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USING COMPLEX AUDITORY–VISUAL SAMPLES TO PRODUCE EMERGENT RELATIONS IN CHILDREN WITH AUTISM

NICOLE C. GROSKREUTZ AND ALLEN KARSINA

NEW ENGLAND CENTER FOR CHILDREN

CAIO F. MIGUEL

NEW ENGLAND CENTER FOR CHILDREN AND NORTHEASTERN UNIVERSITY

AND

MARK P. GROSKREUTZ

NEW ENGLAND CENTER FOR CHILDREN

Six participants with autism learned conditional relations between complex auditory–visual sample stimuli (dictated words and pictures) and simple visual comparisons (printed words) using matching-to-sample training procedures. Pre- and posttests examined potential stimulus control by each element of the complex sample when presented individually and emergence of additional conditional relations and oral labeling. Tests revealed class-consistent performance for all participants following training.

Key words: autism, complex sample, conditional discrimination, matching to sample, stimulus equivalence

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Much of the literature on stimulus equivalence (i.e., formation of equivalence classes) examines relations following training with simple stimuli (Markham & Dougher, 1993) that are either visual (e.g., a cup) or auditory (e.g., hearing the word "cup"), rather than with multiple stimuli (i.e., complex samples) presented simultaneously (e.g., a cup and hearing "cup"). However, conditional relations can be acquired with multiple-stimuli samples (e.g., Maguire, Stromer, Mackay, & Demis, 1994), and the individual elements can acquire independent stimulus control over behavior (Stromer, McIlvane, & Serna, 1993). To assess independent control, researchers have conducted training using complex visual or auditory–visual stimuli as samples and then tested for the formation of relations using the individual elements of the complex samples. For example, Stromer and Mackay (1992) established equivalence classes using complex visual (picture plus printed word) samples with 3 boys with academic deficits, and Maguire et al. demonstrated class-consistent responding in 2 adults with autism and 4 typical young children, following matching-to-sample (MTS) training with complex visual stimuli.

By teaching with complex samples (e.g., presenting the picture while saying "cat") and simple comparisons (e.g., the printed word *cat*), learners may acquire relations between the

Nicole C. Groskreutz and Mark P. Groskreutz are now in the Department of Special Education and Rehabilitation at Utah State University. Caio F. Miguel is now in the Psychology Department at California State University, Sacramento.

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Correspondence concerning this article should be addressed to Nicole C. Groskreutz, Department of Special Education & Rehabilitation, Utah State University, 2865 Old Main Hill, Logan, Utah 84322 (e-mail: nicole.groskreutz@aggiemail.usu.edu) or Caio F. Miguel, Department of Psychology, California State University, Sacramento, 6000 J St., Sacramento, California 95819 (e-mail: miguelc@csus.edu).

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individual elements of the complex sample and the comparison stimuli (i.e., the dictated words, pictures, and printed words) simultaneously. Thus, training with complex samples may be more efficient than training with simple stimuli because equivalence relations can emerge without sequential training of stimulus–stimulus relations. To date, researchers have not evaluated emergence of relations following training using complex samples with children with autism. In addition, when complex samples have been used with persons with other disabilities, the samples have consisted exclusively of visual–visual samples (Maguire et al., 1994; Stromer & Mackay, 1992). The current study extends the literature on stimulus equivalence by examining conditional relations trained using complex auditory–visual samples and testing for emergence of untrained relations with children with autism.

METHOD

Participants, Setting, and Materials

Six children and adolescents who had been diagnosed with autism participated. Each had established generalized identity-matching repertoires and a history of acquiring conditional relations with visual and auditory samples. Kara (16 years old) and Roy (4 years old) displayed complex vocal behavior. Keith (6 years old) vocalized in full sentences only when prompted. Josh (11 years old) and Derrick (18 years old) had picture exchange communication system (PECS) repertoires of roughly 200 icons and made unintelligible vocalizations. Lyle (5 years old) was nonvocal, with a PECS repertoire of approximately 100 icons. Receptive language had been assessed during prior intakes or 3-year reevaluations using the Peabody Picture Vocabulary Test (revised or 3rd ed.). The resulting age-equivalent scores were, for Kara (4 years 7 months), Roy (3 years 5 months), and Keith, Josh, Derrick, and Lyle (below 1 year 9 months).

One to three nine-trial sessions were conducted daily, 1 to 5 days per week. The experimenter sat at a table next to or across from the participant and presented stimulus arrays on a discrimination board (Derrick, Keith, Lyle, and Roy) or the tabletop (Josh and Kara). Experimenters were trained to look directly at the participant's face when presenting stimuli to minimize unintentional cuing. The experimenter selected stimuli based on the participants' educational goals (e.g., animals, instruments); a complete list is available from the first author. Visual stimuli were index cards (7.6 cm by 12.7 cm) with line drawings or photos and computer-generated printed words (36-point Times New Roman font).

Response Measurement and Interobserver Agreement

The dependent measure was independent correct responding, which was defined as the participant selecting the stimulus that matched the sample from a three-comparison visual array or oral labels for words, depending on the phase. Independent correct responses were converted to a percentage after dividing the number of trials with independent correct responses by the total number of trials in a session (nine). The therapist and a second observer independently recorded participants' responses on a mean of 63% of training and testing sessions across participants (range, 43% to 95%). An agreement was scored for each trial if both observers recorded that the same participant response was made, and a disagreement was scored when observers recorded different participant responses. Interobserver agreement was calculated by dividing the number of agreements by agreements plus disagreements and converting to a percentage. Agreement was 98% across participants (range, 94% to 100%). Procedural integrity data were collected in 50% of sessions for Derrick. An observer scored four therapist behaviors for each trial: presenting the prescribed sample, presenting the comparison stimuli in the correct positions, delivering the prompt at the prescribed delay, and delivering the appropriate consequence. Procedural integrity was 100% across all four categories.

Design

A pretest–posttest design was used (Green & Saunders, 1998). The experimenter pretested all participants on the AB (dictated word to picture), AC (dictated to printed word), and BC (picture to printed word) relations. The experimenter also pretested Lyle on the CB relation (printed word to picture) and Derrick, Roy, and Keith on BD (oral labeling pictures) and CD (oral labeling printed words). The experimenter repeated these same tests immediately following training, although Kara and Josh completed only AC and BC relations initially and all remaining tests 1 (Kara) or 4 (Josh) months later.

Procedure

Training. MTS sessions were conducted with complex auditory-visual samples consisting of dictated picture names (A) and pictures (B) and printed word comparisons (C) ([AB]C). The experimenter presented a complex sample (AB) by saying the word while holding up the picture, followed by presentation of the three-comparison array. A session consisted of nine trials with each sample presented three times, and the correct comparison stimulus placed once in the left, middle, and right positions. The experimenter never repeated the sample in consecutive trials and cued responses by pointing to the correct comparison after the sample presentation using progressive delays (i.e., 0 s, 1 s, 2 s, 3 s, 4 s, 5 s). The criterion to increase the delay was two consecutive nine-trial sessions with eight of nine correct responses. The criterion to decrease the delay was two consecutive errors or three total errors in a nine-trial session. For Lyle for the first three trials of Session 11, the experimenter changed the point prompt at the 5-s delay to lifting Lyle's arm to initiate the response with no cue to a particular stimulus to address Lyle's prompt dependence. No further prompts were ever required.

Prompted or independent correct responses resulted in praise and token delivery before removal of the stimuli. The experimenter delivered backup reinforcers identified in paired-stimulus preference assessments (Fisher et al., 1992) at the end of each session in the instructional area. If the participant pointed to the incorrect stimulus prior to or after the prompt or made no selection within 5 s, the experimenter re-presented the same trial with all stimuli in the same positions at a 0-s delay and provided praise following correct responding. Observers recorded only the initial response to the trial presentation. Training was complete when a participant responded correctly and independently on eight of nine trials across two consecutive sessions and two different therapists.

Testing. The experimenter conducted pre- and posttests for three types of relations: (a) visual samples and comparisons (BC and CB), (b) auditory samples and visual comparisons (AB and AC), and (c) oral labeling (tact and textual relations) of visual stimuli (BD and CD). Visual–visual MTS trials (BC and CB) were structured similar to training trials, with the experimenter presenting the visual stimulus followed by a three-comparison visual array. For auditory–visual MTS trials (AB and AC), the experimenter stated the auditory sample to the participant and repeated it with the presentation of the three-comparison visual array. On oral labeling trials (BD and CD), the experimenter held up the visual stimulus and asked the question, "What is this?" or "Who is this?" (consistent within participants). Across all trial types, the experimenter waited up to 5 s for the participant to respond before removing the stimuli and moving on to the next trial. Testing sessions consisted of nine trials interspersed with trials of mastered tasks that were unrelated to the experiment (e.g., following instructions). The experimenter delivered verbal praise and a token regardless of response accuracy every one to three trials during the 5-s intertrial interval, a procedure that has been

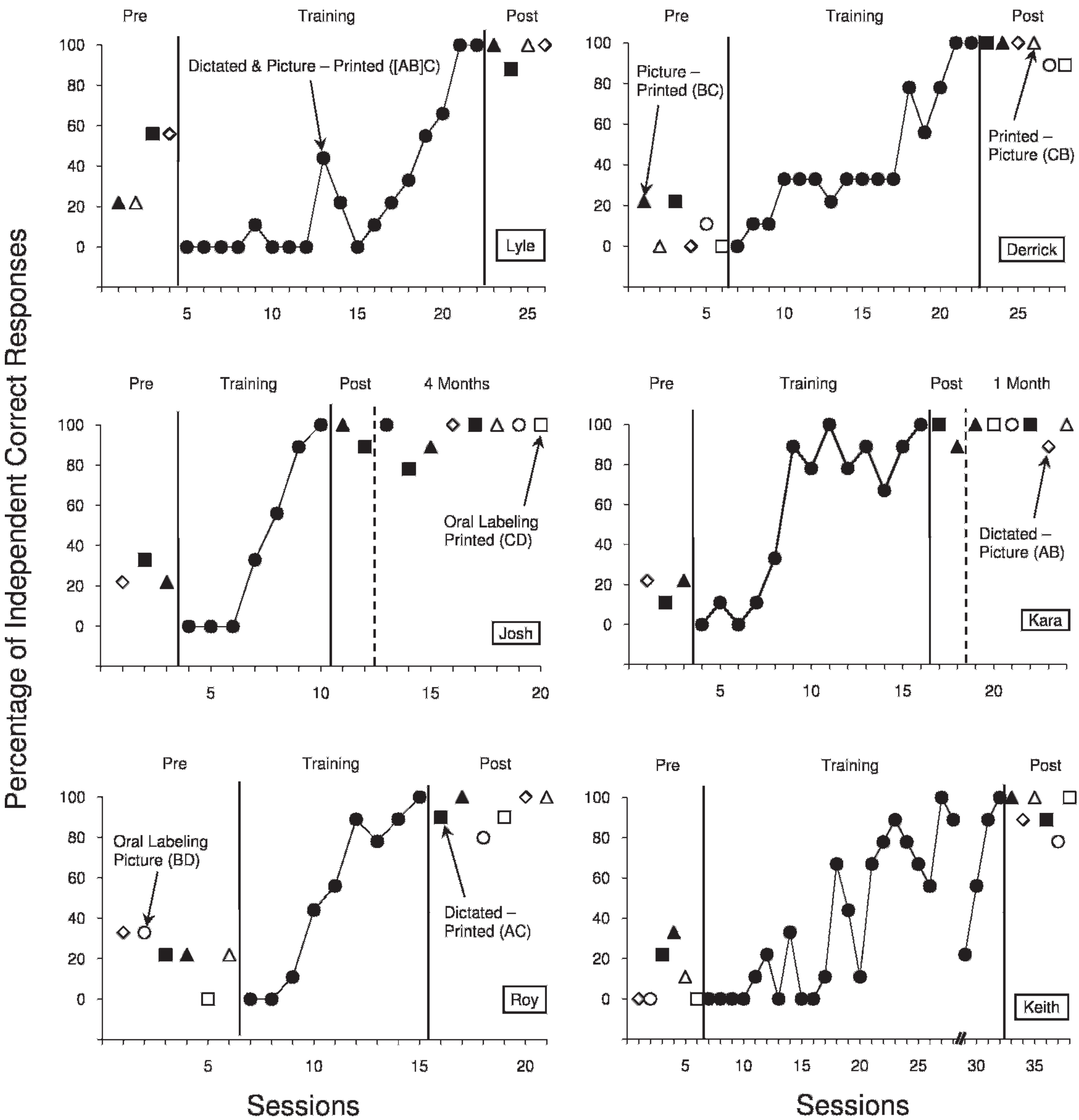

Figure 1. Percentage of independent correct responses during pretest, training, and posttest sessions for Lyle (upper left), Derrick (upper right), Josh (middle left), Kara (middle right), Roy (lower left), and Keith (lower right).

used previously to maintain high rates of responding without affecting test performance (LeBlanc, Miguel, Cummings, Goldsmith, & Carr, 2003).

RESULTS AND DISCUSSION

For all 6 participants, training using a complex auditory-visual sample produced trained and emergent relations among the individual elements, suggestive of equivalence class formation. During pretest sessions, participants responded to the relations at chance levels, except Lyle during the AC and AB pretests (Figure 1), but inspection of his data revealed no consistent pattern of accuracy. Posttest performances indicated conditional relations were evident for all stimuli tested though training was only conducted with the ([AB]C) ([dictated word plus picture] to written word) relation (Figure 1). During training, all participants met the mastery criterion for the trained conditional relation with the complex sample ([AB]C; $M = 14$ sessions, range, 7 to 22). Keith reached the mastery criterion before a 10-day school break, and retraining to criterion required four additional sessions (Figure 1).

Consistent with the literature with other populations (Maguire et al., 1994; Stromer & Stromer, 1990a, 1990b, 1992), both elements of the complex sample exerted stimulus control, even though training procedures did not require discrimination of the individual components for accurate responding. Previous researchers have suggested that participants' learning histories may influence the successful establishment of relations among components of complex samples (Maguire et al.; Pérez-González & Alonso-Álvarez, 2008; Stromer & Stromer, 1990b). Most of their training procedures required discrimination of the individual sample elements (Maguire et al.; Pérez-González & Alonso-Álvarez), or the authors reported prior histories of responding to samples from both auditory and visual modalities prior to training with the targeted complex auditory–visual samples (Stromer & Stromer, 1990b). Although our procedures did not require discrimination of the individual components of the complex samples during training, all participants had a history of both auditory–visual and visual-visual MTS training. This history may have provided the necessary skills to form relations simultaneously using both the auditory and visual components of the complex samples. Future researchers should investigate whether this history is prerequisite to the formation of equivalence relations using complex auditory–visual samples.

Unlike training with simple samples, using a complex sample introduces the participant to three sets of stimuli during one training procedure (e.g., dictated words, pictures, and printed words), allowing the subsequent demonstration of emergent relations. Using a complex sample during MTS training may be a more efficient means of forming relations among stimuli than traditional procedures, which would require direct training of at least two individual relations. However, the current study does not make this comparison directly. Future research should compare the number of trials required to train a set of stimuli using the procedure described in this study ([AB]C) to the number of trials required to train the relations consecutively (AC followed by BC).

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