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A COMPARISON OF METHODS FOR TEACHING RECEPTIVE LABELING TO CHILDREN WITH AUTISM SPECTRUM DISORDERS

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Many early intervention curricular manuals recommend teaching auditory-visual conditional discriminations (i.e., receptive labeling) using the simple-conditional method in which component simple discriminations are taught in isolation and in the presence of a distracter stimulus before the learner is required to respond conditionally. Some have argued that this procedure might be susceptible to faulty stimulus control such as stimulus overselectivity (Green, 2001). Consequently, there has been a call for the use of alternative teaching procedures such as the conditional-only method, which involves conditional discrimination training from the onset of intervention. The purpose of the present study was to compare the simple-conditional and conditional-only methods for teaching receptive labeling to 3 young children diagnosed with autism spectrum disorders. The data indicated that the conditional-only method was a more reliable and efficient teaching procedure. In addition, several error patterns emerged during training using the simple-conditional method. The implications of the results with respect to current teaching practices in early intervention programs are discussed.

Key words: autism, conditional discrimination training, early intervention, receptive labeling, stimulus control

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Conditional discriminations are one of the most commonly targeted skills in early and intensive behavioral intervention (EIBI) (e.g., matching identical items, receptive language). A conditional discrimination involves four components: a sample stimulus, the presentation of comparison stimuli, a response, and a consequence (Saunders & Spradlin, 1989, 1990). In a typical trial during auditory-visual conditional discrimination training, the teacher presents an array (usually two or three) of visual comparison stimuli (e.g., pictures of a bed, chair, and table). Second, the teacher delivers an auditory sample stimulus (e.g., "point to chair"). Third, the learner engages in a response (e.g., pointing to or touching one of the pictures) or is

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prompted to respond. Fourth, the teacher provides differential consequences for correct and incorrect responses. This example of identifying an object from an array after hearing its name is commonly referred to as *receptive labeling* or *receptive identification*.

Accurate responses during conditional discriminations require several prerequisite skills (McIlvane, Dube, Kledaras, Iennaco, & Stoddard, 1990). Learners must observe and differentially respond to comparison stimuli such as a visual array of pictures or objects. Learners must also attend and differentially respond to various sample stimuli that are presented across teaching trials. Learners should attend to the sample stimulus and subsequently observe and respond to the comparison stimuli (i.e., a successive discrimination).

In a recent Internet survey, Love, Carr, Almason, and Petursdottir (2009) assessed a number of EIBI program practices and identified two common approaches to teaching conditional discriminations: the simple-conditional and conditional-only methods. The survey respondents (EIBI program supervisors) reported implementing the simple-conditional method most often (37% of respondents) whereas slightly fewer service providers reported using the conditional-only method (32% of respondents). Other respondents (31%) reported implementing either the simple-conditional method or the conditional-only method depending on the specific repertoire of the child. Given that most EIBI curricular manuals recommend the simple-conditional method (e.g., Leaf & McEachin, 1999; Lovaas, 2003; Maurice, Green, & Luce, 2001), we were surprised that EIBI program supervisors reported using the conditional-only method almost as often as the simple-conditional method.

The simple-conditional method is based on procedures described by Lovaas (2003) for teaching receptive labeling and matching in EIBI programs. This method involves training component simple discriminations in a massed-trial format and introducing increasingly difficult discriminations over time. The rationale behind this approach is to break down the conditional discrimination into multiple, easier steps and gradually increase the difficulty as the learner acquires simpler discriminations. A graphical depiction of how the simple-conditional method can be applied to teaching a three-stimulus array receptive labeling program is shown in Figure 1. Steps 1, 2, and 6 consist of teaching simple discriminations in isolation in a massed-trial format. Simple discrimination training in isolation does not necessarily target or require any of the prerequisite skills to complete conditional discriminations (e.g., attending to the auditory sample stimulus). Steps 3 and 4 involve simple discrimination training in the presence of a distracter stimulus. It should be noted that the distracter stimuli used in Steps 3 and 4 eventually function as a discriminative stimulus (S+) during the simple-conditional method. For example, the distracter stimulus in Step 3 later functions as the S+ in Step 4. Compared to Steps 1 and 2, Steps 3 and 4 involve a more difficult discrimination that requires attending and differentially responding to the visual comparison stimuli. However, the learner is not required to attend to the auditory sample stimulus because it remains the same across the massed trials. Steps 5, 7, 8, and 9 involve either two- or three-stimulus array conditional discriminations in which the learner must attend to both the auditory and visual stimuli to access reinforcement for correct responding.

In her discussion of stimulus control technology, Green (2001) noted that an individual's history with procedures like the simple-conditional method may promote faulty stimulus control during the final steps of conditional discrimination training, particularly for receptive labeling programs (i.e., auditory-visual conditional discriminations). During simple discrimination training in isolation (i.e., Steps 1, 2, and 6), incidental learning may occur such

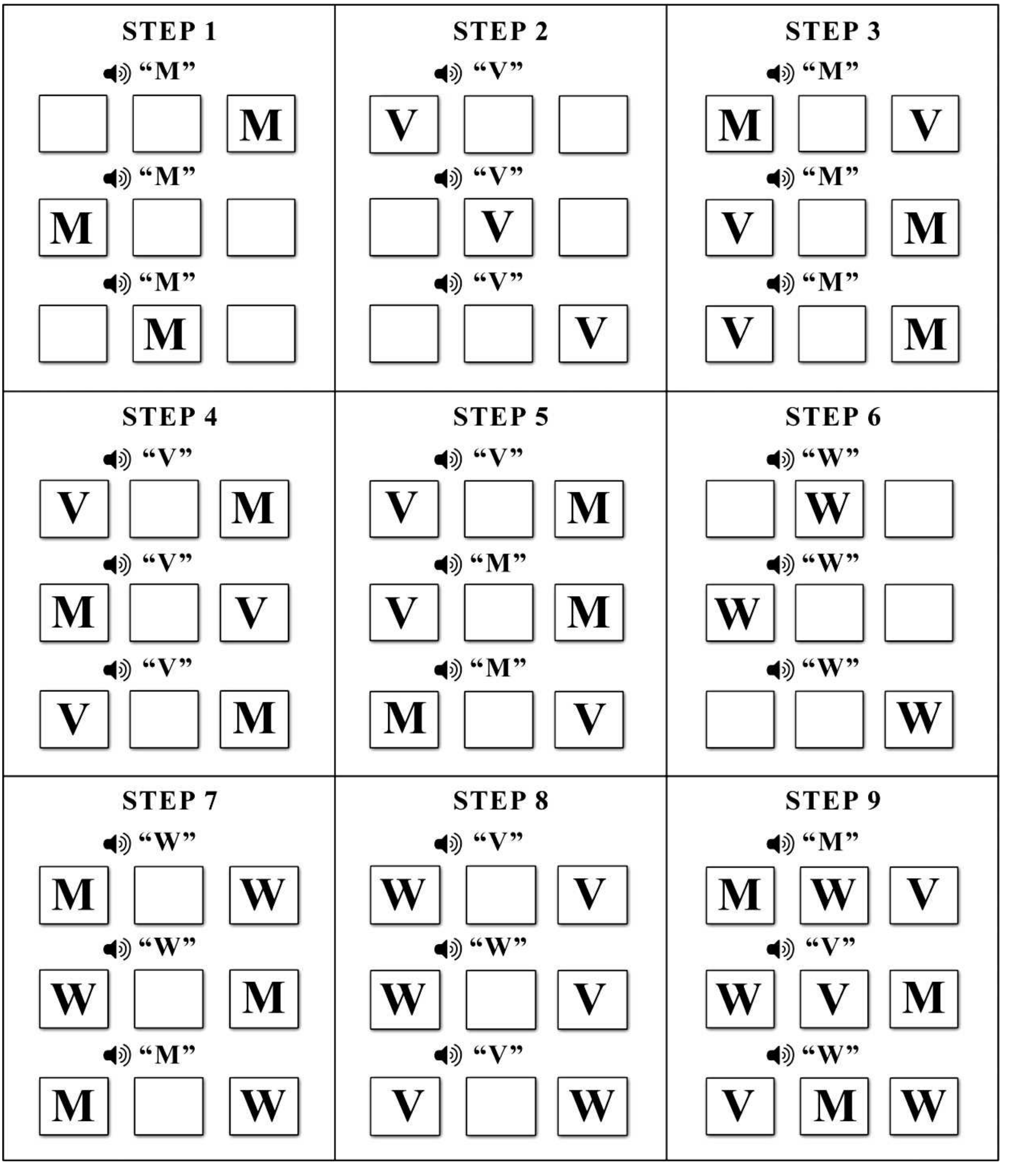

Figure 1. Visual depiction of three trials during each step of the simple-conditional method.

that the learner observes the auditory discriminative stimulus and the correct visual stimulus and relates those stimuli with each other; however, the skill is not directly taught or required (McIlvane et al., 1990). Thus, a learner could respond correctly during Steps 1, 2, and 6 without attending to the specific auditory stimulus (or even the visual stimulus) by simply repeating the same response that was reinforced in the preceding trial. The discrimination in Steps 3 and 4 is made more difficult by requiring differential responding to the visual comparison stimuli, but attending to the auditory sample stimulus is not yet required. Collectively, Steps 1 through 4 may promote overselectivity to the visual component of the antecedent stimuli by establishing a history of reinforcement for responding to the same visual comparison stimulus without requiring attending to the auditory stimulus. Thus, the visual comparison stimulus may control subsequent responding rather than the auditory stimulus and corresponding visual stimulus together, producing faulty stimulus control.

There is some evidence that faulty sources of stimulation may exert control over responses as a function of exposure to the simple-conditional method. Lovaas (2003) described several error patterns that commonly arise during receptive labeling programs. Two types of error patterns, termed *win-stay* responses, may result from a history of the early steps of the simple-conditional method. Molar win-stay responses, characterized by a disproportionately high percentage of responses to the particular visual stimulus that served as the S+ in the preceding acquisition step, might occur during the transition from simple discrimination training of a particular stimulus with distracters to either simple discrimination training with a different stimulus or conditional discrimination training (e.g., transitioning from Step 3 to Step 4). Molar win-stay responses likely result from (a) an immediate reinforcement history involving a particular visual stimulus and (b) the availability of that stimulus as a response option during the subsequent teaching step.

The early steps of the simple-conditional method may also promote molecular win-stay responses that involve responding to the same visual stimulus that was targeted in the preceding trial, regardless of the presented sample stimulus in the current trial. Because the auditory discriminative stimulus remains unvaried in Steps 1 through 4, the learner may ignore the auditory sample stimuli in subsequent conditional discrimination training because prior presentations of auditory stimuli were superfluous to the reinforcement contingency. As a result, the visual stimulus present during either response prompting or reinforcer delivery in the preceding trial may come to influence selection responses.

Other error patterns may occur during the simple-conditional method due to the arrangement of the comparison stimuli during training. More specifically, the majority of steps in the simple-conditional method include an array of only two comparison stimuli, which may result in several error patterns. One such error pattern is position bias, in which the learner reliably selects the stimulus in either the left or right. The schedule of reinforcement (i.e., variable-ratio [VR] 2) associated with many types of error patterns during a two-stimulus array discrimination procedure may support the maintenance of those error patterns over time because the schedule is denser than arrangements with a larger array of stimuli (Kangas & Branch, 2008; MacKay, 1991).

In contrast to the simple-conditional method, in the conditional-only method (described by Green, 2001), component simple discriminations are not targeted prior to conditional discrimination training. Rather, all stimuli (usually at least three) are presented and targeted as a conditional discrimination from the onset of intervention. For example, the experimenter presents three comparison stimuli and irregularly alternates presenting one of three corresponding auditory sample stimuli across session trials. The conditional-only method is identical to Step 9 of the simple-conditional method depicted in Figure 1. The rationale behind this procedure is to begin with a procedure that requires the necessary repertoires needed to respond correctly (i.e., attending and differentially responding to the sample and comparison stimuli). Furthermore, individuals may be less likely to engage in consistent error patterns (e.g., position biases, win-stay responses) during the conditional-only method than during the simple-conditional method because the schedule of reinforcement for a particular error pattern is thinner in the conditional-only method. An important difference between the simple-conditional and conditional-only methods is the arrangement of the sample and comparison stimuli during training. That is, multiple sample and comparison stimulus pairs are targeted in the same teaching session from the onset of training in the conditional-only method, whereas the numbers of sample and comparison stimuli are gradually increased across teaching sessions in the simple-conditional method.

Gutierrez et al. (2009) conducted one of the first studies to evaluate the impact of different types of simple discrimination training on subsequent conditional discrimination learning in applied settings. Three children with an autism spectrum disorder (ASD) were taught to identify a number of stimuli receptively. Half of the stimuli were taught first using simple discrimination training in isolation. After mastery, each of the stimuli was targeted in the presence of a distracter stimulus. The other half of the stimuli were trained in a simple discrimination format in the presence of distracter stimuli from the onset of training. Following both training methods, the previously taught component simple discriminations were targeted in a conditional discrimination format. The learner acquired the stimuli in fewer sessions when the stimuli were taught in the presence of distracter stimuli (i.e., without isolation training). These results may provide some preliminary evidence that Steps 1, 2, and 6 of the simple-conditional method may not build necessary prerequisites for responding accurately during conditional discrimination training or enhance future conditional discrimination learning.

As mentioned previously, the conditional-only method is a widely used procedure for teaching receptive labeling in EIBI programs (Love et al., 2009). Compared to the simple-conditional method, the conditional-only method may promote appropriate stimulus control during conditional discrimination training and may decrease the likelihood of error patterns that interfere with acquisition. To date, no published studies have compared the relative effectiveness and efficiency of the simple-conditional and conditional-only methods for teaching conditional discriminations. Therefore, the purpose of the current study was to compare the relative utility of the simple-conditional and conditional-only methods for teaching receptive labeling to children with ASD.

METHOD

Participants and Setting

Three children with a diagnosis of an ASD participated in the study. Erin was a 7-year-old girl who had been diagnosed with pervasive developmental disorder (not otherwise specified). She spoke in full sentences and independently completed most age-appropriate daily living skills. Prior to the study, she often displayed faulty stimulus control during receptive labeling programs in her early intervention program. She had extensive exposure (approximately 3 years) to both teaching methods evaluated in the study. Sessions were conducted in a room converted into a work area in Erin's home.

Shane was a 4-year-old boy who had been diagnosed with autistic disorder. He communicated using gestures and several spoken words (e.g., pretzels, juice, water) and needed assistance to complete several age-appropriate daily living activities. He had a brief history (approximately 6 months) with the simple-conditional method in his preschool program prior to the study. Sessions were conducted in an unused room in Shane's home.

Devin was a 4-year-old boy who had been diagnosed with autistic disorder and disruptive behavior disorder (not otherwise specified). He communicated using three- to four-word utterances. He had a brief history (approximately 3 months) with the blocked-trial procedure (described in the Discussion section) and the conditional-only method at his early intervention clinic prior to the study. Sessions were conducted in a small treatment room in a clinic setting.

Inclusion for the study required that participants (a) exhibited little or no severe problem behavior, (b) tolerated physical contact, (c) displayed a matching repertoire (evaluated via the Assessment of Basic Learning Abilities; Martin & Yu, 2000), and (d) had goals in their education plans that involved receptive labeling.

Materials

Stimuli (i.e., pictures of objects) were printed on sheets of paper (8.5 in. [21.6 cm] by 11 in. [27.9 cm]) and placed in clear page protectors to generate a trial sheet. The experimenter placed a dark-colored sheet on top of each trial sheet (a) to prevent the participant from viewing the visual comparison stimuli prior to the delivery of the auditory sample stimulus and (b) to provide an opportunity for the participant to complete an observing response (described in more detail below).

Dependent Variables, Measurement, and Interobserver Agreement

A paper-and-pencil method was used to score responses during each trial of a nine-trial session. Observers scored a correct independent response if the participant pointed to the S+ within 5 s of the presentation of the auditory stimulus without errors or experimenter-delivered prompts. Observers scored a prompted correct response if the participant pointed to the S+ within 5 s of an experimenter-delivered prompt. The data collectors scored no response if the participant did not point to a stimulus within 5 s after the presentation of the auditory stimulus. The data collectors scored an observing response when the participant oriented his or her eyes toward each stimulus in the array for approximately 1 s prior to the delivery of the auditory sample stimulus. For each trial, observers also collected data on the comparison stimulus that the participant selected and its location in the stimulus array.

The primary dependent measure was the number of sessions required to meet the mastery criteria for the three-stimulus array receptive labeling program in each condition. The mastery criteria in Steps 1 through 8 of the simple-conditional method required the participants (a) to emit a correct independent response for eight of the nine trials in the session and (b) to respond accurately during the first presentation of each stimulus in the nine-trial session. The mastery criterion for Step 9 of the simple-conditional method and the conditional-only method was three consecutive sessions with 100% correct independent responses.

A second independent observer collected data on several learner responses and aspects of the stimulus arrangement, including independent and prompted correct responses, the location of the first response of each trial, the specific visual stimulus associated with the first response on each trial, and observing responses. An agreement was defined if both observers coded (a) a correct, prompted, or no response; (b) the same visual stimulus for the first response in each trial; (c) the same location of visual stimulus selected; and (d) the occurrence of the observing response. A disagreement was coded during trials in which observers scored any of the responses differently from each other. Point-by-point agreement was calculated by dividing the number of agreements in a session by the number of agreements and disagreements (i.e., nine) and converting the proportion to a percentage. Across all evaluations for Erin, interobserver agreement was assessed during 37% of sessions, and mean agreement was 98% (range, 67% to 100%). For Shane's evaluations, agreement was assessed for 35% of sessions and averaged 97% (range, 89% to 100%). For Devin's evaluations, agreement was assessed

Table 1
Stimuli Taught During Each Evaluation

Participant Evaluation	Conditional only	Simple-conditional
Erin		
1	aardvark, gazelle, hedgehog	bison, lemur, warthog
2	crane, elk, squid	newt, sloth, yak
3	Asia, Australia, S. America	Africa, Antarctica, Europe
Shane		
1	F, J, M (letter name)	B, S, T (letter name)
2	Africa, Antarctica, Europe	Asia, Australia, S. America
3	D, K, L (letter sound)	G, H, R (letter sound)
Devin		
1	bathing, coloring, dancing	catching, giving, sitting
2	C, G, O (letter name)	M, V, W (letter name)

during 32% of sessions and averaged 97% (range, 78% to 100%).

Training Sets

A training set was comprised of three stimuli (i.e., three auditory and corresponding visual stimuli). A stimulus was included in the training set if the participant responded with no greater than 33% accuracy during baseline probes (described below). Stimuli were selected based on the participants' goals in either their individualized education plans or EIBI programs. For each evaluation, one training set was assigned to the simple-conditional and conditional-only methods. That is, six stimuli in total were taught during each comparative evaluation. The specific stimuli taught in the study are displayed in Table 1.

We attempted to equate the training sets by selecting similar stimuli for each evaluation. In addition, the stimuli were grouped such that the auditory stimuli contained the same number of syllables and were as distinct as possible. One exception to this occurred in Devin's second evaluation. Similar visual stimuli were targeted in the training set because Devin had a history of incorrect responses with this type of discrimination. Continents were targeted during Erin's and Shane's second evaluations, and those stimuli were counterbalanced across participants to ensure that outcomes were a function of the teaching methods used rather than characteristics of the stimulus sets.

Procedure

Reinforcer identification. A paired-stimulus preference assessment (Fisher et al., 1992) was conducted with items suggested by either the participant's primary behavior therapist (Devin) or their parents (Erin and Shane) on the Reinforcer Assessment for Individuals with Disabilities (Fisher, Piazza, Bowman, & Amari, 1996) to identify a hierarchy of preferred items. For Devin and Shane, food items were included only in the paired-stimulus preference assessment. For Erin, the paired-stimulus preference assessment was conducted with activities (e.g., board game). We also conducted a brief multiple-stimulus without replacement preference assessment (MSWO; DeLeon & Iwata, 1996) prior to each session with the top four or five items that had been identified in the paired-stimulus preference assessment in an attempt to control for potential fluctuations in preference across sessions.

Baseline probes. Nine-trial baseline probes of relations among stimuli were conducted to identify target stimuli for the subsequent evaluations. During baseline, an array of three pictures was presented to the participant, and he or she was instructed to emit an observing response (i.e., turn over the dark-colored sheet to expose the trial sheet). The purpose of this response was to facilitate the observation of the visual comparison stimuli. If the participant did not observe the comparison stimuli after the sample was presented, the experimenter prompted observing to each comparison stimulus (e.g., pointing to the stimuli, tapping near the stimuli) until it observation occurred. Next, the appropriate auditory stimulus (e.g., "point to lemur") was presented and the participant was given a 5-s opportunity to respond. The auditory sample stimulus and position of the S+ in the comparison array were rotated across trials in the manner recommended by Green (2001). Regardless of whether the response was correct or incorrect, the experimenter removed the stimuli and did not provide differential consequences for selection responses. The experimenter retained stimuli if accuracy was 33% or lower during the baseline probe.

General teaching procedure. As in baseline, the experimenter initiated a trial by presenting the comparison stimuli and prompting the participant to complete an observing response. Next, the experimenter presented the auditory sample stimulus. If the participant made an error or did not respond within 5 s, the experimenter initiated a least-to-most prompt hierarchy (Horner & Keilitz, 1975) that included two levels of model prompts and a physical prompt. The less intrusive model prompt involved the experimenter pointing within 3 in. (7.6 cm) of the correct visual stimulus. The more intrusive model prompt involved the experimenter pointing within 1 in. (2.5 cm) of the correct stimulus. Physical guidance involved the least amount of hand-over-hand guidance necessary to ensure a correct response. The experimenter simultaneously presented the auditory sample stimulus with all prompts. Contingent on correct independent responses during teaching trials, the experimenter delivered enthusiastic praise and a small piece of food (Shane and Devin) or one sticker (Erin). Erin had an extensive history (approximately 3 years) with token economies; therefore, Erin had the opportunity to exchange the stickers for backup reinforcers (i.e., the items identified in the MSWO) after she had accumulated 20 stickers. When given the opportunity to make an exchange, Erin was given a choice between selecting an activity and playing for 5 min or saving the activity time and adding it to a future break.

Simple-conditional method. The simple-conditional method was based on procedures described by Lovaas (2003). The general teaching procedure involved a series of nine steps (see Figure 1). Steps 1, 2, and 6 involved simple discrimination training in isolation for the three stimuli in the training set. For Steps 1, 2, and 6, the experimenter repeatedly presented one sample and one comparison stimulus (i.e., one S+) in each session. Steps 3 and 4 entailed simple discrimination training in the presence of a nontarget distracter stimulus. During Steps 3 and 4, the experimenter repeatedly presented one sample stimulus and two comparison stimuli (i.e., one S+ and one S−) in each teaching session. The S− in Step 3 served as the S+ in Step 4, and the S+ in Step 3 functioned as the S− in Step 4. Steps 5, 7, and 8 included a two-stimulus array conditional discrimination in which both visual stimuli functioned as the S+ and S− across trials in one session. For Steps 5, 7, and 8, the experimenter presented one of two sample stimuli, which were irregularly alternated, and the two corresponding comparison stimuli in each session. Step 9 consisted of the presentation of three stimuli that functioned as both the S+ and S− in a session. That is, the experimenter presented one of three sample stimuli that were irregularly alternated across trials and the three corresponding comparison stimuli in each session.

For Steps 1, 2, 6, and 9, we semirandomly rotated the S+ among the left, middle, and right positions. For Steps 3, 4, 5, 7, and 8, we semirandomly rotated the S+ between the right and left positions. The comparison stimuli were presented in an array of two because counterbalancing two stimuli across three positions in a manner that is consistent with procedures described by Green (2001) was difficult to arrange in a nine-trial session without targeting a particular stimulus in an uneven manner across positions. In a nine-trial session with an array of two comparison stimuli, a given stimulus was disproportionately targeted in the left and right positions in one teaching session. For steps that included an array of two stimuli (Steps 3, 4, 5, 7, and 8), we developed two different stimulus presentations to target each stimulus proportionately in the left and right positions over the course of two sessions.

Conditional-only method. The procedures were identical to Step 9 of the simple-conditional method. That is, a three-stimulus array conditional discrimination was targeted from the onset of training. The S+ irregularly alternated among the left, middle, and right positions. The presentation of each of the sample stimuli was rotated based on procedures recommended by Green (2001).

Additional procedures. In some cases, the simple-conditional and the conditional-only methods were insufficient for teaching the training sets. In those situations, we implemented additional procedures, and the selection of those procedures was based on within-session patterns of responses during training.

Repeated auditory stimulus presentations, additional observing response, and error correction. Based on error patterns in the simple-conditional method during Evaluations 2 and 3 for Erin, we hypothesized that her responses were influenced by the specific visual comparison stimulus that was targeted in either the previous phase or trial. Following the initial delivery of the sample stimulus, Erin was instructed to emit a vocal observing response (i.e., repeat the auditory sample stimulus) to ensure that she attended to the auditory sample stimulus. Next, the experimenter presented the comparison stimuli and re-presented the sample stimulus. Due to the transience of auditory sample stimuli, the auditory stimulus was repeated every 2 s following Erin's observing response (Green, 2001) until a response occurred or 5 s elapsed with no response. In addition, we added an error-correction procedure to increase the likelihood that Erin responded to the correct stimulus and to establish a history of reinforcement for responses to the correct stimulus (Rodgers & Iwata, 1991; Smith, Mruzek, Wheat, & Hughes, 2006). If an error occurred, the experimenter prompted the correct response and immediately re-presented an identical trial. This process was continued until a correct independent response occurred. Correct independent responses during error correction resulted in the delivery of a sticker.

Most-to-least prompting. During Evaluations 2 and 3 for Shane, the experimenter changed the prompting procedure from least-to-most prompting to most-to-least prompting for two reasons. First, low levels of accuracy led to an overall reduction in the number of reinforcers earned during the session, which appeared to evoke problem behavior (e.g., aggression and disruption). A prior functional analysis from Shane's EIBI program indicated that his problem behavior was maintained by access to food and toys (i.e., positive reinforcement in the form of tangible items). Second, Shane allocated a higher proportion of responses to particular comparison positions during teaching, which may have interfered with the acquisition of the conditional discrimination. During the first session of most-to-least prompting, the experimenter physically guided Shane to select the correct comparison stimulus. Next, the experimenter interspersed least-to-most probes after every two most-to-least prompting sessions (a) to determine if prompts could be faded during most-to-least prompting sessions and (b) to assess levels of independent responses across teaching sessions. The prompt that occasioned the highest proportion of correct responses during the least-to-most probe was used during the two subsequent most-to-least prompting sessions. During least-to-most probes, observers collected data on the same dependent variables as those noted for the least-to-most sessions in the prior phase. Thus, observers collected data on independent responses that were comparable across phases.

Alternative observing response. During Shane's second evaluation, he rarely attended to the visual stimuli without repeated experimenter prompts. To enhance independent attendance to the visual comparison stimuli, the experimenter prompted an alternative observing response prior to presenting the sample and comparison stimuli. The experimenter presented the dark-colored piece of paper on top of a trial sheet in an upright position at Shane's eye level. This presentation is different from the original format in which the experimenter presented the trial sheet laid flat on the table. A least-to-most prompting procedure was used to teach Shane to pull the dark-colored paper positioned in front of the trial sheet to expose the visual comparison stimuli.

Maintenance. The experimenter conducted baseline probes (identical to those described above) 3 weeks after mastery of each training set. The purpose of these probes was to assess whether participants' acquisition of the three-array conditional discrimination was maintained. Because Shane did not meet mastery criteria for the stimuli trained using the simple-conditional method in the third evaluation, we did not conduct a maintenance probe for these stimuli.

Design

An adapted alternating treatments design (Sindelar, Rosenberg, & Wilson, 1985) was used to compare discrimination learning during the simple-conditional and conditional-only methods. Two or three comparative evaluations were conducted for each participant.

Treatment Integrity

To assess treatment integrity, an independent observer recorded the experimenter's implementation of the following during each trial: (a) each type of prompt, (b) the order in which prompts occurred, (c) the response interval following prompts, (d) consequences for correct and incorrect responses, and (e) the procedure to facilitate an observing response. Observers collected additional integrity measures for Erin during Evaluations 2 and 3. These included the experimenter's correct implementation of (a) the procedure to facilitate the vocal observing response, (b) additional deliveries of the auditory sample stimulus, and (c) the error-correction procedure. Observers also collected treatment integrity measures for Shane. These included the experimenter's correct implementation of (a) the alternative observing response (Evaluation 2) and (b) a most-to-least prompting procedure (Evaluations 2 and 3). A trial was scored as correct if all experimenter responses were implemented as specified by the research protocol. When calculating the integrity measures, a trial was scored as incorrect if any treatment integrity measure was scored as incorrect by either observer. The percentage of correctly implemented trials was calculated by dividing the number of correct trials by the total number of trials and converting the proportion to a percentage. Treatment integrity was assessed during 37% of sessions and averaged 98% (range, 78% to 100%) for Erin. For Shane, treatment integrity was assessed during 35% of sessions and averaged 97% (range, 78% to 100%). For Devin, treatment integrity was assessed during 32% of sessions and averaged 97% (range, 78% to 100%). Point-by-point interobserver agreement was calculated for all treatment integrity measures and averaged at least 97% for each participant.

Error Analysis

We conducted several error analyses during phases that required additional intervention components to meet the mastery criterion. We reviewed the data sheets and retrieved information that allowed a detailed analysis of responses within each teaching session. An analysis of

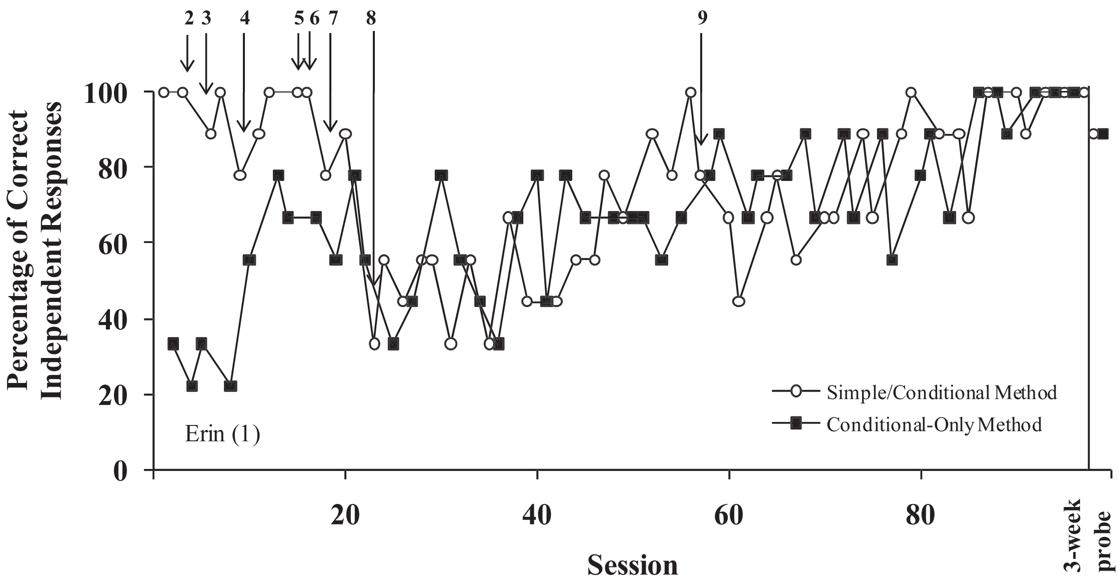

Figure 2. Percentage of correct independent correct responses during Erin's first evaluation. The numbered arrows represent steps in the simple-conditional method.

proportion of molar win-stay responses was conducted if an additional intervention was required for Steps 3, 4, 5, or 7 of the simple-conditional method. The first and fifth authors examined the data sheets after teaching sessions to conduct the error analyses. A molar win-stay response was coded if the participant responded to the visual comparison stimulus that functioned as the S+ in the preceding step. The percentage of molar win-stay responses was calculated by dividing the number of molar win-stay responses by the total number of errors and converting the ratio to a percentage. A molecular win-stay response was coded if the participant responded to the visual comparison stimulus that functioned as the S+ in the preceding trial. The percentage of molecular win-stay responses was calculated by dividing the number of molecular win-stay responses by the total number of errors and converting the ratio to a percentage. We conducted a position bias analysis if a high proportion of responses was allocated to a particular position regardless of the auditory sample stimulus. The percentage of responses to a particular position by dividing the number of responses to the position was calculated by the number of trials and converting the ratio to a percentage.

RESULTS

Erin

Figures 2, 3, and 4 display the results for Erin's evaluations. Figure 2 depicts the percentage of correct independent responses during her first evaluation. The training set taught using the conditional-only method was mastered in slightly fewer sessions (i.e., three) than in the training set taught using the simple-conditional method. At the 3-week follow-up, both training sets were maintained at 89% under baseline contingencies.

Figure 3 depicts the results of Erin's second evaluation. The top panel displays the percentage of correct independent responses. She mastered the training set in the conditional-only method without the use of additional procedures and mastered Steps 1 through 4 of the simple-conditional method with relatively few errors. Step 5 was implemented for 45

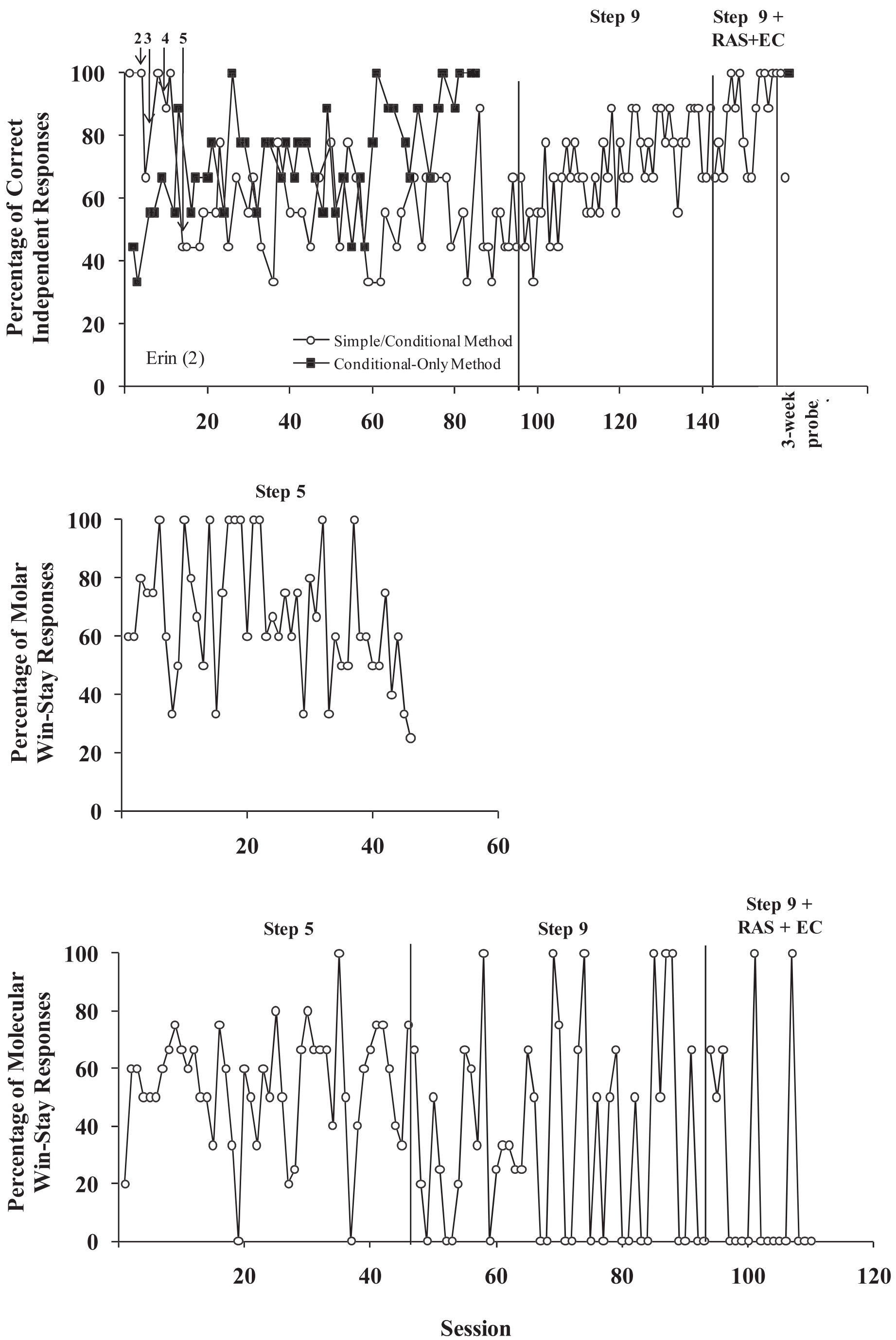

Figure 3. Percentage of correct independent responses (top), percentage of molar win-stay responses (middle), and percentage of molecular win-stay responses (bottom) during Erin's second evaluation. RAS = repeated auditory stimulus; EC = error correction. The numbered arrows represent steps in the simple-conditional method.

sessions, and the level of independent responses did not increase above chance level (i.e., 50%). Given that Evaluations 1 and 2 had demonstrated that the conditional-only method was an effective acquisition procedure, Step 9 (i.e., conditional-only method) was introduced immediately after Step 5. That is, the third, untrained stimulus was added to the array, and the training set was presented in a conditional discrimination format. This change resulted in a noticeable improvement in Erin's responding; however, the mastery criterion was still not achieved. Two additional procedures, a repeated auditory stimulus (RAS) procedure and error correction (EC), were then added to increase the saliency of the auditory sample stimulus and the likelihood that Erin would attend and differentially respond to the sample stimuli. Following the introduction of the RAS and EC components, Erin mastered the training set. At the 3-week follow-up, the conditional-only method training set was maintained at 100%, whereas the simple-conditional method training set was maintained at 67%.

Figure 3 (middle) shows the percentage of molar win-stay responses during Step 5. Erin engaged in a higher percentage of molar win-stay responses during the initial teaching sessions than in the final teaching sessions of Step 5. These data suggest that an instructional history with a massed-trial format in Step 4 might have produced a maladaptive response pattern when the first conditional discrimination was introduced in Step 5. Figure 3 (bottom) displays the percentage of molecular win-stay responses. An increasing trend in molecular win-stay responses was observed during Step 5. After Step 9 was implemented, molecular win-stay responses decreased somewhat and were substantially more variable during Step 9. Nonetheless, an increase in correct independent responses was observed following implementation of Step 9. After the the RAS and EC components were added, molecular win-stay responses declined to zero, and Erin quickly met the mastery criterion for the training set.

Figure 4 displays the results of Erin's third evaluation. The top panel depicts the percentage of correct independent responses. Erin quickly mastered Steps 1 through 4 of the simple-conditional method. After an extensive period in Step 5, she rapidly progressed to Step 9. Erin met the failure criterion (i.e., at least 10 sessions with no increases in independent responses after the mastery criterion had been met in the other condition) during Step 9, and the RAS and EC components were introduced, after which Erin mastered the training set. At the 3-week follow-up, the training sets were maintained at 56% and 89% for the simple-conditional and conditional-only methods, respectively.

Figure 4 (middle) displays the percentage of molar win-stay responses during Step 5. Although Erin completed Step 5 after a lengthy number of teaching sessions, we conducted an error analysis to evaluate error patterns that potentially interfered with more rapid acquisition. Erin engaged in a higher percentage of molar win-stay responses during the initial sessions than in the final sessions of Step 5, which is consistent with her second evaluation (although the effect is more pronounced here). Figure 4 (bottom) displays the percentage of molecular win-stay responses during Step 5, Step 9, and Step 9 with RAS and EC. Molecular win-stay responses increased during Step 5. Although molecular win-stay responses initially decreased following the introduction of Step 9, the percentage of errors that involved molecular win-stay responses was still relatively high. After the introduction of the RAS and EC components, molecular win-stay responses decreased to zero and she met the mastery criterion for the training set shortly thereafter.

Shane

Figure 5 depicts the percentage of correct independent responses during Shane's first

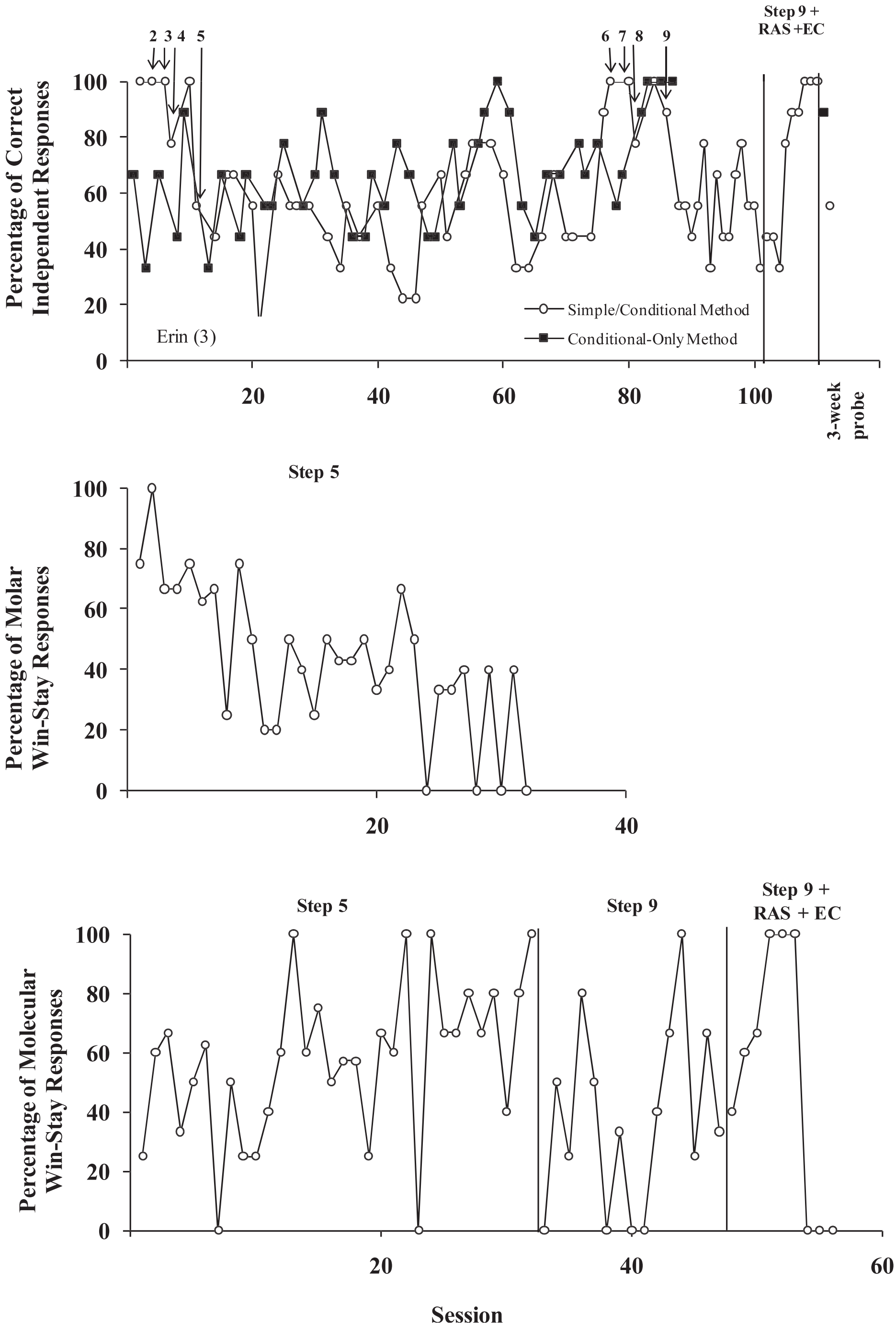

Figure 4. Percentage of correct independent responses (top), percentage of molar win-stay responses (middle), and percentage of molecular win-stay responses (bottom) during Erin's third evaluation. RAS = repeated auditory stimulus; EC = error correction. The numbered arrows represent steps in the simple-conditional method.

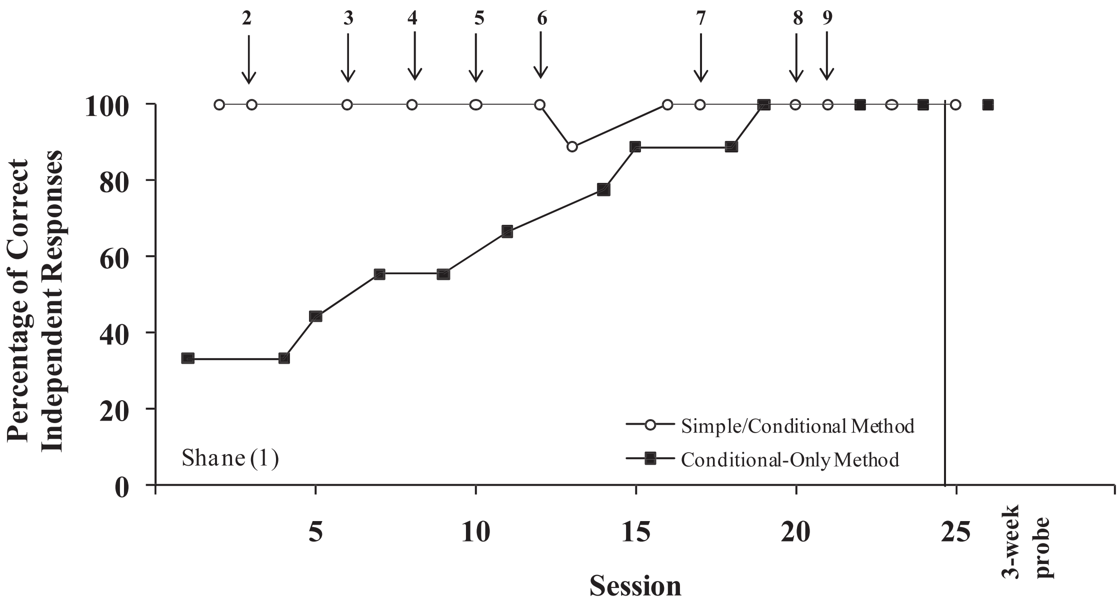

Figure 5. Percentage of correct independent responses during Shane's first evaluation. The numbered arrows represent steps in the simple-conditional method.

evaluation. He acquired the training sets in the same number of sessions in both the simple-conditional and conditional-only methods. During the 3-week follow-up, both training sets were maintained at 100%.

Figure 6 displays the results of Shane's second evaluation. He met the mastery criteria for Steps 1 through 8 of the simple-conditional method with relatively few errors (top panel). However, training during Step 9 did not result in an increase in independent responses. Similarly, correct independent responses did not increase above chance levels in the conditional-only method after extensive training. During teaching sessions in both conditions, Shane engaged in moderate levels of problem behavior including aggression, self-injury, and disruption. We introduced a most-to-least prompting procedure in both conditions to limit opportunities to engage in errors, to increase the number of reinforcers earned during sessions, and to facilitate acquisition of the training sets. However, correct independent responses did not increase in either condition. After the introduction of the alternative observing response, Shane mastered the training set in the conditional-only method in slightly fewer sessions (i.e., nine) than the training set taught using the simple-conditional method. During the 3-week follow-up, the training sets were maintained at 78% and 89% for the simple-conditional and conditional-only methods, respectively. Based on anecdotal observations, little to no problem behavior occurred after most-to-least prompting was introduced.

Figure 6 (middle) displays the percentage of molecular win-stay responses during Step 9 of the simple-conditional method and the conditional-only method. Shane engaged in variable and moderate levels of molecular win-stay responses during the conditional-only method. A slight increasing trend in molecular win-stay responses was observed during Step 9 of the simple-conditional method. After the introduction of most-to-least prompting, molecular win-stay responses stabilized but remained high during the conditional-only method and increased during Step 9 of the simple-conditional

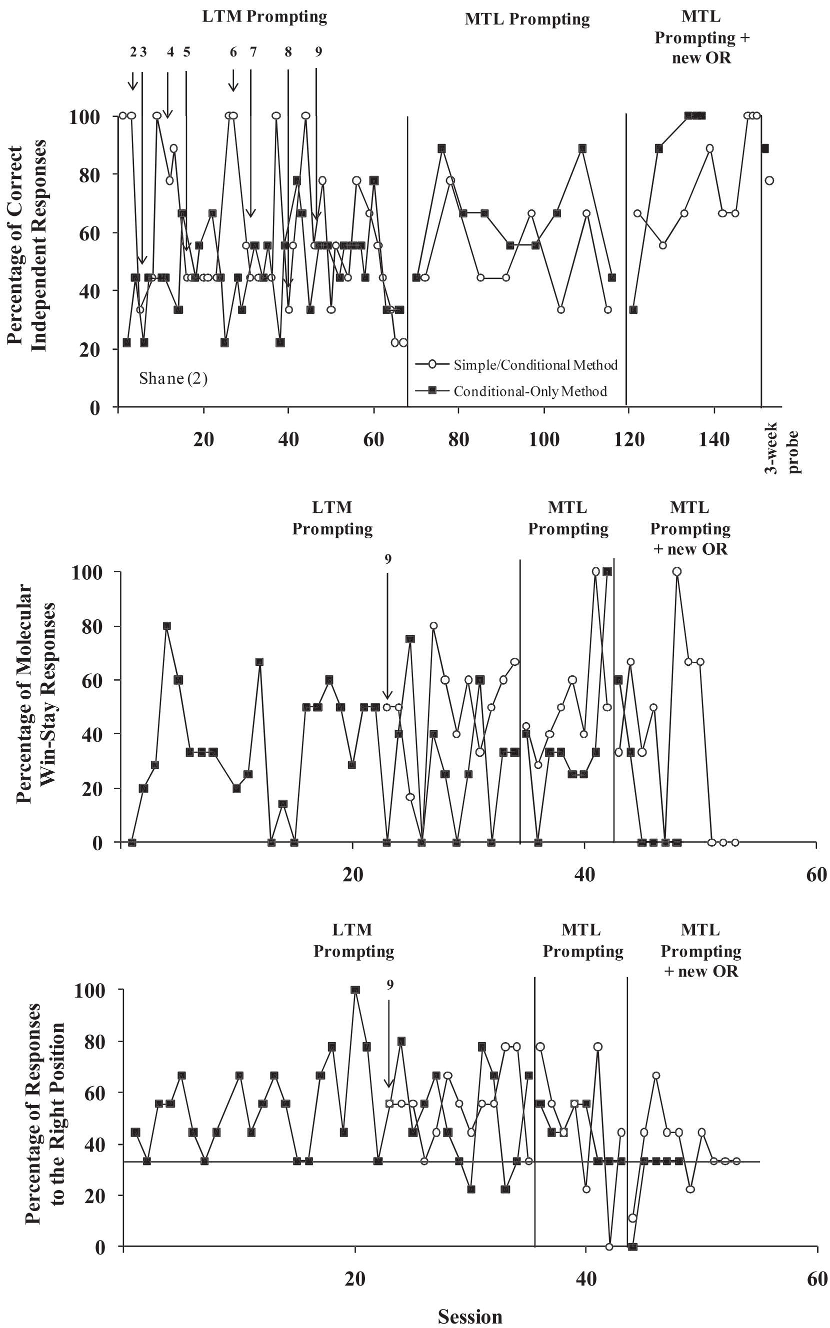

Figure 6. Percentage of correct independent responses (top), percentage of molecular win-stay responses (middle), and percentage responses to the right position (bottom) during Shane's second evaluation. LTM = least-to-most prompting; MTL = most-to-least prompting; OR = observing response. The numbered arrows represent steps in the simple-conditional method; the horizontal line in the bottom panel represents chance-level (33%) responding.

method. After introduction of the alternative observing response, molecular win-stay responses deceased in both conditions.

Figure 6 (bottom) displays the percentage of responses allocated to the right position during Step 9 of the simple-conditional method and the conditional-only method. During Step 9 of the simple-conditional method, Shane exhibited a right position bias that increased toward the end of the phase. Similarly, he responded to the stimulus located in the right position for the majority of trials in each session during the conditional-only method, although the severity of the bias was variable. After implementation of most-to-least prompting (and subsequently, the alternative observing response), responses to the right comparison position decreased to appropriate levels (i.e., 33%) in both conditions, although responding was more variable in the simple-conditional method.

Figure 7 depicts the results of Shane's third evaluation. He met the mastery criteria for Steps 1 through 4 of the simple-conditional method with relatively few errors (top panel). Step 5 was continued for 10 additional sessions after the mastery criterion had been met for the training set taught using the conditional-only method. Given that the conditional-only method was found effective in the first and third evaluations, Step 9 (i.e., conditional-only method) was introduced. An additional 12 sessions of Step 9 were conducted before a most-to-least prompting procedure was implemented. Neither of these additional interventions increased correct responding above chance levels. During the final phase of the evaluation, Shane engaged in moderate levels of problem behavior. The first author discussed Shane's problem behavior with his parents, and all parties determined that it was best to end the evaluation. Because the mastery criterion was not met for the training set taught using the simple-conditional method, a follow-up probe was not conducted. The training set taught using the conditional-only method was maintained at approximately 89% during the 3-week follow-up probe.

Figure 7 (second panel) displays the percentage of molar win-stay responses during Step 5. Molar win-stay responses were high during the initial sessions of Step 5 and declined over time. Figure 7 (third panel) depicts the percentage of molecular win-stay responses during Step 5, Step 9, and Step 9 with most-to-least prompting. Molecular win-stay responses occurred at moderate and variable levels across all of these conditions. Figure 7 (bottom) displays the position bias analysis during Step 5, Step 9, and Step 9 with most-to-least prompting. During Step 5, Shane displayed a bias to the comparison stimulus in the left position. Following the introduction of Step 9, his responses were primarily allocated to the left and middle comparison positions. After we changed the teaching procedure to most-to-least prompting, bias shifted to the middle position.

Devin

Figure 8 displays the percentage of independent responses during Evaluations 1 and 2 for Devin. During the first evaluation (top), Devin met the mastery criteria for the training set taught using the simple-conditional method in fewer sessions (i.e., eight) than the training set taught using the conditional-only method. During the 3-week follow-up probe, he responded accurately during 100% of the trials for both teaching methods. For the second evaluation (bottom), the mastery criterion was met in the conditional-only method a few sessions prior to mastery in the simple-conditional method (i.e., seven fewer sessions). Both training sets were maintained at 100% at follow-up.

Summary

Figure 9 (top) depicts of the number of sessions required to meet the mastery criterion for each evaluation across participants. Training sets taught using the conditional-only method required fewer sessions to meet the mastery

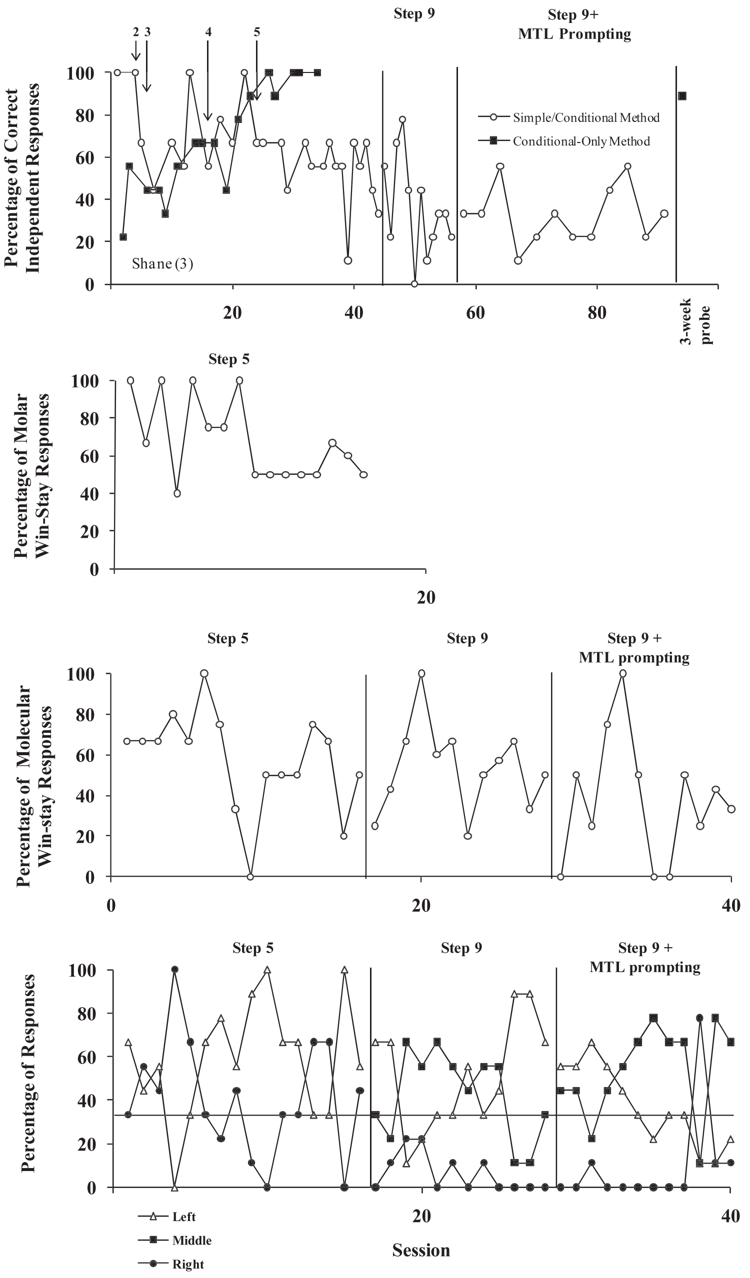

Figure 7. Percentage of independent correct responses (top), percentage of molar win-stay responses (second panel), percentage of molecular win-stay responses (third panel), and percentage responses to the left, middle, and right positions (bottom) during Shane's third evaluation. MTL = most-to-least prompting. The numbered arrows represent steps in the simple-conditional method; the horizontal line in the bottom panel represents chance-level (33%) responding.

criterion (on average, 62% fewer sessions). However, there were small differences in the number of sessions necessary to meet the mastery criterion during Erin's first evaluation. The simple-conditional method was associated with a fewer number of sessions to mastery only for Devin's first evaluation. Figure 9 (bottom) displays the percentage of independent responses

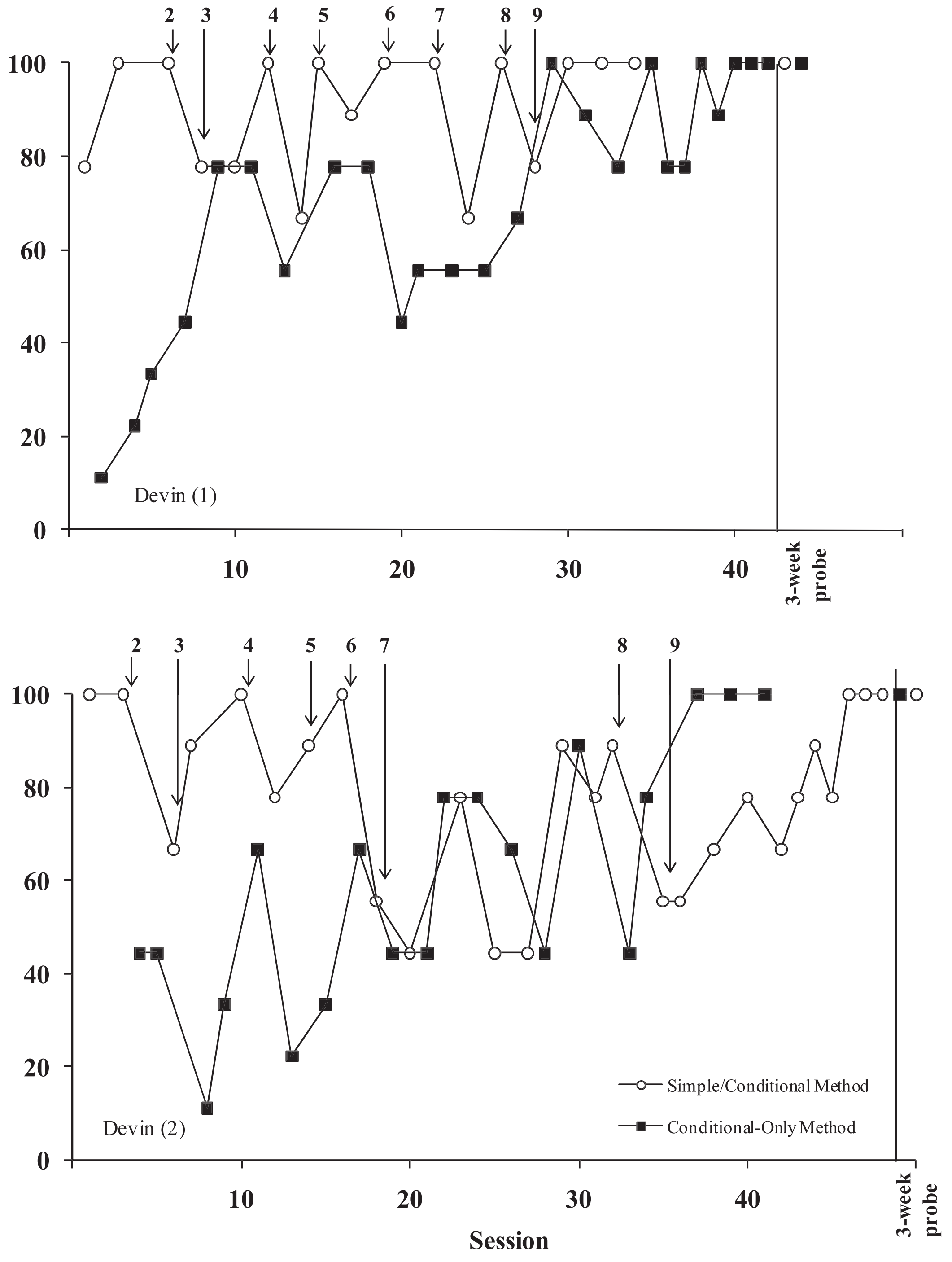

Figure 8. Percentage of correct independent responses during Devin's first (top) and second (bottom) evaluations. The numbered arrows represent steps in the simple-conditional method.

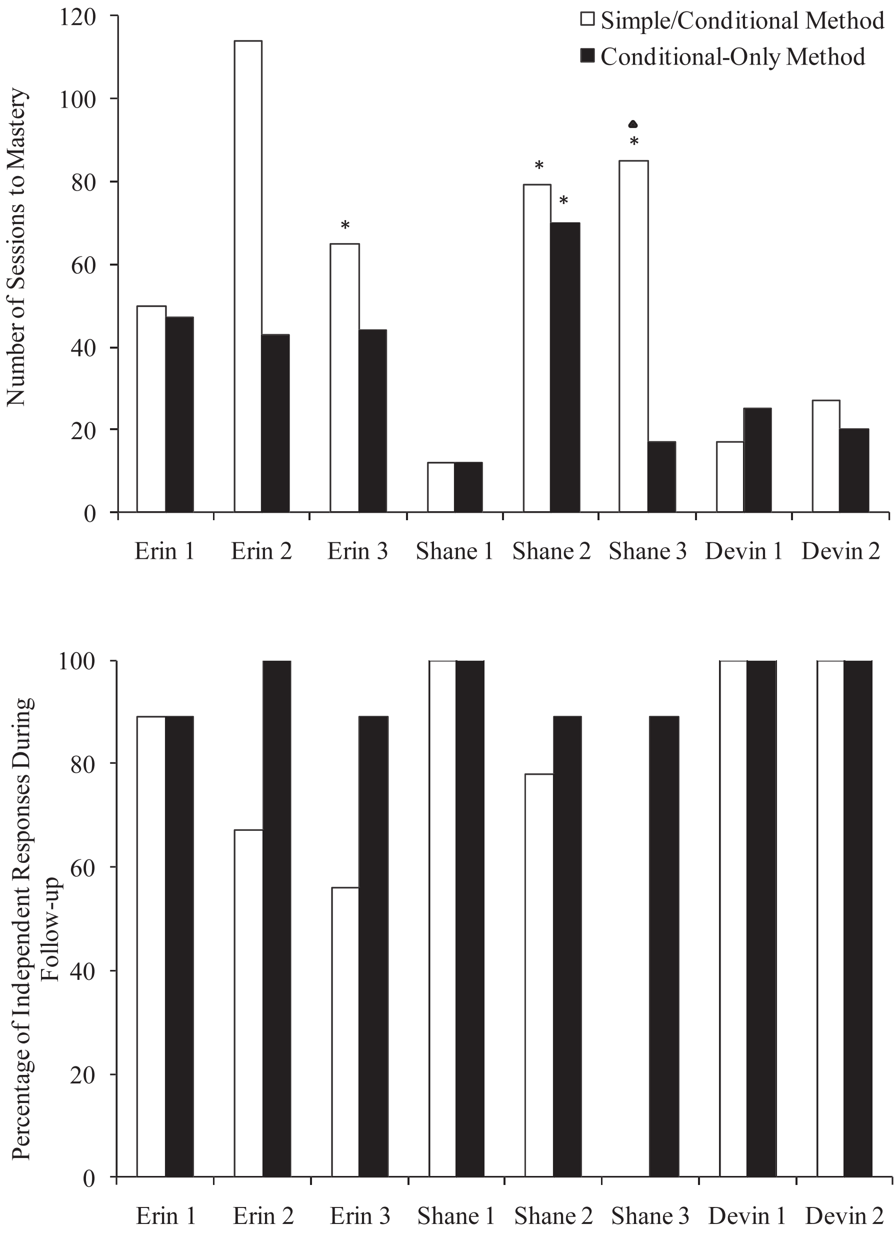

Figure 9. The top panel displays the total number of sessions required to meet the mastery criterion for each teaching method during each evaluation across participants. The triangle indicates training sets that required an additional intervention. The asterisk indicates that the training set did not meet the mastery criterion. The bottom panel displays the percentage of correct independent responses during the 3-week follow-up probe for each evaluation across participants.

during the 3-week follow-up probe for both teaching methods. Maintenance was high in four of the evaluations, regardless of the teaching method. On average, the percentage of independent responses was 26% lower during the simple-conditional method for evaluations that required additional teaching procedures. We did not gather follow-up data for the training set taught using the simple-conditional method during Shane's third evaluation.

DISCUSSION

The purpose of this study was to evaluate two commonly implemented approaches to conditional discrimination training. Without modification, the conditional-only method was effective for seven of the eight evaluations across participants, whereas the simple-conditional method was effective for four of the eight evaluations. Furthermore, the simple-conditional method was associated with error patterns that required additional training components during four of the eight evaluations. Although error patterns occurred during initial training of the conditional-only method, the participants acquired the skills without any additional training components. During the 3-week follow-up probes, better maintenance was observed for the conditional-only method than for the simple-conditional method in four of the eight evaluations. Identical levels of maintenance across the methods were achieved for the other four evaluations. Interestingly, when progress stalled and additional procedures were implemented, maintenance of correct responding was relatively poor (e.g., Erin's second and third evaluations).

The present study suggests that some procedural aspects of the simple-conditional method may foster faulty stimulus control. First, the early steps of the simple-conditional method teach simple discriminations in a massed-trial format that may promote overselectivity to the visual component of the antecedent stimulus in subsequent conditional discrimination training (Green, 2001). Moreover, previous research indicates that children with ASDs are likely to engage in overselective responses to particular aspects (often only one) of a multiple-component antecedent stimulus (Lovaas, Schreibman, Koegel, & Rehm, 1971). For example, molar win-stay responses in the current study may have resulted from a history of repeatedly responding to the same visual stimulus during an acquisition step without the requirement of differentially attending to the auditory stimulus. Issues of faulty stimulus control may arise in Step 5 because attending and differentially responding to the auditory sample stimuli and the comparison array are required to respond accurately, but have not yet been taught in Steps 1 through 4.

Second, most of the steps in the simple-conditional method involve a two-stimulus array discrimination format that poses potential difficulties with faulty stimulus control. Because reinforcers are delivered on a VR 2 schedule of reinforcement when only two comparison stimuli are presented, it is possible that many types of errors (e.g., win-stay responses, side biases) may frequently contact reinforcement. As a result, error patterns may be more likely in steps that use two-stimulus comparison arrangements compared to larger arrays.

Molar and molecular win-stay responses may not occur as often in a three-stimulus array conditional discrimination because those responses rarely contact reinforcers. Close inspection of the error patterns during evaluations with stalled progress suggests that molar and molecular win-stay responses were less likely during a three-stimulus array than during a two-stimulus array. One possible explanation for this difference is that errors are less likely to contact reinforcers in the three-stimulus array. Given that the target stimulus is rotated among three stimuli, there should be very few instances (i.e., one or two out of nine) in which the same stimulus is targeted across two adjacent trials. Thus, the schedule of reinforcement for molecular win-stay responses during the conditional-only method is quite lean compared to that of the simple-conditional method. The results of a study conducted by Koegel, Schreibman, Britten, and Laitinen (1979) suggest that thinning the schedule of reinforcement for overselective responding may reduce errors over time. The results of Erin's second and third evaluations are consistent with those obtained in the Koegel et al. study, in that molecular win-stay responses were lower during the three-stimulus array conditional discrimination than in Step 5 of the simple-conditional method (i.e., a two-stimulus array conditional discrimination). One rationale for using larger arrays of comparison stimuli (at least three) is that identifiable error patterns (e.g., win-stay responses, side biases) are less likely to be established and maintained due to the thinner reinforcement schedule for any particular type of error pattern (Kangas & Branch, 2008; MacKay, 1991).

The error patterns associated with the simple-conditional method call into question the practice of breaking down conditional discriminations into smaller components. Although there is support in the basic literature for training component simple discriminations (e.g., Dube, Iennaco, & McIlvane, 1993; Dube & Serna, 1998; McIlvane et al., 1990; Saunders & Spradlin, 1989, 1990), the simple-conditional method described by EIBI manuals differs from the previously successful training procedures in the basic literature in several ways. First, the simple-conditional method involves both simple discrimination training in isolation (Steps 1, 2, and 6) and in the presence of distracter stimuli (Steps 3 and 4), whereas simple discrimination training in the literature (e.g., blocked-trial procedure; Saunders & Spradlin, 1989, 1990) was conducted only in the presence of a distracter stimulus. Second, the distracter stimuli used in several of the basic studies varied within and across sessions (e.g., Dube et al., 1993; McIlvane et al., 1990). By contrast, the simple-conditional method included the same set of two or three stimuli throughout training. Furthermore, extended periods of simple discrimination training in the presence of distracter stimuli may overtrain attention to the visual comparison stimuli and interfere with appropriate stimulus control during later conditional discrimination training. Although there is a procedural link between the simple-conditional method used in applied settings and the procedures employed in basic stimulus control studies, the present data call into question some of the training steps included in the simple-conditional method.

The results of the present study highlight two potential challenges to implemention of the simple-conditional method and evaluation of the error patterns that may arise. First, the data-collection system used in the present study was perhaps more extensive than typical measures employed in some EIBI programs. The additional data permitted a detailed analysis of within-session error patterns that allowed the development of additional training components that we hypothesized would facilitate the establishment of appropriate stimulus control. For example, the RAS and EC components were added during Erin's second and third evaluations to increase the saliency of the auditory sample stimulus. The selection of those components was based on Erin's molecular win-stay responses, which suggested that her responses were influenced by the visual component of the trial rather than both the auditory and visual components. The time requirement involved in collecting the relevant data and coding several types of errors would likely be prohibitive in many applied settings. Furthermore, EIBI programs are increasingly using discontinuous data-collection systems (e.g., first-trial-only measurement) to reduce the time spent on collecting data and to increase learning opportunities for children during intervention (Love et al., 2009). Thus, the data necessary to conduct many of the error analyses may not be available if discontinuous data-collection systems are used. Second, a great deal of expertise in stimulus control and discrimination learning is required (a) to detect and analyze a wide range of potential error patterns that might develop and (b) to identify treatments that may address faulty stimulus control. It is possible that clinicians may not have the resources or training required to solve problems when issues of faulty stimulus control arise. Given that there are multiple challenges to conducting elaborate error analyses in applied settings, providers should avoid interventions that are associated with the development of faulty stimulus control.

The results of the present study, in conjunction with those obtained by Gutierrez et al. (2009), indicate that simple discrimination training in isolation may not be needed as part of the simple-conditional method. In the current study, participants typically completed Steps 1, 2, and 6 with few, if any, errors. Clinicians in applied settings may endorse the use of the simple-conditional method because initial steps are associated with dense schedules of reinforcement. However, given that simple discrimination training in isolation does not develop any of the prerequisite behaviors required during conditional discrimination, it might be possible to remove Steps 1, 2, and 6 from the procedure. Future research might consider comparing variations of the simple-conditional method to take advantage of any benefits that may result from training component discriminations while attempting to avoid faulty stimulus control that might result from particular aspects of the procedure (i.e., training in isolation). Research could also focus on comparative evaluations of types of simple-conditional methods. For example, the differences in the simple-conditional method described in Lovaas' EIBI manual and the blocked-trial procedure (Saunders & Spradlin 1989, 1990) may produce differential outcomes for learners who benefit from component simple discrimination training.

One potential limitation of this study is that we used a two-stimulus array in Steps 3, 4, 5, 7, and 8, which may have interfered with discrimination learning in Step 9 (i.e., a three-position array). Another limitation of the present study is the use of least-to-most prompting as the initial prompt-fading strategy, which differs from the procedure recommended for the simple-conditional method. The Lovaas (2003) EIBI manual recommends a prompt-fading package that includes position prompts and graduated guidance (i.e., a type of errorless-learning procedure). We used least-to-most prompting in this study to allow independent responses across learning trials. It is possible that the error patterns observed during Erin's and Shane's evaluations may have been prevented if we had used an errorless-learning procedure. Future research might evaluate the simple-conditional and conditional-only methods using an errorless-learning procedure to determine if error patterns are less likely. In addition, many EIBI programs use errorless-learning strategies as the primary teaching strategy (Love et al., 2009), and this evaluation may be useful in the evaluation of current practices in EIBI.

The present study investigated a commonly used but understudied behavior-acquisition procedure in EIBI programs. Many of the EIBI manuals recommend the simple-conditional method, and EIBI supervisors report the use of this method. However, the current study suggests that the simple-conditional method may be associated with error patterns and less efficient acquisition than the conditional-only method. Future research in the area of EIBI should focus on comparative evaluations of procedures that are commonly used in applied settings. Although EIBI can lead to promising outcomes (e.g., Eikeseth, 2009), additional research is needed to refine current procedures and develop new techniques for promoting skill acquisition in children with ASD.

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