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INCREASING RESPONSE DIVERSITY IN CHILDREN WITH AUTISM

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Repetitive and invariant behavior is a diagnostic feature of autism. We implemented a lag reinforcement schedule to increase response diversity for 6 participants with autism aged 6 to 10 years, 4 of whom also received prompting plus additional training. These procedures appeared to increase the variety of building-block structures, demonstrating that an intervention that includes differential reinforcement can increase response diversity for children with an autism spectrum disorder.

Key words: autism, behavioral variability, lag reinforcement, stereotypy, response variability, stimulus variability

Although restrictive or repetitive behavior is a diagnostic feature of autism and other autism spectrum disorders (ASD), research on interventions for such behavior has been somewhat neglected (Bodfish, 2004; Turner, 1999). Repetitive behavior or a restricted range of interests may be a significant impediment to improved functioning for persons with autism (Lang et al., 2009; Pierce & Courchesne, 2001). To date, most studies have focused on consequence-based interventions such as reducing the repetitive behavior itself or the problem behavior occasioned by repetitive behavior (e.g., Napolitano, Tessing, McAdam, Dunleavy, & Cifuni, 2006). A promising alternative, however, may be to apply findings from the experimental analysis of behavior on systematically reinforcing variability in responses. Numerous laboratory studies show that reinforcement reliably increases the diversity of behavior emitted by both nonhumans and humans and may have collateral benefits such as enhancing problem solving and creativity (Neuringer, 2004).

In one of the first applied studies of response diversity, Goetz and Baer (1973) observed that 3 typically developing preschool children had a relatively invariant repertoire of block-building skills compared to their peers. Differential reinforcement in the form of social praise for building novel block structures resulted in increased diversity of block-structure construction for all 3 children. More recently, Cammilleri and Hanley (2005) increased the selection of novel classroom activities with 2 typically developing children using a lag-differential reinforcement schedule. For both participants, differential reinforcement on a Lag 1 schedule produced immediate increases in novel activity choices and a subsequent increase in the number of academic activity choices. In a further demonstration of the utility of lag schedules of reinforcement for increasing response diversity, Lee and Sturmey (2006) evaluated a similar reinforcement schedule for varied verbal responses to a standard question, ''What do you like to do?'' in children with autism. Appropriate, novel responses that differed from the preceding trial were reinforced, and response variability increased for 2 of the 3 participants compared to responses in a condition during which appropriate but nonnovel responses were reinforced.

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The current study extends the work of Goetz and Baer (1973) on increasing the variability in play of children with ASD. We used procedures described by Goetz and Baer and incorporated changes based on recent studies that have targeted verbal responses of individuals with ASD. The changes included adding tangible reinforcement to social praise as a consequence for response diversity, incorporating brief sessions of direct instruction if participants initially failed to respond to the intervention, and targeting responses that differed from the prior response (i.e., response variability) rather than all novel responses. Generalization was assessed with a new task (block building), and maintenance was evaluated over a 2-month follow-up period.

METHOD

Participants, Settings, and Materials

We recruited 1 girl and 5 boys from a university school-based consultation program. Participants met the following criteria: (a) diagnosis of ASD by a developmental pediatrician or psychologist, (b) chronological age of 6 to 10 years, and (c) IQ $\leq$ 70 on a standardized intelligence test or composite standard score $\leq$ 85 on the Vineland Adaptive Behavior Scale (Sparrow, Cicchetti, & Balla, 2005). Results of the Repetitive Behavior Scale–Revised (Bodfish, Symons, Parker, & Lewis, 2000) completed by the participant's parent or teacher were available for 5 of 6 participants and indicated that these 5 participants had at least moderate problems with restricted or sameness behavior. We conducted all experimental sessions in a room with minimal distractions at the child's school. Materials included 24 eight-peg plastic building blocks (six blocks of four primary colors) and various reinforcers identified through a paired-stimulus preference assessment (data available from the first author).

Response Definitions and Interobserver Agreement

Observers scored participant responses for form (variant or invariant) and for color (variant or invariant). With 24 blocks, 23 building responses were possible per session. A *variant form* response differed from the prior form based on placement direction. Ten form variations were possible including a step (block placed in the same direction on half of the pegs of the previous block) and a cross (block placed perpendicular to previous block). A *variant color* response was one that differed from the previous block (e.g., red on a blue block). An *invariant color* response was scored if the participant repeated a color (e.g., blue, blue) or color pattern (e.g., red, blue, red, blue), and an *invariant form* was scored if the form (e.g., step, step) or form pattern (e.g., step, cross, step, cross) repeated. The number of variant responses and the number of invariant responses were each divided by 23 to calculate the percentage per category. Although observers scored both form and color for each response, we present information for only the targeted dimension.

We videotaped all sessions for later scoring. We collected interobserver agreement data for 44% of the experimental sessions across all 6 participants (range, 32% to 67%). We defined an agreement as both observers scoring a response identically on both form and color. We calculated percentage agreement for each session by dividing the number of agreements by the number of disagreements plus agreements and converting to a percentage. Agreement was 92% across all sessions (range, 50% to 100%). Mean agreement was 85% for Ric (range, 50% to 100%), 99% for Jason (range, 97% to 100%), 83% for Oliver (range, 77% to 90%), 96% for Alyssa (range, 87% to 100%), 98% for Zach (range, 96% to 100%), and 92% for Barry (range, 86% to 100%). We collected procedural fidelity data on the accuracy of implementation of the general procedures (e.g., number and color of blocks provided, session length) and the intervention procedures (e.g., reinforcer delivery) for 34% of sessions across all participants. The mean fidelity was 96% (range, 88% to 100%).

Design and Procedure

We used an ABAB withdrawal design to evaluate the effects of the intervention on response diversity for the dimension with the least variability during baseline. The experimenter conducted two to three experimental sessions weekly during consecutive weeks (except for two times when a participant was not available due to the school winter recess). Session duration varied. Each session began when the experimenter provided the student with 24 blocks and ended when one of the following criteria were met: (a) 10 min had elapsed, (b) the participant used all the blocks, (c) the participant said ''I'm done'' or pushed the blocks away, or (d) the participant did not interact with the blocks for 2 consecutive minutes.

Baseline. The experimenter gave the participant the blocks and said, ''build something.'' The experimenter delivered praise intermittently and at least once in each session for building, regardless of the form or color. Individual baseline data were used to select the dimension (i.e., form or color) with fewer novel responses to target in intervention.

Lag 1 reinforcement schedule. The experimenter gave the participant the blocks and the initial verbal prompt, ''build something.'' The experimenter delivered tangible reinforcers (e.g., 30-s access to a preferred item) or edible reinforcers (e.g., small bit of preferred food) following each color (Jason, Alyssa) or form (Ric, Oliver, Barry, Zach) response that differed from the previous one. Preferred tangible and edible items had been identified in a previous preference assessment. Consumption time was excluded from session time, and after consuming the reinforcer participants were told, ''build differently.''

Teaching trials. The experimenter implemented teaching trials for Ric (seven sessions), Oliver (two sessions), Alyssa (five sessions), and Barry (four sessions) because the Lag 1 reinforcement schedule did not result in performance improvements. During teaching trials, both the participant and the experimenter had a set of the blocks. The experimenter gave the initial instruction ''build something,'' then modeled building something different and verbally prompted the participant to imitate her model (e.g., ''now you build something different''). All other procedures were identical to the Lag 1 reinforcement intervention.

Generalization and follow-up. Wooden blocks of similar size and color to the plastic blocks were used to assess generalization under baseline conditions. Follow-up data were collected 2 to 3 months after the end of the final intervention, using procedures identical to the Lag 1 reinforcement condition.

RESULTS AND DISCUSSION

Diverse responding increased for all participants with intervention. Ric's diverse responding increased from a mean of 1% of responses during baseline to a mean of 21% after teaching sessions (Figure 1, top). He replicated the effect in the reversal, with a larger increase in diversity in the second intervention phase to a mean of 65%, with poorer performance during follow-up. Oliver (middle) displayed some diverse responding in baseline (29% of responses) that increased to a mean of 84% in the first intervention phase after a teaching session. He replicated this effect during reversal and maintained it at follow-up ($M = 68\%$). Barry's data (bottom) revealed very little diversity in his block building during both baseline conditions. However, his percentage of diverse responses increased to a mean of 73% in the initial intervention condition and 58% in the second intervention condition. At follow-up, his mean diverse responding decreased from the second intervention, but was maintained at a mean of 25%.

At baseline, Alyssa showed a rate of color variation of only 13%, the minimum possible (Figure 2, top). She initially displayed little improvement in the first intervention condition. After several reinforcer changes, Alyssa's

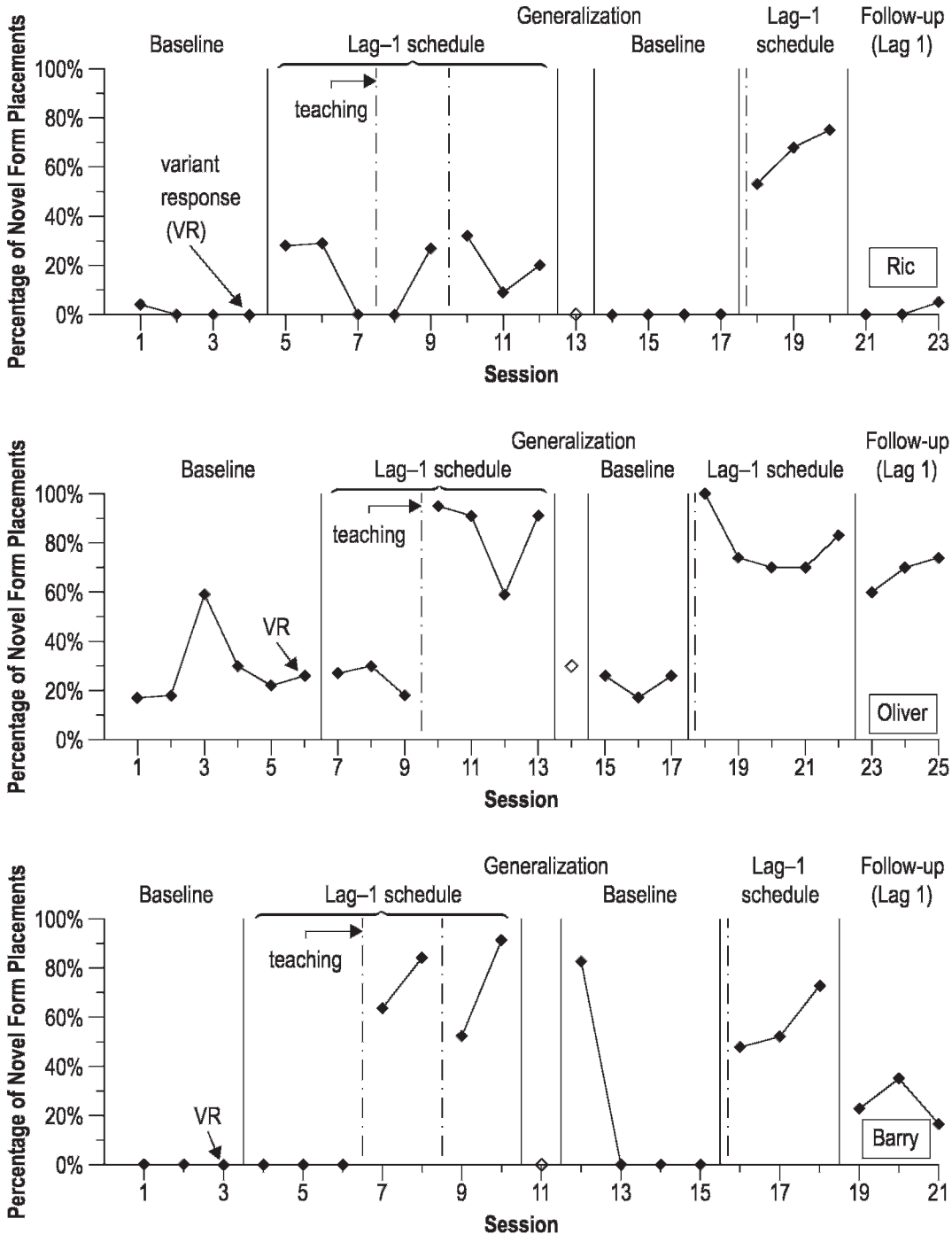

Figure 1. The percentage of variant form responses (VR) displayed by Ric, Oliver, and Barry across all experimental conditions.

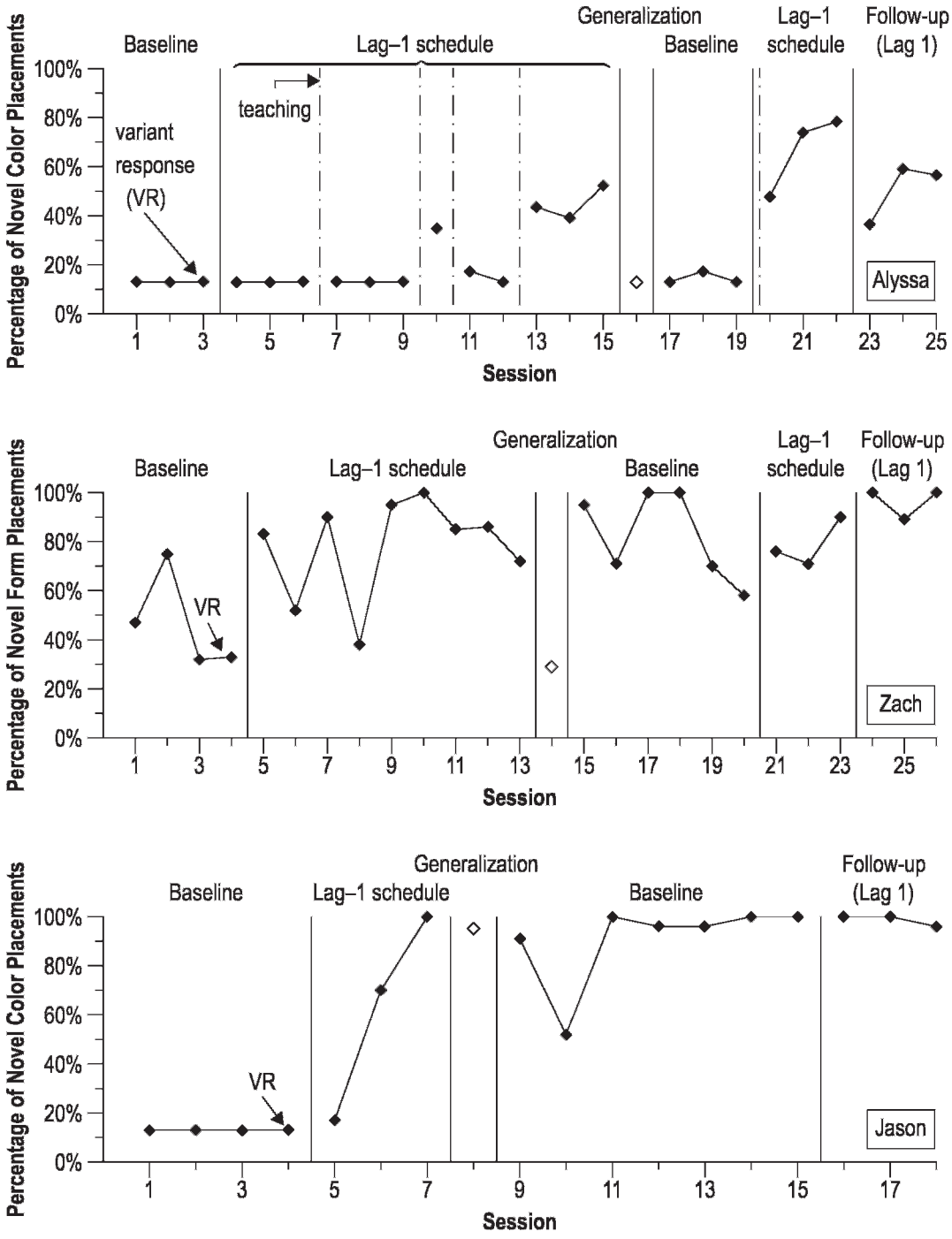

Figure 2. The percentage of variant form responses (VR) displayed by Zach (middle) and variant color responses (VR) displayed by Alyssa (top) and Jason (bottom) across all experimental conditions.

diverse responding increased to a mean of 33%, 67% in the second intervention phase, and 51% in follow-up. Both Zach's and Jason's performances (middle and bottom panels, respectively) improved in the first intervention phase relative to their initial baselines (Jason from 13% to 100%, Zach from 46% to 78%). However, they failed to return to baseline rates in the second baseline condition and maintained a high rate of diverse responses during the remaining phases of the study. Despite the improvements in diverse responding by all participants during intervention and follow-up, only Jason displayed a high rate of responding during generalization.

Overall, the results indicated that an intervention package consisting of differential reinforcement on a Lag 1 schedule combined with additional teaching for some participants and a prompt to "build differently" increased diversity of block-building responses. This finding replicates and extends previous basic and applied behavior-analytic work and holds promising potential for increasing the problem-solving abilities and creativity of persons with ASD (Goetz & Baer, 1973; Lee, McComas, & Jawor, 2002; Lee & Sturmey, 2006; Neuringer, 2004). Further demonstrations of the effectiveness of differential reinforcement on diverse responding in persons with ASD using a variety of materials (e.g., blocks) and across a variety of target behaviors (e.g., vocal responses) have important implications for the treatment of the core features of ASD (i.e., restrictive repetitive behavior) and the development of comprehensive treatment programs.

Limitations of the study include a lack of reversal for 2 participants (Zach and Jason) and only a partial reversal for Ric, which may weaken the conclusions. The lack of reversal to baseline for Zach and Jason, however, may also indicate that diverse responses acquired reinforcing value. Additional limitations may be the lack of a programmed schedule for verbal praise and the addition of the prompt to "build differently" in the intervention, which may have increased the likelihood that the participants understood the contingencies. Finally, the test of generalization did not include a baseline comparison prior to the intervention, which weakens any conclusions that can be drawn from these data. One further consideration is that increasing response diversity for play behavior may have not had any impact on other stereotypic or invariant behaviors for these participants.

Directions for future research include testing interventions to promote response diversity in persons with ASD across a wide variety of social skills and behaviors (e.g., play skills, vocal responses), combining interventions to increase response diversity with interventions to decrease repetitive or invariant behavior, and evaluating long-term global outcomes of such interventions in larger samples of persons with ASD.

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