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Strengthening the research–practice loop in applied animal behavior: Introduction to the special issue

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Though operant learning has been applied to socially significant animal behavior for many years, connections between these practical applications and the basic science that supports them have weakened over time. There is a need for replications and extensions of technologies derived from basic research to applied animal settings, and for practical questions to be taken back to the lab where they can be modeled and studied under controlled conditions before incorporating the results in applied behavior-change research and practice. This special issue highlights ways that behavior analysis can contribute to and support the development of evidence-based applications with animals. Articles in this issue provide context for the relationship between basic research and practice in animal behavior, apply basic principles to animal behavior practice, and investigate practical problems using basic research techniques. Each of these is important for a robust interchange between basic science and practice. Here we comment on the contributions of each article to the literature and identify directions for future research.
Key words: applied animal behavior, experimental analysis of behavior, animal training, animal enrichment

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The history of the application of operant learning to socially significant animal behavior is long and has resulted in tremendously effective technologies benefiting both animals and humans in many different practical settings (Alligood et al., 2017; Edwards & Poling, 2011; Mahoney et al., 2012). Over the past several decades, there has been a weakening of some of the connections between practical applications of operant learning with animals and the basic science that supports those applications, to the detriment of the continued development of effective technologies (Alligood & Friedman, 2022; Kalafut & Freestone, this issue; Kurland & St. Peter, this issue). Given our focus on measuring behavior change in individuals over time, behavior analysis has much to offer to applied animal work in various settings. Indeed, multiple authors have called for increased use of behavior-analytic principles and methodologies in animal care (e.g., Alligood & Leighty, 2015; Alligood et al. 2017; Bloomsmith et al., 2007; Friedman, 2005; Friedman, 2009; Maple, 2007).

The purpose of this special issue is to highlight ways that behavior analysis can contribute to and support the development of evidence-based applications with animals from multiple positions on the spectrum (Kyonka & Subramaniam, 2018) from the experimental analysis of behavior (EAB) to practice. There is a need for replications and extensions of technologies derived from basic research to applied animal settings.

This issue is dedicated to the memory of David P. (Dave) Jarmolowicz. Dave's philosophy was an ideal representation of the goals of this special issue, as reflected by his insistence on being led by data: "As Dave branched into various pursuits, he retained the core value that you never let expertise with behavior principles seduce you into circumventing an empirical analysis." (Reed et al., this issue). Although he did not formally work in applied animal behavior, Dave took an interest in this area both as an important extension of behavior science and as a means of informing the care of the animals in his laboratory. When one of the present authors discussed this special issue with him, he expressed excitement about the prospect of strengthened connections between basic science and practice in applied animal behavior, emphasizing that the best behavior-analytic solutions to practical problems come from returning to basic principles to better understand the problem, eventually allowing the creation of specialized solutions that apply directly to the challenge at hand.

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Concurrently, there is a need for practical questions to be taken back to the lab where they can be modeled and studied under controlled conditions before incorporating the results in applied behavior-change research and practice. In this issue, we are pleased to introduce a series of articles that provide context for the relationship between basic research and practice in animal behavior (Lattal & Fernandez; Kalafut & Freestone; Kodak, Bergmann, & Waite; Kurland & St. Peter, this issue), apply basic principles to animal behavior practice (Davidson & Rosales-Ruiz; Nishimuta, Rosales-Ruiz, Will, & Hunter; Rosales-Ruiz & Katz, this issue) and investigate practical problems using basic research techniques (Bizo, Moser, & Brown; Cameron, Begum-Diamond, & Neuhauser; Platzer & Feuerbacher; Rosales-Ruiz & Peiris; Salzer & Reed, this issue). Each of these is important for a robust interchange between basic science and practice.

Relationship Between Basic Research and Practice in Animal Behavior

Lattal and Fernandez (this issue) provide an expert view of the contributions of EAB to applied animal behavior (AAB). Organized around four of the pillars of EAB described by Lattal (2013), their paper highlights pertinent experimental data from studies on reinforcement, extinction and punishment, stimuli correlated with reinforcement and punishment, and stimulus control. Readers of the special issue will find guidelines and useful references for common issues in AAB including the selection of step sizes in shaping procedures, potential side effects of procedures used in target training (e.g., baiting), and adaptations to consider in clicker training (e.g. the use of second-order schedules). This article also points out for readers some conceptual divergences between EAB and AAB, such as descriptions in AAB that do not carry technical definitions stemming from procedures in EAB but may be accounted for on a process level by EAB (e.g. marking, bridging) and the classification of certain procedures and processes (e.g. the classification of extinction as an aversive procedure and the implications of making distinctions between positive and negative reinforcement).

Kalafut and Freestone (this issue) advocate the blending of EAB and AAB expertise to solve practical problems. The authors provide several examples of situations in which EAB expertise was brought to bear on practical problems with nonhuman animals. Their discussion follows in the tradition of Sidman (2011, p. 973):

> Before entering the worlds of applied research and practice, I spent approximately 10 years intensively involved in basic behavioral research in the laboratory, mostly with nonhumans as subjects. Then, almost as soon as I started to work with people who had suffered strokes or who displayed severe learning and other behavioral deficiencies, I realized that the preceding 10 years had constituted a period of apprenticeship for me. It turned out to have been an effective apprenticeship. By applying principles and investigative techniques I had learned in the laboratory, I found that I could communicate nonverbally with people who could not speak, that I could teach the supposedly unteachable, and that I could often successfully revise ineffective therapeutic procedures.

Kalafut and Freestone's (this issue) examples illustrate the utility of an understanding of basic research methodology and technological tools, as well as basic behavior principles, in collecting data for practical purposes in animal care settings. They end with several recommendations that will be helpful for behavior analysts interested in establishing collaborations focused on applied animal behavior.

To ensure internal validity in research experiments and promote treatment adherence in practice, behavior analysts must measure procedural fidelity, or the extent to which procedures are implemented as designed. While procedural fidelity has been increasingly investigated and discussed in the behavioral analysis literature over the past several decades (e.g., DiGenarro Reed & Codding, 2014; Falakfarsa et al., 2022; Fallon et al., 2020), the topic has received little attention in applied animal behavior research and practice. Kodak et al. (this issue) review the behavior-analytic procedural fidelity literature, including basic and applied studies with human participants, and draw clear connections to applied animal behavior research and practice. Readers will find suggestions for future research directions, as well as an analysis of procedural fidelity measures best suited to AAB research and practice.

In AAB practice, some commonly used terms and related procedures have largely unrecognized connections to the experimental analysis of behavior (Alligood & Friedman, 2022; Lattal & Fernandez, this issue). Kurland and St. Peter (this issue) discuss behavior-analytic conceptualizations and research around the term "loopy training", identifying points of correspondence and research questions to be explored. In addition, they provide several excellent suggestions for improving the "loops" between animal trainers and behavior analysts.

Applications of Basic Principles to Animal Behavior Practice

The special issue showcases several studies that engaged the basic principles of behavior to produce socially significant behavior change in nonhuman animals. Davidson and Rosales-Ruiz (this issue) modified two classes of maladaptive behavior (specifically, mouthing and jumping) by differentially reinforcing those response classes in the presence of a novel SD (which mimicked the original SD but added an additional auditory component with which the dog had no history) and withholding the reinforcer for all other response classes. They simultaneously implemented the contingencies in reverse for the original SD (putting the undesirable response classes on extinction while reinforcing any other behavior). This paper demonstrates a practical amelioration of a pet owner's circumstances without the use of punishment and modeled an intervention for behaviors that need not be eliminated across all contexts.

Lattal and Fernandez (this issue) point out that conjugate schedules, which they define as reinforcement schedules in which "some property of the reinforcer varies with some property of responding", may prove useful in strengthening response classes of interest in AAB. Nishimuta et al. (this issue) incorporated a conjugate schedule into a differential reinforcement procedure by delivering higher quality tactile interactions contingent upon behaviors other than pushing, nibbling, biting, or walking away. Tactile interaction was also used as a reinforcer to shape "stay" and "come" behaviors across a prescribed 29-step shaping program to train the horses to stay on cue and a prescribed 11-step shaping procedure for training the horses to come on cue. One of the interesting implications of this is that tactile stimulation may yield positive training outcomes without the need to incorporate phylogenetically important events (PIEs) such as food.

There is a growing literature on interventions to increase "adoptability" in shelter-housed animals by increasing behaviors that are positively correlated with likelihood of adoption and decreasing behaviors that are negatively correlated (Protopopova & Gunter, 2017). Behaviors labeled as "fearful" have been negatively correlated with likelihood of adoption and often targeted for reduction using desensitization and counterconditioning (DSCC) interventions. Rosales-Ruiz and Katz (this issue) employed an alternative to DSCC in which behaviors classified as fearful were treated as operants, and more preferable alternative ("friendly") behaviors were reinforced with reduced proximity to a novel person. They were able to very efficiently teach preferred behaviors and concurrently reduce fearful behaviors in all three dogs participating in the study, and all three dogs were subsequently adopted. Rosales-Ruiz and Katz describe this intervention as "constructional" because it builds upon the animal's existing repertoire to increase preferred behaviors, and nonpreferred behaviors decrease without being explicitly targeted in the procedures. This paper provides an example of the use of behavior-analytic principles to solve a practical problem in a way that is beneficial to both the dogs (through increased "friendly" behavior) and to the shelter (through effective and efficient training). This demonstrates a critical feature of sustainable solutions in the shelter environment: prioritizing organizational needs. A fruitful direction for future analyses might be a comparison of this procedure to others in the behavior-analytic literature and a discussion of the necessary and sufficient conditions for use of the label "constructional".

Investigations of Practical Animal Behavior Problems Using Basic Research Techniques

This issue also presents several articles describing investigations of practical animal behavior problems using basic research techniques. For example, to maximize the effectiveness and efficiency of applications of behavior analysis with animals, it is important to identify reinforcers for individual animals. For pets, enriching the environment with safe opportunities for exercise is critical for good health. Cameron et al. (this issue) used basic research techniques to investigate both of these practical problems in guinea pigs. Demand testing has been used in the laboratory and in applied settings to assess reinforcer value (Hursh et al. 2013; Rasmussen et al., 2020). Cameron et al. titrated demand by adjusting the slope of a ramp the guinea pigs climbed to reach food items, determining demand based on maximum slope climbed for an item. They were also able to use this metric to identify safe and accessible ramp slopes for habitat enrichment.

Platzer and Feuerbacher (this issue) evaluated the reinforcer efficacy of six different grains for horses, considering factors such as nonstructural carbohydrate content and texture. All grains in the study functioned as effective reinforcers, with few differences in efficacy between grain types, an important finding for horse trainers and researchers alike. Similar results were obtained when the authors evaluated reinforcer efficacy as a function of unit price per kilocalorie. Exploring the extant literature and considering the conditions in effect for the horses in their study, the authors identified important factors that may influence the reinforcer efficacy of grain and other types of food for horses. One such factor is the type of food that horses receive as part of their normal daily rations. With the increasing popularity of horse training using positive reinforcement, clarifying the role of qualitative food characteristics in determining reinforcer efficacy is valuable. This study represents a useful contribution that can inform practice and future research on this topic.

Bizo et al. (this issue) describe the first evaluation of a habituation–dishabituation test for determining the olfactory detection threshold for n-amyl acetate, an organic compound with a banana-like scent, in dogs. To do so, in the experimental condition they presented a mineral-oil filled vial for three trials followed by five trials of increasing concentrations of the target compound for the dogs to explore. Upon achieving mixed results across 35 dogs, they concluded that discrimination testing remains best practice.

Salzer and Reed (this issue) evaluated the utility of the Ideal Free Distribution model in describing the distribution of domestic dogs between resource sites in a dog day-care setting. Automated feeders distributed food according to variable time schedules in two sites and, as predicted by the model, the number of dogs in each site was proportional to the frequency of food delivery in each site. This study is the first to evaluate the Ideal Free Distribution under controlled conditions with domestic dogs. The authors employed methods that can be readily applied by other researchers. For example, the automated apparatus, which the authors thoroughly tested prior to conducting this research, is available commercially, and dog day-care setting are accessible to many researchers. Using similar methods, this line of research with domestic dogs could be extended to explore the relationship between individual behavior (i.e., matching) and the distribution of individuals between resource sites, as discussed by the authors. Given the close relationship between humans and dogs, enhancing our understanding of the factors that determine where dogs spend time is important.

Many animal trainers use a clicker or other stimulus (e.g., a whistle) to "bridge" the gap between a correct response and the delivery of a reinforcer. It is difficult to overstate the controversy in the animal training community surrounding whether it is advantageous to pair each occurrence of the bridging stimulus with the delivery of a reinforcer (see Dorey & Cox, 2018 for a review of common clicker training terminology compared with basic research terminology). The issue has previously been addressed in conceptual analyses (e.g., Alligood et al., 2020; Martin & Friedman, 2011). Rosales-Ruiz and Peiris (this issue) conducted an empirical investigation in two dogs, comparing the behavioral effects of always following a click with food versus only sometimes following a click with food. Their results support what previous conceptual analyses have speculated: Performance of trained behaviors was stronger, and disruptions minimized, when each click was paired with food. The authors provide a sound conceptual analysis of these results that is worthwhile reading for anyone hoping to better understand these issues.

Conclusions

In summary, the articles in this issue provide an excellent foundation for forging connections between basic behavior-analytic research and applications of behavior analysis with animals. The present authors have found our basic research training tremendously helpful in designing analyses and interventions to address practical problems in this area. By the same token, we have found our connections with the settings in which these applications are implemented to be useful in understanding which research questions relevant to these settings might be usefully addressed in the laboratory. We hope that these articles spark readers' interest in this important area of study, and lead to further progress.

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