THE ABCS OF JEAB, SEPTEMBER 1993

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The discriminated operant—a fundamental unit of behavior analysis—is composed of an antecedent stimulus (A), a class of behavior (B), and the consequence (C) of that behavior. The ABC model can provide a useful framework for understanding how analyses of behavior in controlled laboratory settings may be applied to real-life clinical and social settings. Several articles in the September 1993 issue of *JEAB* serve as antecedents to our behavior of seeking relations between basic and applied research; our readers will supply the consequences through their own research.

Applied behavior analysts are often called upon to design environments to decrease the occurrence of harmful or undesirable behavior and to increase adaptive responses. A number of effective methods are available to the practitioner, but there are two related issues that are less well understood: how to make the changes in behavior as persistent as possible after the therapeutic intervention ends, and how to make these changes generalize to novel settings. Three of the articles in the September 1993 issue of *JEAB* remind us of how difficult it may be to achieve these latter goals.

Consider first the article by Cohen, Riley, and Weigle. They performed four experiments with rats or pigeons serving as subjects in single or multiple schedules. In each experiment, they varied the rate of reinforcement provided by various simple schedules, obtained stable baseline response rates, and

then tested the resistance to change of those response rates by prefeeding, by providing additional response-independent reinforcers, and by extinction. When the schedules were arranged singly for a number of sessions and the results were compared between conditions employing different schedules, there was no direct relation between resistance to change and rate of reinforcement. However, when similar schedules were arranged in successive multiple-schedule components defined by distinctive stimuli that alternated within sessions, there was a clear and consistent positive relation between resistance to change and rate of reinforcement. Thus, it appears that the persistence of responding may not be affected by the value of a single schedule. However, it is strongly determined by rate of reinforcement when there is a distinctive stimulus correlated with that schedule, which, in turn, is contrasted with another distinctive stimulus and a different schedule, thus creating two well-defined ABC units.

When a single schedule is arranged, there is an implicit ABC unit—the session itself, which is contrasted with the remainder of the subject's life. In effect, the subject is exposed to a multiple schedule with one component involving reinforcement correlated with the experimental chamber and the other involving extinction in the home cage. However, the home-cage component lacks a specific response manipulandum. In addition, the experimental session is quite short relative to the rest of the subject's life; often, deprivation of the reinforcer is in effect for approximately 23 of 24 hr. Might it be that the single-schedule, short-session procedure is analogous to the usual short intervention periods reported in applied research, and that the

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effective similarity of all intervention schedules, when contrasted with lean reinforcement between intervention periods, may interfere with efforts to establish persistent desirable behavior? If this conjecture is correct, practitioners, applied researchers, and journal editors have added reason to want evaluations of interventions to span longer time periods.

Although Cohen et al. confirmed Nevin's (1992b) general finding of a positive relation between resistance to change and rate of reinforcement correlated with a well-defined stimulus situation, there was one exception to the generalization: There was no consistent positive relation when resistance was tested by arranging response-independent reinforcers during schedule components (see also Nevin, 1984). Thus, noncontingent reinforcement appears to weaken the response-reinforcer relation during resistance test sessions, resulting in lowered response rates for most subjects as the rate of noncontingent reinforcement increased. For applied work, this suggests that the enriched environments recommended by many researchers (e.g., Horner, 1980) may not enhance persistence while reinforcement is plentiful. Instead, the resistance-strengthening effects of response-independent reinforcement may not be evident until the response-reinforcer relation is challenged by another external variable (e.g., distraction, satiation, or extinction). We have shown that supplementing contingent reinforcement with noncontingent reinforcement during baseline training can increase resistance to change in the response that produces reinforcement (Mace et al., 1990; Nevin, Tota, Torquato, & Shull, 1990). The appropriate prescription for applied work may be to arrange a mix of contingent and noncontingent reinforcement for desirable target behaviors in a particular context. These target responses may then be disrupted less when conditions of reinforcement are interrupted.

But what if alternative reinforcement increases the persistence of the undesirable response topography? Nevin et al. (1990) also showed that if one arranges alternative reinforcement of a competing response to reduce the rate of a target response, the target response becomes more persistent. A clinical example was described by Mace (1991), who want-

ed to reduce the rate of food theft by a mentally retarded child who took food items from others an average of 81 times per hour before any interventions were arranged. When food theft was placed on extinction by blocking the child's efforts to reach for food from others, the rate of theft attempts fell rapidly to zero. However, when food theft was reduced to less than five occurrences per hour by providing food reinforcers for proper eating, and then reinforcement was discontinued for both proper eating and food theft, the latter persisted for approximately 36 meals. Because differential reinforcement of alternative behavior (DRA) or other, unspecified behavior (DRO) is so commonly used in applied settings to reduce the rate of undesirable behavior, it is important to recognize that alternative reinforcement may actually enhance persistence even as it reduces response rate. This phenomenon may be responsible for the less-than-complete success of some interventions based solely on alternative reinforcement and extinction. For example, Fisher et al. (1993) found that functional communication training combined with extinction was not completely successful at reducing their subjects' aggression and self-injury until punishment was added to the intervention package.

One way to deal with this problem may be to establish a separate discriminated operant by arranging alternative reinforcers at a high rate for a different response in the presence of a different, alternating stimulus situation. Some suggestive data were reported by Nevin (1992a). Using pigeons as subjects, he showed that increasing the rate of food reinforcement for pecking a green key both lowered the rate of pecking an alternated red key and decreased the resistance of red-key pecking to prefeeding and to extinction. However, Nevin employed the same response and reinforcer in both red and green components. It remains to be seen whether this result can be repeated with different response classes and reinforcers in the two components, and whether the same result can be obtained with humans in applied settings. This sort of research would nicely exemplify the joint development of basic and applied research that Mace (1994) has called for, and we hope to see relevant

work appearing in future issues of both *JEAB* and *JABA*.

The role of differential consequences in conditional stimulus control is specifically addressed by Voss, McCarthy, and Davison. They trained pigeons in two related discriminations. In Procedure A, pecks on the left key in the presence of a bright light produced food, whereas pecks on the right key produced a 3-s time-out. These contingencies were reversed in the presence of a dim light, and the duration of the time-out for incorrect left pecks was varied. In effect, the procedure involved four discriminated operants, pairs of which share common antecedents or common consequences: bright-left-food, bright-right-time-out, dim-right-food, and dim-left-time-out. As the time-out for left-key errors was lengthened in this procedure, the overall accuracy of discrimination improved slightly and the bias toward pecking the right key increased markedly; that is, longer time-outs selectively punished the incorrect response that produced them.

Procedure B was identical except that "correct" right-key responses in the presence of the dim light no longer produced food, but instead produced a 3-s time-out, just like "incorrect" right-key responses. The four operants are bright-left-food, bright-right-time-out, dim-right-time-out, and dim-left-time-out. Thus, two pairs share a common antecedent, but a trio of operants share a common consequence. The results showed that overall accuracy was substantially greater in Procedure B, despite the fact that only one sort of correct response led to food. This is an instance of the differential outcomes effect (DOE), whereby discriminative performance in situations involving two discriminated operants is enhanced by arranging different consequences for their respective responses. In addition, lengthening the time-out for incorrect left-key responses had no effect on response bias; that is, time-out no longer served as an effective punisher.

There are two messages for applied researchers here. First, it is often necessary to establish and maintain difficult discriminations (e.g., distinguishing between dials on washing machines and dryers for persons with mental retardation; Neef, Lens-

bower, Hockersmith, DePalma, & Gray, 1990). The differential outcomes effect suggests that it may help to arrange qualitatively different consequences for correct responses to each object (for a recent and comprehensive review of the DOE, see Goeters, Blakely, & Poling, 1992). Second, time-out from positive reinforcement is frequently used to punish undesired behavior in applied settings, but it may not always be effective (Brantner & Doherty, 1983). The results of Voss et al. suggest that time-out is most effective in suppressing undesired behavior in one stimulus situation (a) when the reinforcer for desired behavior in that situation is also available in a different situation, and (b) where the undesired (incorrect) response in the first situation is similar to the desired (correct) response in the different situation. Consider the student whose hyperactive behavior is disruptive during classroom assignments. Time-out may be most effective in this situation if the teacher approval provided for engagement in academic assignments is also available for energetic participation during physical education. In general, the punishing effect of time-out may depend on the context in which the punished operant occurs—more specifically, on the defining properties of other discriminated operants arranged in the same general setting. However, the Voss et al. article does not deal with resistance to change, the principal concern of the first part of this essay.

The second major concern of this essay is generalization to novel settings. Inevitably, discrimination training of this sort takes place within a definite context, whether it be the operant chamber or the classroom. Although a training program may be highly successful in making undesirable behavior less persistent within the training situation, contextual control may interfere with generalized performance in novel settings. This problem is highlighted in the series of experiments reported by Thomas, Empedocles, Morrison, and Bing. In one of their experiments, pigeons were trained to perform a simple successive discrimination in one chamber in the presence of a distinctive odor, and were then trained to make the reverse discrimination in a different chamber in the presence of a second odor. The birds were then tested in the original chamber

but with reversal contingencies in effect and with the second odor present. Nevertheless, the originally trained performance persisted, showing insensitivity to the reversed contingencies and suggesting powerful contextual control by fairly subtle visual apparatus cues. Other experiments showed that control by visual apparatus cues was actually enhanced rather than overshadowed by the odors. The authors concluded that "In applied settings, . . . we would like the behavior acquired in one setting to generalize to other appropriate settings. To achieve this objective, it seems wise to train subjects in as many different settings as possible. It must be admitted, however, that context specificity of operant performance is easier to produce than to avoid" (p. 329).

Applied behavior analysts have written extensively about the problem of achieving generalized performance (e.g., Stokes & Baer, 1977; Stokes & Osnes, 1989), and there is at least one study showing that generalization can be facilitated by presenting reinforcers used in training independently of responding in the generalization setting. Koegel and Rincover (1977) trained autistic children to comply with simple requests, and then presented similar requests in a novel posttraining setting. They obtained persistent generalized responding when they presented the reinforcers used in training non-contingently every 20 trials in the novel setting (see their Figure 4). It may well be that the consequences of responding, as stimuli, are more effective in overshadowing contextual cues than are environmental stimuli such as odors. In any event, when contextual control interferes with generalizing skills to new settings, explicit efforts to broaden the ABC unit to new stimulus situations should be evaluated (cf. Shore, Iwata, Lerman, & Shirley, 1994), including persistence-strengthening measures, removal of potent situation-defining stimuli, and addition of reinforcers correlated with the training setting.

In conclusion, the discriminated operant, which is so fundamental to behavior analysis, turns out to be a complex subject for study even under laboratory conditions. In far more complicated real-life situations, establishing and generalizing a relevant ABC unit that persists in the face of numerous

challenges to its integrity is the ambitious goal of most applied work. We are persuaded that applied behavior analysts can make progress toward this goal by testing the applicability of basic research findings related to discriminated operants in their interventions to improve social behavior. Successful applications will further encourage collaborations between basic and applied researchers toward the common goal of advancing the science of human behavior.

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- Received March 9, 1994
Initial editorial decision March 11, 1994
Final acceptance March 17, 1994
Action Editor, Nancy A. Neef