompt or if he or she physically guided. During A-V conditional discrimination training, we defined a prompted correct response as touching the correct comparison stimulus within 5 s of the therapist’s model or after the therapist moved the correct comparison stimulus 15 cm closer to the participant. Scanning was defined as an uninterrupted shifting of the participant’s eye gaze from one stimulus to the next. We converted each of these measures to a percentage after calculating the number of trials with the occurrence of a target behavior divided by the total number of trials in a session.

Two independent observers simultaneously collected data on all dependent variables during at least 40% of sessions. A trial was scored as an agreement if both observers recorded the same target responses during the trial. We calculated trial-by-trial agreement coefficients by dividing the number of trials with an agreement by the total number of trials in the session and converting the result to a percentage. Mean agreement collected across all dependent variables (except scanning) for the skills assessment was above 95% (range, 87% to 100%) for all participants. Mean agreement for scanning was above 94% (range, 82% to 100%) for all participants. A second observer also collected data during 26% to 97% of all A-V conditional discrimination training sessions. Mean agreement for all dependent variables for the A-V conditional discrimination training was above 90% (range, 90% to 100%) for all participants with the exception of Linda, whose mean agreement was 90% (range, 56% to 100%).

Procedural Integrity

A second observer also collected data on procedural integrity during 41% to 94% of A-V

### Table 1
Participants’ Characteristics

<table>
<thead>
<tr>
<th>Participant and age (years:months)</th>
<th>PPVT age equivalence</th>
<th>Diagnosis</th>
<th>Echoic repertoire</th>
</tr>
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<tbody>
<tr>
<td>Hal 5:1</td>
<td>&lt;2</td>
<td>Autism</td>
<td>No</td>
</tr>
<tr>
<td>Linda 8:3</td>
<td>3:6</td>
<td>Autism</td>
<td>Yes</td>
</tr>
<tr>
<td>Rose 4:6</td>
<td>2:8</td>
<td>Autism</td>
<td>Yes</td>
</tr>
<tr>
<td>Brandon 6:7</td>
<td>5:4</td>
<td>Autism</td>
<td>Yes</td>
</tr>
<tr>
<td>Larry 5:1</td>
<td>&lt;2</td>
<td>Autism</td>
<td>No</td>
</tr>
<tr>
<td>Freddy 9:4</td>
<td>&lt;2</td>
<td>Autism</td>
<td>No</td>
</tr>
<tr>
<td>Wyatt 4:3</td>
<td>2:9</td>
<td>Autism</td>
<td>Yes</td>
</tr>
<tr>
<td>Josh 5:5</td>
<td>3:2</td>
<td>Autism, global developmental delay</td>
<td>Yes</td>
</tr>
<tr>
<td>Amar 5:10</td>
<td>2:10</td>
<td>Autism, Fragile X</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*aPeabody Picture Vocabulary Test–4.*

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conditional discrimination training sessions for Hal, Rose, Linda, Brandan, Larry, Freddy, Wyatt, and Amar. We also collected procedural integrity data for Josh; however, these data were collected during only 12% of sessions. We scored an instance of procedural integrity for each trial if the experimenter presented the stimuli as indicated on the data sheet, provided a clear and concise instruction, and provided the correct consequences after unprompted and prompted correct responses or an incorrect response, as indicated in the protocol. We calculated procedural integrity for each session by dividing the total number of trials implemented with integrity by the total number of trials in a session and converting the result to a percentage. Mean procedural integrity for treatment was above 95% (range, 96% to 100%) for all participants.

General Procedure

All skills assessment sessions contained 12 trials. Conditional discrimination training sessions contained 10 (Josh), 12 (Wyatt and Amar), or 16 trials (Hal, Rose, Linda, Brandan, Larry, and Freddy). We conducted two to seven skills assessment sessions and two to six conditional discrimination training sessions per day, two to five times per week. We evaluated the effects of each condition of the skills assessment on unprompted correct responses and scanning within a multielement design. We evaluated whether participants acquired the target stimuli during A-V conditional discrimination training within either a concurrent (Hal and Rose) or nonconcurrent (Larry, Freddy, and Brandan) multiple baseline design across participants, a reversal design (Linda), or an adapted alternating treatments design (Wyatt, Josh, and Amar).

The mastery criterion for the skills assessment was two consecutive sessions with unprompted correct responses at or above 80%. We also used this criterion to determine mastery of scanning. We conducted two consecutive sessions with unprompted correct responses at or above 80%. We also used this criterion to determine mastery of scanning. We continued to collect data on scanning, even if the participant reached the mastery criterion, if unprompted correct responses had not yet reached the mastery criterion. Our mastery criterion for A-V conditional discrimination training was two consecutive sessions with unprompted correct responses at or above 80%.

Preferential Assessment

We conducted multiple-stimulus-without-replacement (MSWO) preference assessments daily for tangible and edible items according to procedures described by Carr, Nicolson, and Higbee (2000). Participants received one of the top three items identified in the daily MSWO contingent on unprompted correct responses.

Skills Assessment

During each trial, the experimenter placed two or three picture cards (10 cm by 15 cm) or a single blank white card in front of the participant. We evaluated the effects of each condition of the skills assessment on unprompted correct responses and scanning within a multielement design. We evaluated whether participants acquired the target stimuli during A-V conditional discrimination training within either a concurrent (Hal and Rose) or nonconcurrent (Larry, Freddy, and Brandan) multiple baseline design across participants, a reversal design (Linda), or an adapted alternating treatments design (Wyatt, Josh, and Amar).
picture cards. The data collectors measured unprompted correct responses and scanning during each trial.

**Imitation of pointing.** The experimenter placed two picture cards in an array on the table in front of the participant and said “do this” while she pointed to one of the pictures. If the participant pointed to the same picture card within 5 s, the experimenter provided enthusiastic praise and 20-s access to a highly preferred edible or tangible item. If the participant pointed to an incorrect picture card or did not respond within 5 s, the experimenter removed the array and moved to the next trial. She modeled touching the stimulus located in the left and right positions in the array an equal number of times per session. The purpose of this condition was to determine whether the participant could imitate the experimenter’s behavior with picture cards. Data collectors measured unprompted correct responses and scanning during each trial.

**Auditory discrimination.** The experimenter placed a blank white picture card on the table in front of the participant and presented one of two auditory stimuli in a random order across trials. If the participant touched the white card in the presence of one auditory stimulus (e.g., a cat meowing; S+) within 5 s, the experimenter delivered enthusiastic praise and a highly preferred edible or tangible item for 20 s. The absence of a card touch in the presence of the second auditory stimulus (e.g., a car horn; S−) within 5 s produced reinforcement. If the participant emitted an error (i.e., touched the card in the presence of the S− or did not touch the card in the presence of the S+), the experimenter removed the card and initiated the next trial.

For the first two sessions of this condition (data not shown), a 0-s prompt delay was used to ensure contact with the contingency for correct responding before independent correct performance on the auditory discrimination was assessed. During these sessions, the experimenter immediately physically guided the participant to engage in the correct response (i.e., either touching the white card or refraining from touching the card by folding his or her hands in his or her lap or on the table for 5 s), and delivered reinforcement. After two sessions at the 0-s prompt delay, the experimenter waited up to 5 s for a response and did not provide any type of physical guidance for the 10 sessions whose data are shown in the figures. The purpose of this condition was to evaluate whether the participant differentially responded across the two auditory stimuli.

**Visual discrimination (all participants except Freddy).** The experimenter presented two picture cards on the table in front of the participant. She did not provide any type of vocal prompt during trials. During each trial, touching one picture card (e.g., a dog; S+) within 5 s resulted in reinforcer delivery in all sessions. If the participant touched the second stimulus (e.g., a triangle; S−) or did not engage in a response within 5 s, the experimenter removed the picture cards and initiated the next trial. The S+ was placed in the left and right positions an equal number of times per session. As in the auditory discrimination condition, a 0-s prompt delay was conducted for the first two sessions (data not shown) to ensure contact with the contingency for correct responding. During these sessions, the experimenter immediately physically guided the participant to touch the picture card associated with reinforcement and delivered praise and a highly preferred edible or tangible item. After two sessions at the 0-s prompt delay, the experimenter did not provide physical guidance for the remainder of the sessions. The purpose of this condition was to evaluate whether the participants differentially responded across visual stimuli. The visual discrimination condition was not conducted with Freddy because he demonstrated accurate visual discriminations before the study when he used pictures to communicate.

**Scanning.** We collected data for scanning during sessions from two other conditions (identity matching and imitation trials) in the
skills assessment. We measured scanning during these two conditions to evaluate potential differences in participants’ scanning behavior when they were required to scan two (imitation) or three (identity matching) pictures. The purpose of this measurement was to evaluate whether participants consistently looked at each stimulus within an array of visual stimuli.

Auditory–Visual Conditional Discrimination Training

The training procedures were based on those described by Kodak et al. (2011). In addition, we included training procedures that were frequently used during conditional discrimination training in the participants’ classroom at school (e.g., baseline with praise, reinforcement condition) and early intervention programming (e.g., identity-matching prompt). During each trial, the experimenter placed an array of three or four stimuli in front of the participant on the table, presented the auditory sample stimulus, waited 5 s for a response, and provided a consequence if relevant to the condition. For sessions with 12 trials, the presentation of stimuli was randomized so that each stimulus served as S+ and S− an equal number of times across sessions, and each sample stimulus was equally placed in the left, center, and right positions of the array. For sessions with 10 or 16 trials, we attempted to equate the location of stimuli across sessions so that each stimulus served as an S+ and S− an equal number of times in each session or across blocks of four sessions.

Pretest. To identify potential target stimuli to include in training, the experimenter placed three (Wyatt, Josh, and Amar) or four (Hal, Rose, Linda, Brandan, Larry, and Freddy) comparison stimuli on the table in front of the participant and presented an auditory sample stimulus (e.g., “banana”). If the participant responded correctly within 5 s of the auditory sample stimulus, the experimenter provided brief praise. The experimenter presented each stimulus four times in random order. Only stimuli associated with correct responding on none or one of four trials were included in treatment.

For the adapted alternating treatments design (Wyatt, Josh, and Amar), we attempted to equate the target responses across conditions by (a) assigning targets that had the same number of correct responses during the pretest, (b) matching the number of syllables in targeted words, and (c) assigning targets with similar beginning sounds (e.g., bed and book) to different conditions. We assigned three (Wyatt and Amar) or five (Josh) targets to each condition with an adapted alternating treatments design. We assigned eight targets for participants with a multiple baseline design across participants or a reversal design.

Baseline. The experimenter placed three (Wyatt, Josh, and Amar) or four (Hal, Rose, Linda, Brandan, Larry, and Freddy) comparison stimuli on a table in front of the participant and presented the auditory sample stimulus. Correct responses within 5 s produced brief praise followed by presentation of the next instructional trial.

Baseline without praise (Linda, Wyatt, and Josh). The procedures were identical to baseline except that the experimenter did not provide praise for correct responses. We removed praise for correct responding for these participants because it was hypothesized that praise alone may function as reinforcement (based on responding in other instructional programs). The purpose of baseline without praise was to evaluate responding in the absence of reinforcement.

Reinforcement. The procedures were similar to baseline except that the experimenter delivered praise and a highly preferred stimulus (i.e., one small piece of food or 20-s access to a leisure item) after correct responses within 5 s of the auditory sample stimulus. If the participant made an error or did not respond within 5 s, the next trial began.

Position prompt and reinforcement. This condition was identical to the reinforcement condition except that we included a 5-s constant prompt delay (Karsten & Carr, 2009) during training. The experimenter conducted one session at a 0-s prompt delay for all participants.
with an adapted alternating treatments design (Wyatt, Josh, and Amar; 0-s session data are not shown), and increased the delay to 5 s in the second session of training. Contingent on an unprompted correct response, the experimenter delivered praise and a preferred item. Contingent on an error or no response within 5 s, the experimenter presented a prompt by moving the correct comparison stimulus approximately 15 cm closer to the participant and then representing the auditory sample stimulus. If the participant touched the correct comparison stimulus that was 15 cm closer, this was recorded as a prompted correct response and only praise was delivered. If the participant did not emit a correct prompted response, the experimenter removed the material and initiated the next trial.

Model prompt and reinforcement (Amar only). This condition was identical to the position-prompt condition except that instead of moving the correct comparison stimulus contingent on an error or no response within 5 s, the experimenter modeled the correct response by pointing to the correct comparison stimulus while she re-presented the auditory sample stimulus. As in the position-prompt condition, the experimenter provided praise and an edible item for unprompted correct responses and praise only for prompted correct responses. If the participant did not emit a correct prompted response, the experimenter removed the materials and initiated the next trial.

Identity-matching prompt and reinforcement (Hal and Amar). This condition was identical to the position-prompt condition except that instead of moving the correct comparison 15 cm closer to the participant contingent on an error or no response within 5 s, the experimenter presented an identity-matching prompt (Fisher, Kodak, & Moore, 2007). That is, the experimenter held up a picture card that was identical to the correct comparison stimulus and said, “This is a —. Point to —.” Unprompted correct responses produced praise and a preferred item. Prompted correct responses produced praise only.

Blocking plus identity-matching prompt and reinforcement (Hal only). This condition was identical to the identity-matching prompt and reinforcement condition except that we reduced the size of the array and taught stimuli in pairs using the blocking procedure described by Saunders and Spradlin (1990). The experimenter repeatedly presented one sample stimulus during all 16 trials until Hal showed correct unprompted responses during at least 80% of trials for one session (i.e., the mastery criterion for reducing the block size). Contingent on an error or no response within 5 s of the initiation of the trial, the experimenter delivered the identity-matching prompt. Unprompted correct responses produced praise and a preferred item. Prompted correct responses produced praise only. Incorrect prompted responses resulted in the initiation of the next trial. After Hal’s correct unprompted responding reached the mastery criterion, the second sample stimulus was presented during all 16 trials until Hal reached mastery. The experimenter reduced the size of the blocks of trials by half (eight trials of each stimulus) until responding met the 80% criterion. The experimenter continued to reduce the size of the blocks by half (i.e., four, then two, randomly alternating between stimuli) each time correct unprompted responding reached the mastery criterion. We repeated the blocking procedure with additional pairs of stimuli until Hal mastered all eight stimuli in this condition.

RESULTS

The results of each participant’s skills assessment are summarized in Table 2. Figure 1 shows the results of the skills assessment for Hal, Rose, and Linda. Hal reached mastery criterion in only the matching condition. Rose displayed mastery-level responding in all assessment conditions within two sessions except for the auditory discrimination condition, which took nine sessions. Linda also met the mastery criterion in all assessment conditions, and she mastered each condition within two sessions. Hal, Rose, and
Linda exhibited high levels of scanning behavior during the matching and imitation conditions. Figure 2 shows the results of the skills assessment for Brandan, Larry, and Freddy. Brandan met the mastery criterion in all assessment conditions within two sessions. Larry reached the mastery criterion in all assessment conditions except for the auditory discrimination condition. Freddy met the mastery criterion during the matching and imitation conditions but not during the auditory discrimination condition. Brandan and Freddy exhibited high levels of scanning during the matching and imitation conditions. Larry showed levels of scanning in the second matching session and in both sessions of the imitation condition. Therefore, the results indicated that Brandan and Larry had all assessed skills in their repertoire, and Freddy showed three of the four assessed skills.

Figure 3 shows the results of the skills assessment for Wyatt, Josh, and Amar. Wyatt met the mastery criterion for all assessed skills within two sessions per condition except for scanning. He engaged in scanning in 90% of trials during one session of the imitation condition, and he displayed lower levels of scanning in the second session. Additional sessions were not conducted because his correct responding met the mastery criterion in the imitation condition. Josh met the mastery criterion for all assessed skills, although he required three sessions to demonstrate mastery in the visual discrimination condition. Amar met the mastery criterion in the imitation, visual discrimination, and matching conditions. However, he did not meet the mastery criterion in the auditory discrimination condition.

The results of conditional discrimination training are displayed in Table 2 and Figures 4 and 5. The results for Hal, Rose, and Linda are displayed in Table 2. Their conditional discrimination training results are not shown but are available in Kodak et al. (2011). Hal’s results (p. 1065; Figure 2, bottom) showed that conditional discrimination training using reinforcement, position prompt, or identity matching did not result in mastery performance, whereas training using a blocking procedure did result in criterion performance (p. 1072; Figure 8). Blocking has been shown to produce conditional discriminations with sets of two targets at a time (Saunders & Spradlin, 1989, 1990). Hal’s skills assessment results correlated with the results of his A-V conditional discrimination, because he did not show mastery of auditory and visual discriminations or imitation in the skills assessment nor

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### Table 2

<table>
<thead>
<tr>
<th>Participant</th>
<th>Trials per session</th>
<th>Identity matching</th>
<th>Imitation</th>
<th>Auditory discrimination</th>
<th>Visual discrimination</th>
<th>Scan</th>
<th>A-V CD</th>
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<tr>
<td>Hal</td>
<td>16</td>
<td>+</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Rose</td>
<td>16</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Linda</td>
<td>16</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Brandan</td>
<td>16</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Larry</td>
<td>16</td>
<td>+</td>
<td>+</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
</tr>
<tr>
<td>Freddy</td>
<td>16</td>
<td>+</td>
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<td>–</td>
<td>+</td>
<td>+</td>
<td>–</td>
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<td>Wyatt</td>
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<td>+</td>
<td>+</td>
<td>+</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Amar</td>
<td>12</td>
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<td>–</td>
<td>–</td>
<td>+</td>
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</tbody>
</table>

**Note.** The number of training trials per session during A-V conditional discrimination training (A-V CD), and responding that met (+) or did not meet (−) the mastery criterion during identity-matching, imitation, auditory discrimination, visual discrimination, and scanning conditions. The final column shows whether the participants acquired the A-V conditional discriminations during training in at least one condition.

*An alternative training procedure was required to produce mastery during training.*
did he learn A-V conditional discriminations through standard training procedures (e.g., prompt delay). However, his assessment results were not correlated with his outcomes during blocking. Rose (p. 1069; Figure 6, middle) and Linda (p. 1067; Figure 4) showed mastery of A-V conditional discriminations in the reinforcement condition, which corresponds to criterion performance in all conditions of their skills assessment.

The conditional discrimination training results for Brandan, Larry, and Freddy are shown in Figure 4, which displays unprompted correct
responses only. Brandan’s unprompted correct responses reached the mastery criterion in the reinforcement condition after 11 sessions. Therefore, Brandan’s mastery performance in all conditions of the skills assessment was correlated with his mastery of targets during conditional discrimination training. Larry’s responding remained low in the reinforcement condition and was variable and at chance level in the position-prompt condition. Larry’s low levels of responding during A-V conditional discrimination training were correlated with his
outcomes on the skills assessment, which showed that he did not display accurate responding to the auditory discrimination task. Freddy’s training data showed consistently low levels of unprompted correct responding across the reinforcement and position-prompt conditions. Thus, we observed a correlation between Freddy’s A-V conditional discrimination training and the results of his skills assessment, because he did not master A-V conditional discriminations.
or auditory discriminations in the skills assessment.

The conditional discrimination training results for Wyatt, Josh, and Amar are shown in Figure 5, which displays unprompted correct responses only. We used an adapted alternating treatments design with these participants to compare the effects of several training procedures on acquisition of targeted A-V conditional discriminations. Wyatt’s unprompted correct responses were at or below chance level in baseline. During training, he reached the mastery criterion in the position-prompt condition after four sessions and in the reinforcement condition after nine sessions. His responding remained near chance level in the control condition. Josh’s results showed that unprompted correct responses were low and consistent across conditions in baseline. He showed an immediate increase in unprompted correct responses in the position-prompt condition, and he reached the mastery criterion after two sessions. His unprompted correct responses did not meet the mastery criterion in the reinforcement or control conditions, despite the fact that more than double the number of training sessions were conducted than in the
position-prompt condition. Overall, the skills assessment outcomes for Wyatt and Josh correlated with those obtained during A-V conditional discrimination training, because they demonstrated mastery of all conditions in the skills assessment and acquired A-V conditional discriminations in at least one training condition.

Amar engaged in low levels of correct responding in all conditions in baseline. After the introduction of training, Amar demonstrated mastery of the targets in the reinforcement condition in eight sessions. We discontinued training in the identity-matching and model-prompt conditions after we had conducted more than twice the number of sessions required to produce mastery in the reinforcement condition. Amar was near the mastery criterion during some sessions of the identity-matching condition, and he frequently labeled the target stimuli as well as other stimuli by their correct color (e.g., pointed at green items and said “green”). He did not frequently label items by the colors included in the model-prompt condition. Overall, the outcomes of Amar’s A-V conditional discrimination training and his skills assessment were inconsistent, because mastery-level responding during A-V conditional discrimination training did not correlate with his low levels of correct responding in the auditory discrimination condition of the skills assessment.

**DISCUSSION**

The results of the skills assessment were correlated with outcomes of A-V conditional discrimination training for seven of our nine participants. A lack of correspondence was observed for Hal and Amar. Both of these participants did not show criterion performance during the skills assessment and subsequently demonstrated mastery during conditional discrimination training in either the blocking (Hal) or reinforcement (Amar) training condition. Although Amar did not exhibit criterion performance during the auditory discrimination condition of the skills assessment, he exhibited different response latencies in the presence of the $S^+$ and $S^-$ during this condition. Amar’s latency from stimulus presentation to touching the card averaged 1.4 s in the presence of the $S^+$ and 3.3 s in the presence of the $S^-$. Although Amar’s response latency was different in the presence of each auditory stimulus, these data were not used for determining mastery performance because we did not conduct similar analyses with the other participants to determine mastery performance in this condition.

This study replicates and extends the existing literature on A-V conditional discrimination training in several ways. First, the current investigation extends the literature on measuring skills that may be related to accurate performance during visual–visual conditional discrimination (Saunders & Spradlin, 1989) to A-V conditional discrimination. Both participants in Saunders and Spradlin (1989) exhibited functional speech and identity matching before participation in the study. Although all of the participants in the present investigation demonstrated accurate identity matching in the skills assessment, they had limited vocal repertoires. In fact, all but one of the participants who failed the auditory discrimination condition in the skills assessment could echo (i.e., point-to-point correspondence with an auditory verbal stimulus; Skinner, 1957) fewer than three sounds (see Table 2 for a list of participants who did and did not echo). The strength of an individual’s echoic repertoire may have implications for A-V conditional discrimination training because participants who do not echo words or sounds may be unable to engage in a successive discrimination between auditory sample stimuli (i.e., an auditory discrimination). In this case, participants who are unable to discriminate between the auditory sample stimuli *dog, banana, and cat* during A-V conditional discrimination training will be unlikely to benefit from this type of training. However, all of the participants in our study had goals related to A-V conditional discrimination and were working on
these skills in their classroom settings. The relation between a child’s echoic repertoire and success with A-V conditional discrimination training should be investigated further in future studies.

Previous research that measured skills for A-V conditional discrimination training suggests that the conditions included in the skills assessment are helpful variables to measure before A-V conditional discrimination training is initiated (e.g., Martin, Yu, & Vause, 2004). The components of the current skills assessment are similar to conditions included in the ABLA (Kerr et al., 1977). However, there are a few distinctions worth noting. First, tasks in the ABLA occur in a particular order. For example, the ABLA measures imitation before matching is evaluated. If an individual does not demonstrate mastery at one level, the assessment ends. Although it is reasonable to discontinue an assessment if it is presumed that the individual will not demonstrate mastery of skills at higher levels, the results of the current investigation challenge whether mastery of one task is necessary for mastery of a different task. For example, Hal demonstrated mastery of matching but not imitation, auditory discriminations, or visual discriminations. In addition, all but one of the participants who failed at least one condition in the skills assessment demonstrated mastery of matching in just two sessions (the fewest number of sessions possible to conduct in the assessment, based on the mastery criterion). Thus, it remains unclear whether the difference in performance across skills relates to the types of tasks included in our assessment compared to the ABLA or some other variable.

The current skills assessment measured scanning, which is not a behavior that is measured in the ABLA. Correct performance on A-V conditional discriminations is facilitated if the participant attends to the comparison stimuli in the array before he or she responds (Fisher et al., 2007; Smith, 2001). However, less is known about the role of scanning during A-V conditional discriminations. Although participants could attend to stimuli at various points in time without scanning from one picture to the next, scanning may be beneficial when arrays of materials are presented. For example, during training of sight words, students should scan all the letters within each word in the array to assist in acquiring discriminations among written words that are similar (e.g., seen and sees). Responding may be inaccurate if the student does not scan each and every letter in every word before responding. Anecdotal observations of participants in the current study indicated that they may have scanned the array until they reached the picture associated with the correct response in a trial. We observed this pattern of responding during Larry’s first matching session in the skills assessment. He frequently scanned the array until he came to the comparison stimulus that matched the sample stimulus (an identical picture). Thus, he frequently responded correctly despite not having scanned the entire array of comparison stimuli. Although measuring scanning in this way may underestimate the participant’s level of scanning within the session by omitting instances of partial or incomplete scanning of the array, scanning an entire array is an important skill for many educational tasks. More research on levels of scanning and accurate responding during conditional discrimination training is warranted.

The present investigation also extends Kodak et al. (2011) and Lerman, Vorndran, Addison, and Kuhn (2004) by evaluating a variety of interventions for training conditional discriminations. Kodak et al. conducted a brief experimental analysis (BEA; e.g., Eckert, Ardoin, Daly, & Martens, 2002) of instructional variables that influence acquisition of A-V conditional discriminations and found that the BEA accurately identified an intervention that was equally or more efficient than an arbitrarily selected intervention. The conditional discrimination training results for Amar, Josh, and Wyatt replicate and extend prior work on BEA
by applying this method to the identification of effective academic interventions for individuals with ASD or global developmental delay. Similar to the results of Lerman et al., our conditional discrimination training data also indicated that the most effective and efficient training procedure varied across participants, although we did not compare the same interventions with all participants. This collection of studies suggests the importance of conducting brief assessments to determine instructional strategies that will produce the most rapid learning for children with ASD.

The current study replicates previous research on differential reinforcement during skill acquisition (e.g., Karsten & Carr, 2009; Vladescu & Kodak, 2010). Several of our participants acquired A-V conditional discriminations in the reinforcement condition (Rose, Brandan, and Amar). Of particular interest are the data from Amar’s conditional discrimination training in which he acquired targets in the reinforcement condition before he acquired targets in conditions that included both prompting and differential reinforcement. Previous evaluations with Amar showed that praise functioned as reinforcement. In the current investigation, the type of differential reinforcement across conditions varied. The reinforcement condition was associated with different schedules of reinforcement (i.e., a fixed-ratio 1 schedule of reinforcement for unprompted correct responses and extinction for incorrect or no responses). In comparison, conditions that included prompts produced different qualities of reinforcement (i.e., high-quality praise and edible items for unprompted correct responses and lower quality praise for prompted correct responses). Our findings highlight the need for additional research that compares the effects of different types of differential reinforcement (i.e., different schedules, differences in quality) on skill acquisition.

There were several limitations of the current study. First, Freddy’s skills assessment included only seven auditory discrimination sessions, whereas other participants had a greater number of sessions in this condition. Therefore, it is possible that Freddy could have demonstrated mastery of the auditory discriminations had we conducted an additional three sessions. In addition, we did not include a visual discrimination condition with Freddy because he consistently engaged in accurate visual discriminations when he communicated using pictures in other settings. It may have been helpful to include a visual discrimination condition to demonstrate mastery of this skill and maintain consistency across participants.

Another limitation of the study was that we did not collect data on the duration of the skills assessment. Our long-term goal is for teachers, school psychologists, behavioral consultants, and other practitioners to use the skills assessment with students before A-V conditional discrimination training is conducted. Therefore, information regarding the efficiency of the assessment tool would be useful. Future research on this assessment procedure should measure the amount of time required to complete the assessment. It is also unclear if a 10-session maximum is an appropriate discontinuation criterion. Rose was the only participant in the current study who demonstrated mastery of one of the targeted skills after the fifth session. It may be possible to decrease the total number of sessions further to improve the efficiency of this assessment tool. However, any attempts to improve efficiency should be evaluated in relation to the potential for inaccurate outcomes.

We used a nonconcurrent multiple baseline design across participants with Brandan, Larry, and Freddy during conditional discrimination training. We recommend use of the adapted alternating treatments design in future studies so that each participant serves as his or her own control. In addition, the skills assessment did not include a control condition. Inclusion of a control condition in a multielement design permits a demonstration of experimental control when all test conditions in the assessment produce similar
levels of responding. The absence of a control condition is less problematic in assessments in which we observed differentiated levels of correct responding across conditions (Hal, Rose, Larry, Freddy, and Amar). Future studies using similar skills assessments could include at least one relevant control condition to demonstrate that changes in responding in assessment conditions are related to the independent variable and not some extraneous variable.

The use of only two stimuli in the visual discrimination condition of the skills assessment could also be considered a limitation. Children may be more likely to demonstrate position biases in smaller arrays of stimuli due to the likelihood of reinforcement (Kangas & Branch, 2008; MacKay, 1991). That is, responding to one position in a two-stimulus array is reinforced on approximately a variable-ratio 2 schedule. A larger array of stimuli could be included in future studies with a visual discrimination condition. In addition, our skills assessment did not inform a specific instructional strategy to use during A-V conditional discrimination training. Future studies could evaluate whether modification of the current conditions or the addition of specific conditions would inform the selection of instructional strategies.

The present investigation did not seek to demonstrate a causal link between the absence of certain skills measured in the assessment and failure to acquire targets during A-V conditional discrimination training. This endeavor would require teaching skills not associated with mastery-level responding on the skills assessment and conducting A-V conditional discrimination training after the missing skills had been mastered. Our research team is currently investigating whether doing so will improve outcomes on conditional discrimination training for students who initially fail to demonstrate mastery of these skills.

It remains unclear whether we identified all of the repertoires that are correlated with performance on A-V conditional discrimination training. It may be possible in future research to modify the procedures in certain conditions to enhance the accuracy or efficiency of this assessment. For example, if echoic behavior is predictive of correct responding during the auditory discrimination condition, this condition could be replaced with an echoic assessment such as the Early Echoic Skills Assessment included in the Verbal Behavior Milestones Assessment and Placement Program (Sundberg, 2008). Furthermore, if the individual consistently uses the picture exchange communication system (PECS) to communicate with others and has completed Phase 3 of PECS training (Bondy & Frost, 2001), a visual discrimination condition could be omitted.

Our participants’ inaccurate responding during the auditory discrimination condition warrants further investigation. Incorrect responding during this condition may be related to inadequately developed auditory discrimination skills or a prior history of reinforcement for engaging in a card-touch response. All of the participants had a history of reinforcement for pointing to or touching cards presented in an array. Although we did not specifically program an alternative response to engage in during the presentation of one auditory stimulus (S–), we did guide the participants to keep their hands together in their laps or on the table during these trials in the 0-s prompt-delay sessions. Thus, clasping one’s hands together could be considered an alternative response that was reinforced during relevant 0-s prompt-delay trials. We based our auditory discrimination condition procedures on prior go/no-go research, in which participants refrain from responding to a compound visual stimulus (two symbols presented side by side) if the symbols are not arbitrarily related (e.g., Debert, Matos, & McIlvane, 2007). However, specifically programming two nonvocal responses (e.g., clapping and raising arms) in the auditory discrimination condition may be preferable for students with a history of reinforcement for card touching.
The present investigation offers preliminary information on measuring behavioral repertoires within a skills assessment that can be used by professionals who seek to teach A-V conditional discriminations to individuals with ASD. Conducting assessments that determine the presence or absence of related skills may prevent exposing students to lengthy training from which they are unlikely to benefit.

REFERENCES


ASSESSMENT OF SKILLS 69


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