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TOWARD GREATER INTEGRATION OF BASIC AND APPLIED BEHAVIORAL RESEARCH: AN INTRODUCTION

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The disconnection between basic and applied research in behavior analysis has been lamented for over a decade now (e.g., Deitz, 1978; Michael, 1980; Pierce & Epling, 1980). The articles appearing in this special issue of the *Journal of Applied Behavior Analysis* represent a significant step toward increasing the interactions between the basic and applied sectors of our field. These papers cover a wide range of topics and illustrate, in a very practical sense, how basic science discoveries can stimulate the development of behavioral technologies (Mace, 1994). Although this series of articles exemplifies the influence basic research can have on technology, this influence can certainly be bidirectional. That is, specific applied problems that have proven resistant to solution with existing behavioral technologies can occasion the design of laboratory studies to examine the basic behavioral relations that maintain these problems. Such reciprocal influences should be reflected in the cross-citation patterns in *JABA* and *JEAB* (i.e., *JEAB* papers cited in *JABA*, and vice versa). The article by Poling, Alling, and Fuqua in this issue reports a recent increase in cross-citations that seems to reflect the growth in basic–applied interactions that this special issue tangibly represents. Our hope is that as these interactions prove to be profitable, basic scientists will also increasingly pose research questions with direct relevance to human problems.

The articles in this special issue address some of the most fundamental topics in both applied and basic work: choice, resistance to change, and stimulus control. In addition, methodologies that are new to many applied behavior analysts are presented for investigating "new" types of behavior (adjunctive behavior) and for systematizing an "old" mainstay of behavioral teaching (shaping).

Choice

Many authors have recognized that most human behavior can be conceptualized as choice behavior, that is, choices among concurrently available response alternatives. Herrnstein's (1961, 1970) pioneering work on the matching law provided us with an experimental paradigm and conceptual framework for studying choice behavior and the variables that control it. But, as is true of most basic research, before Herrnstein's findings can affect applied work, laboratory preparations must be translated into procedures suitable for studying applied problems. The lead article in this issue by Neef, Shade, and Miller makes an important contribution toward this end. Neef and her colleagues present a coherent assessment methodology for identifying which variables influenced the choices made by students with serious emotional disturbance to perform concurrent sets of math problems. The math alternatives varied systematically with respect to different reinforcer dimensions (rate, quality, and delay) and/or response dimensions (problem difficulty). The 6 students in the study showed different, but consistent, sensitivities to the four variables, which can give specific direction to the design of individualized educational programs.

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Early applications of the matching law prompted enthusiasm for our ability to predict response allocation patterns in applied settings quantitatively, based on relative rates of reinforcement obtained from available response alternatives. However, as more and more applied studies are conducted on the matching relation, some limits to matching-law accounts of human choice are increasingly evident. Mace, Neef, Shade, and Mauro presented adolescents with three different ratios of concurrent variable-interval variable-interval (conc VI VI) reinforcement for performing two identical sets of math problems. Parametrically varying the conc VI VI schedules parallels the methods used in basic research and permits regression analysis of the linear relationship between relative response rate and relative frequency of reinforcement. Although the subjects' choices varied as a function of relative rate of reinforcement, replicating basic research with humans and nonhumans, allocation patterns for all 3 subjects were slow to change with changes in the conc VI VI reinforcement conditions. The findings showed that human choice in applied situations may not be very sensitive to rapid changes in relative rates of reinforcement, suggesting that choice may be contingency shaped at times and rule governed at others.

The dynamic character of choice in natural settings was also suggested in the study by Tustin. Drawing on basic research in behavioral economics and reinforcer substitutability, Tustin assessed the extent to which preferences for qualitatively different reinforcers established under fixed-ratio (FR) 1 test conditions remained constant as the "cost" for reinforcers increased. Subjects in Tustin's study varied their preferences for reinforcers as the relative cost for the reinforcers changed (as represented by different FR schedules). This finding challenges the assumption that reinforcer preference established under conditions of low schedule requirements will necessarily generalize as schedule requirements increase.

A further indication of the complexity of human choice is evident in the study by Hantula and Crowell. Using a computerized stock investment task, subjects were able to invest "stock" in two "markets" arranged in a two-component multiple schedule. During baseline, the two markets yielded equal returns according to VI schedules, and subjects invested similar amounts in each market. However, when investment returns were reduced to zero in one market and returns remained constant in the other market, investment in the unchanged market increased substantially while investing extinguished in the zero-return market. This study not only replicates behavioral contrast effects reported in numerous basic studies but it also points out that allocation patterns or choice can be influenced by reinforcement conditions in temporally contiguous situations as well as those concurrently available.

Resistance to Change

The rate of reinforced behavior tends to persist (i.e., has momentum) even when the response–reinforcer relation maintaining the behavior is challenged by some external variable such as extinction, satiation, alternative reinforcement, punishment, or distraction. This resistance to change is a fundamental property of reinforced behavior that applied behavior analysts have only recently begun to integrate into their interventions. Basic studies have shown that a behavior's momentum is a positive function of response rate and reinforcement rate. One explicit application of this property of behavior, based on Nevin's formulation of the behavioral momentum metaphor (Nevin, Mandell, & Atak, 1983), involved presenting a rapid sequence of instructions with which an individual was likely to comply (i.e., high-probability or high-*p* instructions) immediately before an instruction to perform a low-probability (low-*p*) response. Consistent with Nevin's essential finding, the intervention arranges a high rate of reinforcement for a high rate of responding that, in turn, can increase compliance to the low-*p* instruction. Four articles in this issue extend this growing literature by applying this type of intervention to new populations and target responses. Importantly, these studies further identify the conditions under which the intervention will produce the desired outcome.

Davis, Brady, Hamilton, McEvoy, and Williams used the high-*p* instructional sequence to increase social interactions with peers for 3 socially withdrawn boys with severe disabilities. The intervention not only increased performance of low-*p* social responses but also resulted in extended interactions and unprompted social initiations that generalized to different peers and settings. Fortunately, in the Davis et al. study, treatment gains were maintained when the intervention was discontinued, perhaps because social interactions began producing reinforcing consequences. However, when this does not occur naturally, a systematic method is needed to promote maintenance. The study by Ducharme and Worling demonstrated the effectiveness of a procedure for systematically fading out high-*p* instructions. The number of high-*p* instructions was reduced gradually from three to one, and then the latency from the last high-*p* instruction to the delivery of the low-*p* instruction was gradually increased.

As is true of nearly all behavioral interventions, certain conditions must be in place for the high-*p* instructional sequence to be effective. Zarcone, Iwata, Mazaleski, and Smith implemented the momentum-based intervention to improve compliance for 2 profoundly mentally retarded men who also engaged in self-injurious escape from tasks. When the high-*p* sequence was used alone, self-injury continued to occur at high rates and compliance was very low. However, when combined with an escape extinction procedure, the high-*p* instructional sequence was associated with both increased compliance and decreased self-injury. Finally, Houlihan, Jacobson, and Brandon again showed that the latency between the last high-*p* instruction and the issuance of the low-*p* instruction can be critical to the success of the intervention. When the latency was 5 s, the high-*p* intervention increased compliance; however, a 20-s latency failed to produce sufficient momentum to overcome the resistance of the low-*p* instruction.

Stimulus Control

Basic research with humans has shown stimulus control to be quite complex. The correlations established between stimuli and reinforcers, during reinforcement, also appear to establish stimulus–stimulus relations that are capable of controlling behavior. The study by Wulfert, Greenway, Farkas, Hayes, and Dougher illustrates that, once formed, these stimulus–stimulus relations can sometimes be more powerful than even direct reinforcement contingencies. Adults were presented with a computer task requiring them to press a button to move a marker through an array of five squares displayed on a TV screen. In the first of two experiments, relatively slow button pressing moved the marker through the squares more effectively (i.e., a differential-reinforcement-of-low-rate, or DRL, 4-s schedule) when the squares were yellow. When the squares were blue, fast pushes on the button worked better (i.e., an FR 18 schedule). Subjects were given either accurate instructions about the most effective response patterns in each color condition or they were given minimal instructions. After low-rate (DRL) and high-rate (FR) responding was established, button pressing in both components was placed on extinction. Subjects who were provided with instructions describing the operative contingencies had a strong tendency to persist in their FR-patterned behavior, showing an insensitivity to the extinction schedule. In the second experiment, all subjects were exposed to a single FR 8 schedule and were told that fast button pushing works best. After stability, the schedule was switched to a DRL contingency, but only half of the subjects were informed of the change. Once again, the stimulus–stimulus relations established by the instructions continued to affect the response patterns of the uninformed subjects. Perhaps the most interesting finding was that, prior to the study, subjects were grouped as showing "high rigidity" or "low rigidity" based on a self-report test. Those whose self-reported behavior was characterized as rigid were also those who showed the least sensitivity to changes in the reinforcement contingencies. The applied significance of this work is that the behavior of some individuals may be especially resistant to change by contingencies. If behavioral assessments can identify these individuals in advance, they may be more responsive to interventions aimed explicitly at modification of rule-governed behavior.

Conditional discrimination training of the sort used to teach sight-word reading also establishes untrained stimulus–stimulus relations. Kennedy, Itkonen, and Lindquist taught mentally retarded children A-B, B-C, and C-D conditional discriminations involving words from the four food groups. In a stimulus equivalence paradigm, tests for the emergence of untrained relations showed that symmetry (e.g., if A-B, then B-A) emerged before one-node transitivity (e.g., if A-B and B-C, then A-C), which in turn emerged before two-node transitivity relations (e.g., if A-B, B-C, and C-D, then A-D). These equivalence relations constitute the basis for a behavioral analysis of concept formation. Finding strong nodality effects in a sight-word instruction task suggests that explicit training of multinode transitivity relations may be necessary for some students with disabilities to develop key concepts.

Young, Krantz, McClannahan, and Poulson evaluated the influence of response topography of generalized imitation with 4 young children with autism. The authors showed that generalized imitation is limited by response topography—imitative responding generalized within but not across response types. In addition, some types of responding were more difficult than others for all children, perhaps because of competing behaviors. This study, then, provides an analysis of some of the dimensions that influence imitative behavior with autistic children and provides direction for how socially meaningful behavior can be specifically programmed via stimulus control of distinct response classes.

Glat, Gould, Stoddard, and Sidman provide an analysis of how one common procedure in the applied literature—delayed cues—can promote stimulus control. Further, the authors show how the application of this procedure can be both complex and difficult. As in the study by Young et al., an interaction appeared to occur between antecedent stimuli and target responses. In the Glat et al. study, discriminative control may have been a function of the response rather than the stimulus. This led initially to unsuccessful attempts to use the procedure to teach conditional discriminations to an individual with moderate mental retardation. Across three experiments, this initial problem was identified, analyzed, and remediated. This study demonstrates, once again, that applied procedures based on basic processes are neither good nor bad. Of importance are the conditions under which the procedures have facilitative effects on treatment outcomes, either alone or as one component in a treatment package.

Lalli, Casey, Goh, and Merlino provide another example of how stimulus control can be the cornerstone of applied interventions. The authors taught 2 youths who engaged in escape-maintained aberrant behavior to follow daily schedules. The goal was to teach these individuals to follow visual stimuli (printed words and photographs) and oral stimuli to guide their behavior throughout entire days on an inpatient hospital unit, with the hope that as the youths became better able to discriminate upcoming activities, aberrant behavior would decrease. A time-delay procedure was used to teach the individuals to match the various stimuli, and escape extinction followed aberrant behavior. Both compliance and aberrant behavior improved with training, but some noteworthy differences across types of activity schedules also emerged. The study is also of interest because it further shows the complexity of applications of stimulus control procedures even under tightly controlled hospital conditions.

The final study on stimulus control by Partington, Sundberg, Newhouse, and Spengler showed that stimulus control was disrupted by the occurrence of a blocking stimulus. Specifically, a 6-year-old girl with autism was successful in acquiring mands but not tacts. An analysis revealed that the presence of a verbal stimulus prevented the nonverbal stimulus from establishing the control needed for tacting. Instead, when the verbal stimulus was present, nonfunctional and aberrant behavior occurred. When the verbal stimulus was removed, however, multiple tacts were quickly acquired.

Each study in this section showed that applications of stimulus control procedures can have immediate, facilitative effects on target behavior. Each, however, also demonstrates that preexisting stimulus–response and stimulus–stimulus relations can disrupt treatment.

New Methodologies

Applied behavior analysts practice under the assumption that behavior is maintained directly by its environmental consequences. Although this assumption proves to be reasonable in most cases, at least some clinically relevant behavior appears to be maintained *indirectly* by reinforcement contingencies. The study by Lerman, Iwata, Zarcone, and Ringdahl presents a viable assessment methodology for identifying the adjunctive characteristics of self-injurious behavior and stereotypy. Adjunctive behavior is behavior maintained indirectly by reinforcement of another response class or by the noncontingent presentation of reinforcement. The authors' assessment methodology compared three different conditions in a multielement design extending across different phases of reinforcement amounts: fixed-time food reinforcement, no reinforcement, and a control condition consisting of presession massed food reinforcement. Although the self-injury of none of the 4 subjects showed adjunctive characteristics, the stereotypy of 2 subjects appeared to be induced by the scheduled (noncontingent) presentation of food. The Lerman et al. study is the first analysis of adjunctive behavior to appear in *JABA,* and its publication promises to encourage further investigations defining the character of human stereotypic behavior.

One technique that distinguishes a skilled behavior analyst from the novice is that of shaping new response topographies. Shaping refers to the differential reinforcement of successive approximations to a terminal response. As with any differential reinforcement procedure, shaping involves alternately reinforcing some responses and extinguishing others. However, judging when to reinforce and when to extinguish, so as to move behavior efficiently toward a response criterion, has historically been a skill we acquire by practice rather than by following a set of rules. In this issue's discussion article, Galbicka introduces applied behavior analysts to a technology, used for years inside the laboratory, that formalizes the rules of shaping. Percentile schedules provide objective criteria for delivering reinforcement during shaping, allowing the subject's recent progress to determine when a given response should be reinforced. The key is to strike the proper balance between the response variability induced by extinction and the response specificity produced by reinforcement. The article by Lalli, Zanolli, and Wohn illustrates how this balance can be manipulated to induce new response topographies that then permit reinforcement of expanded repertoires. Their subjects were 2 children with very limited toy-play repertoires. By placing their limited toy play on a rich schedule of reinforcement and then placing toy play on extinction, new play responses were induced and subsequently reinforced. Shaping, of course, replicates this process until subjects reach a skill level that is often far removed from their baseline repertoire. Galbicka's excellent primer on shaping and percentile schedules should promote considerable innovative applied research on response differentiation.

The final article in this special issue is an essay by Cataldo and Brady. Their paper is part of an ongoing series, begun in the Summer 1993 issue, that teams an applied behavior analyst with a basic researcher to discuss potential applications of recent *JEAB* research. The theme underlying this issue's essay is the critical role that verbal behavior plays in influencing human actions. We anticipate that the essay by Cataldo and Brady will, as their predecessors apparently have, continue to promote linkages between basic and applied research.

We conclude by emphasizing that the basic processes that underlie human behavior are complex and dynamic. The progress that has been made in basic research toward understanding these fundamental relations has been, and will continue to be, the source of multiple applied procedures. As with all new developments, however, our confidence in the robustness of these research findings must await the results of systematic replications. But the process of developing new technologies must start somewhere. The articles that follow represent important innovations that extend our technologies in new directions, stimulated by developments in basic research.

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