Sample First versus Comparison First Stimulus Presentations: Preliminary Findings for Two Individuals with Autism

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Abstract

The current study was a replication of Petursdottir and Aguilar (*Journal of Applied Behavior Analysis*, 46, 58–68, 2016). Two different stimulus presentations were evaluated during auditory-visual discrimination training. A sample-first procedure, in which the sample stimulus was presented before the comparison stimuli, was compared to a comparison-first procedure, in which the sample presentation was presented after the comparison stimuli. The results indicated that both participants learned more quickly in the comparison-first condition, a finding that differed from Petursdottir and Aguilar (*Journal of Applied Behavior Analysis*, 46, 58–68, 2016).

Keywords Matching to sample · Receptive language · Stimulus control

Many instructional programs for individuals with autism spectrum disorder (ASD) target auditory-visual conditional discriminations, more commonly referred to as receptive label training. Such training typically uses a matching-to-sample (MTS) format, in which the instructor presents an auditory (spoken) sample stimulus and the learner selects a corresponding picture from an array of pictures (comparison stimuli). Green (2001) recommends that during training, the sample stimulus is presented first followed by the presentation of the comparison stimuli, at which point the learner makes a selection. However, other early behavioral intervention manuals suggest that the comparison stimuli are presented first in front of the learner followed by the sample stimulus (Leaf & McEachin, 1999; Lovaas, 2003).

There have not been any direct evaluations of the order of stimulus presentation and the potential effects on acquisition for individuals with intellectual disabilities. However, two studies have used a comparison-first arrangement during MTS training. McIlvane, Kledaras, Stoddard, and Dube (1990) demonstrated that presenting comparison stimuli first resulted in increased accuracy scores during a visual-visual matching task for two participants with developmental

disabilities. Presenting the comparison stimuli first appeared to eliminate irrelevant sources of stimulus control by the comparison alone, as participants' responses before the sample stimulus were less likely to compete with control by the sample stimulus. Doughty and Saunders (2009) replicated these findings with two participants with intellectual disabilities. Both participants demonstrated a stimulus bias that appeared to hinder the acquisition of conditional discriminations. The comparison-first procedure appeared to reduce the stimulus bias and increase accurate responses for both participants.

More recently, two studies evaluated stimulus presentations with typically developing children. Petursdottir and Aguilar (2016) evaluated the order of stimulus presentation when teaching receptive labeling to three typically developing children using computerized instruction. A trial-and-error procedure with differential reinforcement for correct responses was used, but prompting procedures were not. The results indicated that all three participants met mastery criterion more quickly in the sample-first condition. It is possible that the typically developing participants had advanced verbal repertoires and engaged in covert echoics or other verbally mediated strategies (Miguel et al., 2015) following the presentation of the sample stimulus. Such verbal repertoires might have enhanced the efficiency of the sample-first procedure, a finding that may not apply to individuals with ASD who have more limited verbal abilities.

Schneider, Devine, Aguilar, and Petursdottir (2018) systematically replicated the procedures of Petursdottir and

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Aguilar (2016) with an additional prompted error-correction procedure with four typically developing children. The results demonstrated quicker acquisition in the comparison-first condition in four of seven evaluations. In contrast, two of seven evaluations indicated an advantage for the comparison-first condition but were associated with slower acquisition in both conditions and some evidence of unwanted sources of stimulus control. One possible explanation for these findings is that when there are specific sources of control by the comparison stimuli that interfere with acquisition of conditional discriminations, the comparison-first procedure may be advantageous. For example, two of the participants in Schneider et al. (2018) that learned more quickly in the comparison-first condition demonstrated mild position or stimulus biases in the sample-first condition but not in the comparison-first condition. These findings are tentative, and additional replications are needed with individuals with ASD.

To date, researchers have not formally evaluated different stimulus presentations with individuals with ASD. The purpose of the present study was to replicate and extend Petursdottir and Aguilar's (2016) procedures by (a) comparing sample-first to comparison-first procedures during receptive label training for two teenagers with ASD, (b) utilizing transfer-of-control procedures (prompt delay) commonly used in applied settings, and (c) presenting the stimuli during table-top instruction.

Method

Participants

Roger was a 17-year-old boy diagnosed with ASD. Roger followed 10 one-step instructions, receptively identified body parts, and receptively labeled approximately 175 pictures of common objects. Roger communicated with an augmentative and alternative communication (AAC) device and manded for several preferred items with vocal approximations. Roger's results on the Receptive One-Word Picture Vocabulary Test, Fourth Edition (ROWPVT-4; Martin & Brownell, 2011), indicated a raw score of 16; standard and percentile ranks could not be calculated, as the raw score fell below testing scores of same-aged peers. Roger had a history of faulty stimulus control during receptive label training that occurred prior to the study as he demonstrated position and stimulus biases. Eric was a 15-year-old boy diagnosed with ASD. He spoke in one- to three-word phrases, followed one- and two-step directions, and receptively identified body parts, as well as approximately 200 common objects. Eric's results of the ROWPVT indicated a standard score of 55, placing him in the 1st percentile.

Setting

All sessions occurred in a conference room with a table and three chairs; no other students or teachers were present. Sessions occurred 3 to 5 days per week and lasted approximately 5 min per session.

Materials

The stimuli, displayed in Table 1, were 24 colored picture cards depicting flowers (Roger) and flags (Eric) printed on 7.62 cm × 12.7 cm laminated cards. Stimuli selected were those that the participants had no prior exposure to and were randomly assigned to four sets (two sets per condition), with three stimuli per set for each participant. Flowers were selected for Roger as he had previous exposure to the sets of flags used in Eric's comparisons.

Dependent Variable and Measurement

The dependent variable was the percentage of unprompted correct responses. Unprompted correct responses were defined as the participant touching the visual stimulus (picture) corresponding to the sample stimulus within 5 s of the sample, without errors or instructor prompts. A prompted correct response was scored if the participant touched the picture corresponding to the sample stimulus after an instructor's prompt. An incorrect response was scored if the participant touched a picture that did not correspond to the sample stimulus. A presample response was scored in the comparison-first condition if a participant touched a comparison stimulus prior to the presentation of the sample stimulus. Presample responses were not counted as correct or incorrect responses. Two independent observers collected data to assess reliability in 27% and 29% of sessions for Roger and Eric, respectively. An agreement was scored if both observers scored a response as (a) unprompted correct, (b) prompted correct, or (c) incorrect. We calculated trial-by-trial interobserver agreement by dividing the number of trials with agreements by the total number of trials in a session and multiplying by 100. Mean agreement was 99.8% for Roger (range 94%–100%) and 99.9% for Eric (range 99%–100%).

Table 1 Stimulus sets for both participants

Stimulus Sets		
Participants	Comparison First	Sample First
Roger	Set 1 lily, tulip, mum	lizzie, bloom, iris
	Set 2 orchid, rose, lupin	peony, stock, lilac
Eric	Set 1 Sweden, Georgia, Mali	Yemen, Togo, Fuji
	Set 2 Finland, China, Iraq	Thailand, Malta, Brazil

Experimental Design

An adapted alternating treatments design (Sindelar, Rosenberg, & Wilson, 1985) was used to evaluate discrimination learning in the comparison-first and sample-first conditions. Each condition occurred once per day, and the order of conditions was alternated each day, with no condition occurring for more than two consecutive sessions. The mastery criterion was two consecutive sessions of 89% unprompted correct responses or better. There were two evaluations for each participant, and the evaluations were conducted sequentially.

Procedures

Before each session, the participants were provided a brief choice opportunity where they selected an edible that was delivered contingently upon correct responses during the session. Each session consisted of 18 trials, and on each trial three comparison stimuli (picture cards) were placed horizontally in front of the participant. The comparison stimuli were counterbalanced to ensure proportional placement of the positive comparison in the left, middle, and right positions. Each picture card served as a positive comparison on 6 trials and as a negative comparison on 12 trials. The order of the sample stimuli varied unsystematically, and the same sample stimulus was not presented on more than two consecutive trials.

Sample-First Condition At the beginning of each trial, the instructor arranged the comparison stimuli on the table but behind a clipboard and out of sight of the participant. The instructor presented a trial-initiation response by instructing the participant to “get ready,” at which point the participant placed his hands on the table and made eye contact with the instructor. The instructor then presented the sample stimulus and said, “Touch [name of flag/flower]” and immediately removed the clipboard and revealed the comparison stimuli on the table. During the first three training sessions, the instructor initially used an immediate picture prompt (0-s delay) to indicate the correct picture card to the participant. The instructor held an identical picture at eye level until the participant responded or 5 s elapsed. A progressive-prompt delay, ranging from 0 to 4 s, was used to remove prompts. The sample stimulus was not re-presented with the prompting procedure. Following two consecutive sessions at 88% correct (unprompted and prompted), the prompt delay increased by 2 s up to a maximum of 4 s. During the 0-s delay, prompted correct responses resulted in the delivery of praise and an edible. Once the delay was increased, prompted correct responses resulted in praise, whereas unprompted correct responses resulted in the delivery of praise and an edible. Incorrect responses resulted in an error-correction procedure. The instructor covered the comparison stimuli for 2 s and re-presented the sample stimulus followed

by an immediate picture prompt. Praise and edibles were not delivered following error correction. The intertrial interval was 5 s, during which time the instructor rotated the comparison stimuli out of sight of the participant.

Comparison-First Condition At the beginning of each trial, the instructor arranged the comparison stimuli on the table but behind a clipboard and out of sight of the participant and presented the trial-initiation response described previously. The instructor removed the clipboard and after approximately 1 s presented the sample stimulus. All prompting and programmed consequences were the same as described in the sample-first condition. If the participant emitted a presample response and touched a comparison stimulus before the sample was delivered, the instructor did not respond. The instructor waited until the participant stopped responding for 2 s and then presented the sample stimulus. If the participant touched an incorrect stimulus, the instructor covered the comparison stimuli for 2 s, removed the clipboard, and re-presented the sample stimulus followed by an immediate picture prompt. Praise and edibles were not delivered following error correction.

Baseline The order and presentation of the stimuli varied depending on the condition in effect, and the counterbalancing of stimuli varied as described previously. There were no differential consequences for correct or incorrect responses. The trial was terminated if the participant did not respond within 5 s of the presentation of the sample. Known instructions were interspersed every three trials, and a preferred edible was delivered contingent on correct responses on the known instructions. During Roger’s second evaluation, the differential observing response (DOR) was implemented, as described in the following section.

DOR (Roger Only) Starting in Session 69 of the first evaluation, a DOR (i.e., an echoic response to the sample stimulus) was added to both conditions for Roger. This was added because of Roger’s limited progress and a prior history with DORs used during conditional discrimination training to facilitate acquisition. The instructor stated the word to be echoed before presenting a trial as described previously. If Roger did not respond, the instructor re-presented the verbal stimulus every 2 s until he vocally imitated it. The instructor proceeded with the trial-initiation response and presented the sample stimulus or the comparison stimuli, depending on the condition in effect.

Final Best Treatment During both of Roger’s evaluations, the stimuli initially assigned to the sample-first condition were reassigned to the comparison-first condition. This reassignment of stimuli occurred because Roger met criterion in the comparison-first condition and continued to respond below

the mastery criterion in the sample-first condition for more than twice as many sessions. There was no predetermined criterion for switching conditions.

Procedural Integrity

An independent observer collected procedural integrity data in 27% and 29% of sessions for Roger and Eric, respectively. The observer scored a correct trial if the instructor presented the stimuli in the correct order (i.e., comparison or sample first, depending on the condition), presented the stimuli as shown on the data sheet (correct order of sample and positions of comparison), implemented prompts at the appropriate delay or withheld prompts, and delivered the proper consequences for correct and incorrect responses. For Roger, the observer also scored if the DOR was properly implemented. Mean procedural integrity was above 99% (range 98%–100%) for both participants.

Results

During Eric's first comparison, he responded at or near chance levels in baseline (Fig. 1, top panel). In the sample-first condition, Eric averaged 35% correct (range 33%–39%), whereas in the comparison-first condition, he averaged 31% correct (range 28%–33%). Following three sessions at 0-s delay in each condition, Eric averaged 92% correct (range 83%–100%) and met mastery criterion in three sessions in the comparison-first condition. In the sample-first condition, Eric averaged 77% correct (range 33%–100%) and met criterion in seven sessions. Eric's responding during baseline in the second comparison was at or near chance levels, as he averaged 28% correct (range 22%–33%) in the comparison-first condition and 33% correct (range 28%–39%) in the sample-first condition (Fig. 1, bottom panel). After three sessions at 0-s delay, Eric averaged 77% correct (range 50%–94%) and met mastery in five sessions in the comparison-first condition. In the sample-first condition, Eric averaged 74% correct (range 56%–89%) and met mastery criterion in nine sessions. Eric did not emit any presample responses during the two evaluations.

During Roger's first comparison, baseline responding was at or near chance levels for both conditions, as he averaged 27% correct (range 17%–33%) in the sample-first condition and 38% correct (range 33%–50%) in the comparison-first condition (Fig. 2, top panel). Following three sessions at 0-s delay in each condition, Roger's responding improved but was variable in both conditions, as he averaged 54% correct (range 44%–72%) in the sample-first condition and 55% correct (range 11%–78%) in the comparison-first condition. After the introduction of the DOR, Roger averaged 79.5% correct (range 67%–100%) and met the mastery criterion in 10

sessions in the comparison-first condition. Roger's responding remained variable and below mastery in the sample-first condition, as he averaged 72.5% (range 50%–89%); after 24 sessions with the DOR, the sample-first condition was switched to the comparison-first stimulus presentation. Roger averaged 85% correct (range 78%–89%) and met criterion in three sessions after switching to the comparison-first format. Roger emitted seven presample responses in the comparison-first condition during the first evaluation. During baseline in Roger's second comparison (Fig. 2, bottom panel), Roger responded at or near chance levels in two out of three sessions in the sample-first condition, as he averaged 26% correct (range 11%–39%), and below chance levels in the comparison-first condition, as he averaged 8% correct (range 0%–17%). After three sessions with a 0-s delay, Roger averaged 88% correct (range 78%–100%) and met mastery in the comparison-first condition in seven sessions. Roger averaged 76% correct (range 50%–94%) in the sample-first condition but had not met mastery after 20 sessions, so the format was switched to a comparison-first presentation. Roger met mastery in two sessions following the switch. Roger emitted four presample responses in the comparison-first condition during the second evaluation.

Discussion

The current study replicated and extended the findings of Petursdottir and Aguilar (2016) by comparing different stimulus presentations with individuals with ASD. The procedures included a prompt delay and were delivered in a tabletop format, similar to behavior-analytic instruction commonly used in applied settings. The results indicated that both participants met mastery more quickly in the comparison-first condition, although one participant required a procedural modification (i.e., DOR). These results differed from those of Petursdottir and Aguilar (2016), as all three of their participants performed better in the sample-first condition, and are significant as they provide empirical support for the use of comparison-first procedures for some learners with ASD.

One explanation for the different outcomes is procedural variations used in the current study, in particular the use of prompting procedures and tabletop instruction. It is possible that the effects of the transfer-of-control procedures vary depending on the stimulus presentations. It is also possible that some learners with ASD benefit more from the comparison-first procedure in which the presentation of the sample is delayed. This might be the case for Roger, who demonstrated a stimulus bias during training similar to the participants in Doughty and Saunders (2009) that appeared to be remediated by switching the order of the sample presentation. The participants' verbal repertoires might have also affected the outcomes. The participants in prior studies (Petursdottir &

Fig. 1 The percentage of unprompted correct responses for Eric during the first (top) and second (bottom) comparisons

Aguilar, 2016; Schneider et al., 2018) had much more developed verbal repertoires and may have covertly echoed sample stimuli in the sample-first condition, rendering that condition more effective. Although the current participants had echoic repertoires, they may not have developed verbal-mediation strategies observed in individuals with more advanced verbal repertoires (Miguel et al., 2015). Last, individual learning histories might also influence the relative effectiveness of different stimulus presentations, as researchers have demonstrated recent exposure to different prompting procedures may be a variable that determines efficiency when teaching intraverbal behavior (Coon & Miguel, 2012). This seemed to be the case for Eric, who did not demonstrate a stimulus bias in his responding but had prolonged exposure to comparison-first procedures used at his school prior to the study.

Comparison-first procedures may be used more frequently in applied settings due to their ease of implementation during tabletop instruction (Petursdottir & Aguilar, 2016).

Our procedure, which entailed blocking the participants' view of the comparison stimuli with a clipboard, offers a simple way to implement the sample-first procedure for learners who benefit from this procedure. Roger also appeared to benefit from the pretrial DOR that has been used in other studies to remediate stimulus control problems (Vedora, Barry, & Ward-Horner, 2017). The use of the DOR with different stimulus presentations warrants further research, as one might expect faster acquisition in the sample-first condition because it resulted in a successive discrimination (Petursdottir & Aguilar, 2016), possibly enhancing control by the stimulus that immediately followed it (sample stimulus).

Roger's data must be viewed cautiously, as it may be argued that the inclusion of the DOR essentially changed the comparison-first condition to a sample-first condition. However, the low number of presample responses emitted by Roger in the comparison-first condition mitigates this

Fig. 2 The percentage of unprompted correct responses for Roger during the first (top) and second (bottom) comparisons

concern. Because the addition of the DOR did not result in an increase in presample responses, the verbal stimulus occasioning DOR did not appear to exert control over the selection of comparison stimuli. Instead, the sample stimulus presented after displaying the comparison stimuli exerted control, thereby maintaining the integrity of the comparison-first format.

The number of participants limits the generality of the current study. Additional research is needed to determine if other individuals with ASD learn more effectively and efficiently in the comparison-first format. The absence of a control condition during the comparison phases is a limitation of the current study, as a control strengthens the internal validity when using an adapted alternating treatments design (Sindelar et al., 1985).

Despite these limitations, the present findings replicated and extended Petursdottir and Aguilar (2016) to individuals

with ASD during tabletop instruction that included transfer-of-control procedures. The results provide preliminary support for the use of comparison-first procedures for some individuals with ASD. Moreover, this study underscores the utility of single-subject designs used to compare procedures and determine which is more effective for a particular individual. Additional comparative studies are needed to identify more generally the conditions under which one stimulus presentation is more effective than the other type, and for which skills and individual learners. For example, researchers might manipulate individual learning histories to determine what effects those histories have on acquisition of receptive labeling. Such comparative studies might yield more general recommendations or guidelines around the use of different stimulus presentations used in MTS tasks with individuals with ASD.

Implications for Practice

- Provides empirical support for the use of comparison-first procedures for some learners with ASD;
- Illustrates a simple procedure for implementing sample-first procedures in a tabletop format;
- Describes procedures for remediating erroneous sources of stimulus control; and
- Highlights the importance of individual learning histories.

Compliance with Ethical Standards

Conflict of Interest Joseph Vedora declares that he has no conflict of interest. Tiffany Barry declares that she has no conflict of interest. John C. Ward-Homer declares that he has no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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