*ELIMINATION OF POSITION-BIASED RESPONDING IN INDIVIDUALS
WITH AUTISM AND INTELLECTUAL DISABILITIES*

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Five individuals with autism or other developmental disabilities participated in paired-stimulus preference assessments during repeated baseline probes. All subjects initially showed a pronounced bias by typically selecting the stimulus placed in either the left or right position. Biased responding for 3 subjects was eliminated when training trials were conducted in which a stimulus of known lesser quality was presented as one of the choices. Reinforcer-quality training was unsuccessful for 2 subjects, as was a condition in which reinforcer magnitude was modified to favor unbiased responding. These subjects' biased responding was eliminated only when a correction procedure (repetition of error trials) was implemented.

Key words: selection bias, directional bias, preference assessment, reinforcer quality, reinforcer magnitude, error correction

The ability to make selections from stimuli presented in an array is a prerequisite skill for many forms of discrimination learning, picture exchange communication, and several types of preference assessments (Bondy & Frost, 2001; DeLeon & Iwata, 1996; Fisher et al., 1992). When responding is not under the control of prevailing contingencies but, rather, is biased in some way (e.g., selecting the sample presented on the left in a two-choice array), efforts to conduct assessment or training may be severely compromised.

Galloway (1967) examined biased responding in four individuals who were orthopedically disabled or emotionally disturbed with normal to low-normal IQ. Subjects responded on a match-to-sample task in which sample and comparison stimuli consisted of white shapes superimposed on colored backgrounds. One of the two comparisons always included the sample shape; the other always included the

sample background color. All subjects initially exhibited biased responding controlled by either shape or color when tokens (exchangeable later for toys) were delivered for any response. During subsequent phases, Galloway shifted subjects' bias toward one stimulus feature and then reversed their bias toward the original feature by manipulating the magnitude of reinforcement, that is, by delivering different numbers of tokens for responding toward one feature relative to the other.

The procedure used by Galloway (1967) involved manipulation of one dimension of reinforcement—magnitude—to influence choice. Neef and colleagues (Neef, Mace, & Shade, 1993; Neef, Mace, Shea, & Shade, 1992; Neef, Shade, & Miller, 1994) conducted a series of studies on multiple dimensions of reinforcement—quality, immediacy, and rate—as well as response effort, that may influence choice. Participants responded on two concurrently available sets of math problems, each associated with a different outcome, and the measure of choice was response allocation toward one of the two options. The studies examined preference for one or more dimensions of reinforcement when presented in

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varied parametric combinations. A general finding across studies was that reinforcer quality seemed to be the most consistent determinant of choice. These results suggest the possibility of eliminating bias through a manipulation of reinforcer quality if biased responding controlled by some irrelevant feature of a task, such as position, is viewed as a systematic preference.

Kangas and Branch (2008) described an alternative method for eliminating response bias. They divided 15 pigeons into three groups during training on a two-choice match-to-sample task. All six subjects assigned to the control group (no correction) initially showed a position bias, which eventually disappeared for five subjects, although hundreds of training trials were required for some subjects. The other groups were exposed to a correction procedure contingent on errors, either after the subject had completed a set number of training trials ($n = 4$, midcourse correction) or from the outset of training ($n = 5$, correction from outset). The correction procedure involved continued presentation of the "error trial" until a correct response occurred. All subjects assigned to the midcourse group showed an initial side bias that was eliminated quickly when the correction procedure was implemented, and none of the subjects in the correction-from-outset group developed a side bias.

Results from the above studies suggest that biased responding might be minimized by either (a) enhancement of the quality or quantity of reinforcement for unbiased responding or (b) implementation of correction procedures that make biased responding less reinforcing. We examined both types of procedures in the present study with individuals who showed position-biased responding in the context of preference assessments.

METHOD

Participants, Settings, and Sessions

Five individuals were referred to the study based on clinician reports of suspected position

biases in selecting stimuli from a presented array. Tina was a 6-year-old girl who had been diagnosed with autism and whose primary form of communication was picture exchange. Ron was a 10-year-old boy who had been diagnosed with autism and whose primary forms of communication were picture exchange and a dynamic voice-output device. Adam was a 16-year-old boy who had been diagnosed with autism, Jane was a 41-year old woman who had been diagnosed with Down syndrome and moderate mental retardation, and Tom was a 43-year-old man who had been diagnosed with moderate to severe mental retardation. Adam, Jane, and Tom could follow simple instructions and communicated with a few spoken words. Tina's, Ron's, and Adam's sessions were conducted in quiet areas of the school that they attended or in their homes; Jane's and Tom's sessions were conducted in training rooms at the vocational program where they worked. During each session, an experimenter presented stimuli to the participant while both sat at a table facing each other. Sessions lasted approximately 15 min, and one to three sessions were conducted per day, 2 to 4 days per week.

Single-Stimulus Preference Assessment

Prior to the study, a single-stimulus preference assessment (Pace, Ivancic, Edwards, Iwata, & Page, 1985) was conducted with each participant. Edible items were presented singly in a semirandom order across trials until each item had been presented five times. During each trial, an experimenter placed a small sample of one edible item 25 cm in front of the participant. If the participant approached the item, he or she was allowed to consume it. If the participant did not approach the item within 5 s, the item was removed, and the next trial was initiated. Data were summarized as the percentage of trials on which an item was approached. Assessment continued until seven items were identified that had been approached and consumed on at least four of five trials.

Paired-Stimulus Preference Assessment

A paired-stimulus preference assessment (Fisher et al., 1992) was conducted during each session throughout baseline and treatment conditions. Stimuli consisted of the seven edible items designated as preferred from the single-stimulus assessment, and pairs of items were presented in semirandom order until each item had been paired twice with every other item, resulting in a total of 72 trials per session. The position of each item and each pair of items was counterbalanced such that every item appeared an equal number of times in the left and right positions. During each trial, an experimenter presented two items 25 cm in front of the participant and 25 cm apart. If a participant approached either item, he or she was allowed to consume it (except as noted below under error correction). Simultaneous approaches to both items were blocked. If neither item was approached within 5 s, the items were removed, and the next trial began. A variation of this procedure was used for Adam. Stimuli, trials, and positioning were identical; however, line drawings of the edible items (rather than the items themselves) were presented on each trial. Selection of a drawing resulted in access to the item depicted in the drawing.

Data were summarized in two ways. First, a percentage selection score was calculated for each item by dividing the number of times an item was selected by the number of times it was presented. Second, an overall percentage bias score was calculated by subtracting the number of selections to the side (left or right) chosen less frequently from the number of selections to the side chosen more frequently, and dividing this number by the total number of trials. If a subject chose left and right positions on an equal number of trials, the resulting bias would be 0%.

Observation and Reliability

An observer recorded data on a trial-by-trial basis during each session, noting the stimulus selected by a participant. During paired-stimulus

sessions, the observer also recorded the position (left or right) of the selected stimulus. A second observer collected data during a mean of 36% of all trials (range across subjects, 27% to 45% of trials). Interobserver agreement was calculated by comparing the two observer's records and dividing the number of agreement trials by the total number of trials in a session. Reliability for Tina, Ron, and Adam was 100%; mean reliability was 99.7% (range, 95% to 100%) for Jane and 99.8% (range, 96% to 100%) for Tom.

General Procedure

During baseline, paired-stimulus assessments were conducted to establish the extent of each participant's position bias. During treatment, training trials were conducted as described below, and baseline sessions were conducted after each training session to assess generalization of treatment effects. A treatment was not considered successful until it produced effects that generalized to ongoing baseline sessions. Manipulation of reinforcer quality was evaluated in a multiple baseline design across participants for Tina, Ron, and Adam. This intervention had no effect on Jane's or Tom's position bias. Therefore, two additional treatments—manipulation of reinforcer magnitude and an error-correction procedure—were evaluated in multiple baseline (Jane and Tom) and reversal (Tom) designs. When a positive outcome was observed during baseline sessions that were interspersed with training trials, training was discontinued for Tina, Ron, and Jane to determine whether their bias-free responding would be maintained. These final baseline sessions were not conducted for Adam or Tom, who were unavailable for continued participation in the study.

Baseline. Each session consisted of a paired-stimulus preference assessment as described above.

Quality training. Quality training was deemed to be the easiest intervention to implement because it simply involved substituting one

stimulus for another, so it was the first procedure that attempted to eliminate the side bias that had been observed during baseline. The same seven stimuli included in baseline were used. However, instead of being paired with each other, during each trial one of these seven stimuli was paired with an item that had been identified as nonpreferred during the single-stimulus assessment. A nonpreferred item was defined as one that was never approached on any of the five trials of the single-stimulus assessment (Ron, Adam, Tom, and Jane). Tina approached every item on every trial, so we selected an item that she only consumed once as her nonpreferred item. During every session, each of the seven preferred items was paired with the nonpreferred item four times, two times on each side (28 total trials). An approach to either of the items resulted in access to that item, and approaches to both were blocked. If neither item was approached within 5 s, the items were removed, and the next trial began. Data on the participant's performance during this and subsequent training conditions were calculated as percentage biased responding (see above).

Magnitude training. These training sessions were conducted only with Jane and Tom. Magnitude training sessions were identical to baseline except that the magnitude of one of the options presented on each trial was five times that presented during baseline. For example, if one piece of a particular candy was the typical amount presented, five pieces of candy were placed in front of the participant as one of the choice options on trials in which this item was designated as high magnitude. Selection of the high-magnitude option resulted in access to the five items, whereas selection of the low-magnitude option resulted in access to the one item. Each item was designated as high and low magnitude an equal number of times.

Magnitude training plus error correction. These training sessions also were conducted with Jane and Tom only. Sessions during this condition were identical to the magnitude training sessions except that, contingent on

selection of the low-magnitude option on a given trial, an error-correction procedure was implemented after the participant consumed the item. The correction procedure consisted of five trials. On each trial, the high- and low-magnitude options from the preceding training trial were re-presented. Selection of the high-magnitude option resulted in access to the items and, following consumption, the next correction trial. Selection of the low-magnitude option was blocked, and the participant was manually guided to select the high-magnitude option. Manually guided responses did not result in access to the presented items.

RESULTS

The line graphs in Figure 1 show percentage bias scores across conditions for Tina, Ron, and Adam. Tina's percentage bias during baseline averaged 46.4%. During quality training, her bias quickly dropped to zero during training sessions; during interspersed baseline probes, her bias was 9% on the first session and 4% during the second. When training was terminated, Tina's percentage bias remained low, averaging 6% (range, -9% to 38%). The bar graphs show percentage selection scores for the seven edible items during a subset of paired-stimulus assessments. Specific sessions were chosen for more detailed analysis to show preference hierarchies obtained during baseline and after exposure to treatment conditions. The first was conducted at the end of baseline and showed a moderate amount of differentiation in item rankings. The additional baseline sessions correspond to Tina's last day of training and her last day of the study and showed more distinct rankings for the edible items.

Ron's bias during baseline was 100% for all but one session. His bias quickly decreased to zero during quality training sessions and eventually decreased to a very low level (a slight bias in the opposite direction) during interspersed baseline sessions. During the return to baseline, his data were quite variable, but the

Figure 1. Percentage biased responding during baseline probes and training sessions (line graphs) and percentage selections during baseline probes (bar graphs) prior to and at several points during treatment (sessions indicated by numbers) for Tina, Ron, and Adam.

consistent bias observed during the initial baseline did not return. Selection percentages for Ron's first baseline session showed a perfectly even distribution corresponding to

consistent left-side selections. Additional baseline results represent the end of training and his final session and reflect a full range of selection percentages.

Figure 2. Percentage biased responding during baseline probes and training sessions (line graphs) and percentage selections during baseline probes (bar graphs) prior to and at several points during treatment (sessions indicated by numbers) for Jane and Tom.

Adam's percentage bias during baseline was noticeable, although not as pronounced as Ron's, and averaged 51.3%. His percentage bias decreased quickly during quality training sessions and interspersed baseline sessions, but he was no longer able to participate in the study after five treatment sessions. Nevertheless, his performance during treatment was consistent, and the selection percentages from two baseline assessments taken early in baseline and at the end of treatment show a very noticeable shift

from nearly equal selections across stimuli to a more differentiated pattern of selections. Figure 2 shows Jane's and Tom's data. Jane's percentage bias during baseline was 100% for all but one session. When quality training was implemented, her bias during training sessions immediately dropped to zero; however, her bias during interspersed baseline sessions remained at 100%. During magnitude training, Jane's biased responding in both training and baseline sessions showed a noticeable downward trend,

but neither approached zero, which had been observed during quality training sessions. When an error-correction procedure was added to magnitude training, biased responding continued to decrease during training sessions while remaining somewhat variable during interspersed baseline sessions. To determine whether the variability in Jane's responding would continue or show a consistent trend toward either biased or nonbiased responding, we terminated training sessions. Responding during the final baseline assessments was both biased and variable for seven sessions; thereafter, however, her responding showed relatively equal selections across both left and right positions. Her selection percentages showed flat or nearly flat distributions during the initial baseline, quality training, and early magnitude training but more differentiated selections during the final magnitude training plus error correction and baseline conditions.

Tom's pattern of responding during the initial baseline was different than that observed for other subjects. He exhibited a noticeable bias during each baseline session, but its direction was not consistent: Sometimes he selected primarily the option on the right and sometimes he selected the option on the left, such that the range was from -100% to $+100\%$. His percentage bias decreased during quality training sessions but he continued to show a high degree of bias (now consistent to the right side) during interspersed baseline sessions. Magnitude training had no effect; he showed consistent bias during both training and baseline sessions. When the error-correction procedure was added, Tom's biased responding quickly decreased during both training sessions and interspersed baseline sessions. Biased responding reemerged during baseline sessions when training was discontinued, and decreased again when training was reinstated. We were unable to conduct further baseline evaluations because Tom was not able to continue in the study. Selection percentages are shown from four baseline sessions. The first three were from

Tom's initial baseline, quality training, and magnitude training, and show relatively flat distributions. The fourth session was from Tom's final magnitude training plus error-correction condition and shows much greater variability in the rankings of edible items.

DISCUSSION

The five individuals who participated in this study showed a pronounced position bias that precluded not only assessment of their preference for reinforcers but also their participation in varied discrimination-learning tasks. Position biases were decreased or eliminated by reducing the quality of reinforcement for biased responding (Tina, Ron, and Adam) or by increasing the quantity of reinforcement for unbiased responding and imposing an error-correction procedure (Jane and Tom). Effects of these interventions generalized to baseline sessions in which training conditions were not present.

Response biases are patterns of behavior that do not conform to prevailing contingencies but instead are controlled by some idiosyncratic influence. These patterns presumably may be acquired and maintained in a number of ways. Some individuals may enter into a given procedure with a particular inherited disposition (e.g., being right handed and reaching out toward the right instead of across the body to the left when making selections). Others may have a history of reinforcement in which positional responding was reinforced explicitly (e.g., placing the fork on the left and the knife on the right) or adventitiously if responding in a particular position happens to contact reinforcement and thus becomes more likely in the future. Given these potential learning histories, biased responding may be expected to be maintained over time because it continues to result in reinforcement, whereas switching to a different response pattern may require more effort. Regardless of their origin, positional biases may be particularly susceptible to reinforcement in the context of paired- and

multiple-stimulus preference assessments, as well as any training procedure that involves selection of stimuli from an array. If most of the stimuli included in a preference assessment function as reinforcers (Roscoe, Iwata, & Kahng, 1999), there may be no differential consequences for switching a selection position. That is, selecting the stimulus presented on the left always will be reinforced. Even an explicitly arranged contingency for selecting one stimulus from an array of two or three might not be sufficient to promote switching. If the positions of the stimuli are altered randomly from trial to trial, always selecting the same position would be reinforced on a variable-ratio (VR) 2 or VR 3 schedule, which may be sufficient to maintain a bias, particularly when potent establishing operations are not present. For example, an individual whose responding is maintained by edible reinforcement might earn two to three reinforcers per minute in spite of biased responding if presented with one trial every 10 s. This would produce over 100 instances of reinforcement in an hour. Selecting the "correct" option would produce a higher density of reinforcement; however, at already high rates of reinforcement, this difference might not be sufficient to produce behavior change.

Given the above considerations, we attempted to create a greater disparity in consequences for biased versus unbiased responding. During quality training, an edible item known to be nonpreferred was offered as one of the options during paired-stimulus training trials and was placed in both left and right positions. Thus, a participant could obtain a preferred item only by switching the position of selections, and all five participants began switching during training trials. Tina's, Ron's, and Adam's performance generalized to interspersed baseline assessments, during which the nonpreferred item was no longer present, and Tina's and Ron's unbiased selections on baseline probes were maintained when training sessions were discontinued. These results most likely were due to the fact that Tina, Ron, and Adam first

contacted the consequences of making differential selections, a feature that is inherent to preference assessments, during quality training.

Although quality training also eliminated Jane's and Tom's biases during training trials, their performance did not generalize during baseline assessments. Their responding on training trials seemed to reflect exclusive control by the nonpreferred item. When the nonpreferred item was present during training, Jane and Tom generally chose the alternative, but when the nonpreferred item was no longer present during baseline sessions, the position biases they showed prior to quality sessions remained unchanged. Thus, differential consequences for selection during baseline were insufficient to override preexisting response biases even when biases were eliminated in quality training sessions. It is unlikely that their baseline selections during quality training reflected indifference to the stimuli (i.e., equal preference); if that were the case, responding would have been distributed more evenly to left and right positions.

We subsequently determined whether a difference in reinforcer quantity would influence Jane's and Tom's bias. During magnitude training, participants could obtain five times the normal amount of reinforcement by switching selection positions. Jane apportioned a near equal number of choices to left and right during training trials, although she still showed a slight bias to the left position, and her performance during baseline sessions showed some degree of generalization. Two aspects of the magnitude training procedure may have influenced her behavior. First, the larger number of reinforcers for selecting the nonbiased side on every other trial may have made that option more valuable. Second, it is possible that the discriminative feature of more reinforcers simply made one of the options more salient. In either case, the decrease in bias during baseline suggests that her behavior became more sensitive to the consequences of differential selection during magnitude training. By contrast, Tom's bias was

unaffected by reinforcer magnitude, even during training trials. These results provide further support for the conclusion that his apparent decrease in biased responding during quality training reflected avoidance of the nonpreferred item: When a nonpreferred item was absent during magnitude training trials, Tom's selections continued to be controlled by position, in spite of the fact that they resulted in fewer reinforcers.

The final intervention involved addition of an error-correction contingency. The fact that it was combined with magnitude training resulted in an unavoidable confounding effect (i.e., the effects of error correction could not be distinguished from those of magnitude training). Unlike other studies in which error correction is applied to responses known to be wrong, there was no way to determine on any given trial of a preference assessment whether an "error" had occurred, because there is no correct or incorrect response; the subject simply selects a stimulus. To establish a basis for identifying errors, we applied error correction to magnitude training trials and defined errors as selections of the smaller quantity. The slight bias ($M = 25.8\%$) that Jane showed during magnitude training trials decreased further when the error-correction procedure was implemented. However, it is possible that biased responding eventually would have decreased during the baseline sessions without the use of error correction. By contrast, Tom's bias decreased on both training trials and interspersed baseline sessions only during the error-correction condition. What is unclear from his data is whether magnitude training had any effect on his performance. In other words, it is quite possible that error correction in conjunction with quality training would have eliminated his biased responding. In either case, his data indicate that error correction was the main determinant in bringing his behavior into contact with differential consequences of selecting stimuli during the preference assessment.

An interesting feature of this study was the use of interspersed (all participants) and posttreatment (three participants) baseline sessions to assess generalization of treatment effects and the maintenance of those effects after the completion of treatment. Unbiased performance during training conditions, when contingencies were in effect to switch selection locations, would not insure that bias would be eliminated under other conditions. This was shown most clearly in Tom's data. That is, his unbiased responding during quality training sessions had no effect whatsoever on his baseline performance. Thus, the criterion we used for successful treatment was unbiased responding during conditions that were typical of a preference assessment, and data presented on the actual stimuli selected during these baseline assessments showed that participants' selections after treatment were not only unbiased but also more clearly differentiated. Although less evident in Tina's data, the preference assessments of the remaining participants showed a relatively flat distribution of selections prior to treatment, but one in which specific stimuli were chosen more frequently following treatment.

Some aspects of the data and design limit our interpretation of the findings. First, although quality training reduced Tina's, Ron's and Adam's biased responding on interspersed baseline sessions during the intervention phase (Figure 1), posttreatment baseline sessions were conducted only for Tina and Ron. In a similar way, magnitude training plus error correction decreased Jane's and Tom's bias in baseline sessions during training, but the effects were maintained during the posttreatment baseline only for Jane.

In summary, results of this study showed that position biases observed during preference assessments can be eliminated with contingencies that favor unbiased responding and that these changes are reflected under the prevailing (original) contingencies associated with assessment. Several types of extensions might be considered in future work. First, it would be interesting to identify specific reinforcement

histories that produce positional biases so that they may be avoided during training programs. Second, it is possible that other determinants of choice may influence biased responding. We examined manipulations of reinforcer quality and magnitude; reinforcer delay would be relatively easy to manipulate, although its effects are unknown in the present context. Third, error-correction procedures have been shown to be effective across a wide range of performances and conceivably would have eliminated biased responding in all of our subjects, although some basis for determining what constitutes an error is needed. Finally, the generality of treatment for biased responding could be examined further. Our results showed that procedures implemented during training sessions generalized to baseline sessions involving the same type of task (making selections during a preference assessment). It would be interesting to see whether unbiased responding, established in one context, would generalize across performance on two- and three-choice discrimination tasks.

REFERENCES

- Bondy, A., & Frost, L. (2001). The picture exchange communication system. *Behavior Modification, 25*, 725–744.
- DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis, 29*, 519–532.
- Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis, 25*, 491–498.
- Galloway, C. (1967). Modification of a response bias through differential amount of reinforcement. *Journal of the Experimental Analysis of Behavior, 10*, 375–382.
- Kangas, B. D., & Branch, M. N. (2008). Empirical validation of a procedure to correct position and stimulus biases in matching-to-sample. *Journal of the Experimental Analysis of Behavior, 90*, 103–112.
- Neef, N. A., Mace, F. C., & Shade, D. (1993). Impulsivity in students with serious emotional disturbance: The interactive effects of reinforcer rate, delay, and quality. *Journal of Applied Behavior Analysis, 26*, 37–52.
- Neef, N. A., Mace, F. C., Shea, M. C., & Shade, D. (1992). Effects of reinforcer rate and reinforcer quality on time allocation: Extensions of matching theory to educational settings. *Journal of Applied Behavior Analysis, 25*, 691–699.
- Neef, N. A., Shade, D., & Miller, M. S. (1994). Assessing influential dimensions of reinforcers on choice in students with serious emotional disturbance. *Journal of Applied Behavior Analysis, 27*, 575–583.
- Pace, G. M., Ivancic, M. T., Edwards, G. L., Iwata, B. A., & Page, T. J. (1985). Assessment of stimulus preference and reinforcer value with profoundly retarded individuals. *Journal of Applied Behavior Analysis, 18*, 249–255.
- Roscoe, E. M., Iwata, B. A., & Kahng, S. (1999). Relative versus absolute reinforcement effects: Implications for preference assessments. *Journal of Applied Behavior Analysis, 32*, 479–493.

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