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APPLIED IMPLICATIONS OF CURRENT JEAB RESEARCH ON DERIVED RELATIONS AND DELAYED REINFORCEMENT

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This review examines a subset of articles from the March 1993 issue of the *Journal of the Experimental Analysis of Behavior*. The issue contains many excellent articles, but we will focus on four that seem to us to have applied implications.

The Conditions That Give Rise to Equivalence: You Have to Know the History

No area of basic behavior-analytic research has more obvious applied importance than the study of derived relational responding, including stimulus equivalence, exclusion, and relational frames. In this issue of *JEAB* comes confirmation that the likelihood of formation of stimulus equivalence classes cannot be known without knowing the histories of the individuals involved. Before we explain what was found, it is worth discussing why equivalence is important in the first place.

The applied importance of relational responding. The applied impact of stimulus equivalence comes largely from the way relational responding combines with principles of direct contingency control and classical conditioning so as to create entirely new means of establishing discriminative, reinforcing, motivative, and eliciting functions. The simplest case is that of stimulus equivalence—simplest because all trained and derived relations are the same. Suppose a child learns that the written word C-A-T is called "cat" (and not, say, "ball") and that this written word goes with a class of furry mammals (and not, say, round playthings). The child will probably now derive the mutual relation between the oral name and actual cats, between the oral name and written word, and between cats and the written word, all without explicit training with these particular stimuli (e.g., Dixon & Spradlin, 1976; Sidman, 1971; Sidman, Kirk, & Willson-Morris, 1985; Sidman & Tailby, 1982; Spradlin & Dixon, 1976).

The basic stimulus equivalence finding would be of limited applied importance (outside of areas such as reading) were it not for a second property of relational responding. Imagine that the child in our example goes to her next-door neighbor's house and plays with cats for the first time. If the experience is a positive one, several functions may be directly established by this experience. Cats may elicit smiling, have discriminative functions over approach behavior, serve as establishing stimuli for getting a small ball from a toy box, or reinforce trips next door. What is of immense applied importance is that all of these functions may now adhere in the *word* "cat" (or the written name, for that matter) at least to some degree and in some contexts. Our child may now smile when cats are being discussed, may approach when her mother says "oh, a cat," or may work to produce the word itself ("tell me about cats again Mommy"), all without any direct experiences with the word "cat" that might give rise to such functions.

These functions, which appear to be instances of higher order classical conditioning, discriminative control, or conditioned reinforcement, are probably not because the histories involved do not fit these technical terms. For example, a discriminative stimulus is a stimulus that has its functions because there has been a greater probability of reinforcement for a given response in the presence of that stimulus than in its absence. If the child approaches upon hearing "oh, a cat" for the first time, this cannot be a discriminative stimulus because there has been no history of differential reinforcement for approach with regard to the word. Rather, the function is discriminative-like but is due to a transformation of stimulus functions through an equivalence class.

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There is extensive evidence demonstrating these transformations of psychological functions through derived stimulus relations (Catania, Horne, & Lowe, 1989; De Rose, McIlvane, Dube, Galpin, & Stoddard, 1988; Gatch & Osborne, 1989; Hayes, Brownstein, Devany, Kohlenberg, & Shelby, 1987; Hayes, Kohlenberg, Hayes, 1991; Kohlenberg, Hayes & Hayes, 1991; Lazar, 1977; Lazar & Kotlarchyk, 1986; Wulfert & Hayes, 1988). Relational responding thus greatly increases the number of ways in which behavioral functions can be established. In addition, the source of these functions can be much more subtle and indirect than in explicit learning situations, because deriving stimulus relations turns out to be an extremely flexible response. Verbal humans, at least, will derive equivalence or other types of relations quite literally at the drop of a hat, so applied workers need to sensitize themselves to the range of conditions that can lead to such responses and the behavioral effects they produce. That leads us back to our target article.

Deriving Equivalence Relations Is Based on History

At one time the behavior-analytic world of stimulus equivalence was a simple place. The definition of stimulus equivalence had a weight and precision to it that derived from its close link to mathematical formulations. The conditions that gave rise to equivalence also seemed fairly well understood: It emerged virtually automatically from conditional or conditional conditional discriminations. Increasingly, things now seem much more complicated.

Johnson and Sidman (1993) show what happens when adult human subjects are provided with an immediate history in a matching-to-sample task that encourages subjects to derive a relation between a sample and the comparison that was *not* chosen, rather than the comparison that *was* chosen. How they did this is not critical here, but as an example of one part of their procedure, they had many more "right" answers than "wrong" ones, so that it was much easier to learn just to pick anything other than "*x*" (the wrong answer) than to focus on the positively trained relations. Given this history, the normal matching-to-sample situation works differently. Subjects were trained in these six relations: A1—B1 not B2; A2—B2 not B1; B1—C1 not C2; B2—C2 not C1; C1—D1 not D2; C2—D2 not D1. Without pretraining, subjects would surely derive two equivalence classes given these trained relations: A1, B1, C1, D1 and A2, B2, C2, D2. Instead, the two classes were A1, B2, C1, D2, and A2, B1, C2, D1. In addition, subjects systematically failed to show reflexivity (e.g., given A1, they did not pick A1). This is a delightful finding that contradicts a simplistic conception of stimulus equivalence. To account for these results, we cannot focus attention only on what was trained in a formal sense; we must also know the histories involved so that we can know which stimuli were functionally important in the training situation.

It is now clear that what people actually do in equivalence testing is highly dependent upon the historical and situational context that surrounds that performance. For example, this study shows that subjects can derive relations between a sample and a "reinforced" comparison, or between a sample and a "nonreinforced" comparison, depending upon their history. If contextual cues had been associated with distinct pretraining histories (one to encourage a focus on the rejected comparison and the other a focus on the selected comparison), both patterns might have been shown within the same subjects given only the correct contextual cues. This seems highly likely, because it is already known that with the right kind of pretraining and contextual cues that indicate which aspect of pretraining is relevant, it is possible to produce three (Steele & Hayes, 1991), four (Lipkens & Hayes, 1991), or even more distinct patterns of relational responding simultaneously within the same individual in an arbitrary matching-to-sample procedure.

Such behavioral flexibility and sensitivity to historical and current situational contexts should, of course, look familiar to behavior analysts. Increasingly it appears that deriving stimulus relations is a situated action of an organism—in short, an operant—and thus subject to all the influences that bear on any operant (Hayes & Hayes, 1989, 1992).

If so, there seems to be no reason that equivalence should be the only such relational operant, but even if it is, viewing equivalence as an operant suggests that almost *any* procedure can lead to equivalence if the context supports the proper relational activity.

Given the behavioral impact of derived stimulus relations, applied behavior analysts must face the difficult task of predicting and controlling the relational activities of clients. Speaking loosely, we simply must find a way to know what clients are thinking and to learn how to alter this activity. This problem, of course, is precisely the problem that cognitive therapists have struggled with, largely unsuccessfully. Behavior analysts, however, have some conceptual and methodological advantages that might be exploited. Most especially, the structuralistic views of cognitive therapists, with their thought questionnaires and other static instruments, will be avoided in favor of a more functional and flexible approach to relational activity as it actually occurs. Johnson and Sidman remind us again, if behavior analysts need the reminder, that a functional approach is necessary.

Dealing with Delay

In applied situations, reinforcement is often delayed considerably. Several articles in this issue dealt directly or indirectly with the issue of delay.

Critchfield and Lattal (1993) examined the acquisition of spatially defined operants. They note that responding, particularly in standard operant procedures, produces stimuli in the form of sound (e.g., clicks), kinesthetic feedback, and so on. As a theoretical matter, this complicates assessment of the reinforcing effectiveness of delayed consequences, because there may be conditioned reinforcing properties to response-produced stimulation that could account for the change in behavior. To overcome potential confounding effects of this sort, Critchfield and Lattal examined the effects of delayed consequences (using a procedure that ensured at least a 30-s delay between responding and a consequence) on a spatially defined response (breaking a photobeam) that in some conditions was free of experimenter-programmed response-produced feedback and in others produced a tone. They found both that delayed reinforcement worked in the absence of response-produced feedback, and that such feedback assisted in response acquisition.

In another article, Leung (1993) examined the effects of segmented versus unsegmented aperiodic schedules. Humans playing a video game for money could detect "enemy aircraft" in a concurrent chains procedure either on a long variable-interval (VI) schedule or via a matched sequence of VI schedules with associated stimulus changes. For example, in one condition, a "radar screen" was followed by a screen showing aircraft detection at average time x; in another condition, a grid on the screen was followed by a "radar screen" at average time $\frac{1}{2}x$ followed by a screen showing aircraft detection at average time $\frac{1}{2}x$. The monetary consequences were thus exactly the same, but subjects preferred the unsegmented schedule and preferred fewer segments over many.

Omino and Ito (1993) showed that preference for a short delay to reinforcement versus a long delay to reinforcement was greatest for pigeons in a concurrent chains procedure when keylights remained illuminated in the terminal link. The effect was greatest when the color of the keylight changed to indicate which alternative had been selected, but the effect was still evident even if the key color did not change. A series of control conditions showed that the effect derived from the conditioned reinforcing properties of the keylight itself.

These three articles focus attention on what is meant by "delay" and why it may have an effect. Psychologically, a delay is not a simple event that can be usefully characterized by orderly processes of change in a physical substance (e.g., the unwinding of a spring that produces ticks on a clock, the vibration of a crystal, or emission of atomic material). In a psychological sense, "delay" is a way of referring to unspecified happenings—changes that occur in the organism's interaction with its environment. For example, in the Critchfield and Lattal study, a subject who responded during the delay had the time to reinforcement set back to 30 s, because the schedule involved differential reinforcement of other behavior (DRO 30). This is essentially a punishment contingency, and this his-

tory and the tendency to respond in this fashion were part of what "delay" meant to the organism. In the Omino and Ito study, the delay included seeing or not seeing a keylight that had been associated with reinforcement. In the Leung study, delay involved seeing stimulus conditions stay the same until reinforcement or seeing them change from those not associated with reinforcement to those more closely associated with reinforcement. In other words, the effects of delays have very much to do with what happens while the clock ticks.

As an applied matter, these studies remind behavior analysts to think carefully about what occurs during delays to reinforcement. Segmenting a schedule, for example, is readily done verbally, and such segmentation can produce strongly negative reactions, especially in young children. Parents are often mystified when young children immediately have a tantrum when they are told of great things that will happen tomorrow or next week, or wonder why such tantrums seem to be greater the more wonderful the eventual treat. Such talk defines the present as a period in which the described consequence is unavailable, and the more wonderful the treat the more keenly that unavailability is likely to be felt. However, over time, such verbal segmentation can itself take on positive properties, as stimuli are related to consequences directly or via verbal relations ("Imagine—only 14 more courses to take until I have my PhD.").

Applied behavior analysts should examine ways that response-produced stimuli might be increased and be more effectively related to desirable outcomes. There may be direct ways to accomplish this, but verbal behavior is probably the primary way this is done in normal development. This brings us back to an earlier point: Applied behavior analysts must find a way to predict and control the relational activities of clients and to manipulate the behavioral outcomes of these verbal relations.

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