JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2000, **33,** 411–418 NUMBER 4 (WINTER 2000)

CURRENT RESEARCH ON THE INFLUENCE OF ESTABLISHING OPERATIONS ON BEHAVIOR IN APPLIED SETTINGS

BRIAN A. IWATA
THE UNIVERSITY OF FLORIDA

RICHARD G. SMITH
UNIVERSITY OF NORTH TEXAS

AND

JACK MICHAEL
WESTERN MICHIGAN UNIVERSITY

This article provides commentary on research published in the special section of the *Journal of Applied Behavior Analysis* devoted to establishing operations (EOs). Three major themes are highlighted: (a) identification of the influence of EOs on behavior in applied settings, (b) the use of EO manipulation as an assessment tool, and (c) the development of interventions based on the alteration of EO influences. Methodological issues pertaining to research on EOs are addressed, and suggestions for future investigation are provided.

DESCRIPTORS: establishing operations, antecedent events

Applied researchers have long recognized the fact that antecedent events other than discriminative stimuli can influence the occurrence of operant behavior; however, the exact nature of that influence and what to call it have been ambiguous throughout much of the field's history. As a result, in most of the early research published in the *Journal of Applied Behavior Analysis* (*JABA*), authors referred to antecedent conditions in general terms such as setting events or contextual variables, emphasized the procedural aspects of antecedent manipulations (e.g., as in deprivation, satiation, or reinforcer sampling), and often attributed observed changes in behavior to the process of stimulus control. A conceptual foundation for organizing research on antecedent variables was provided by Michael (1982), who presented a much-needed distinction between the discriminative and motivational properties of antecedent events and proposed the term *establishing operation* (EO) as a functional description for events of the latter type. Applied researchers gradually came to recognize practical implications of the EO and, since the late 1980s, have found the concept of the EO increasingly helpful in describing, studying, and arranging antecedent influences over behavior, as evidenced by the growing number of citations to Michael's (1982, 1993) articles and the use of the term in *JABA* (see Figure 1).

Current applied research on EOs tends to fall into three broad categories: (a) general demonstrations of the influence of an EO on behavior, (b) the use of EO manipulations to clarify results of behavioral assessments, and (c) attempts to improve (increase or decrease) behavior by incorporating EO manipulations as treatment components. Ar-

We thank Eileen Roscoe and April Worsdell for compiling the citation data presented here.

Correspondence should be addressed to Brian A. Iwata, Psychology Department, The University of Florida, Gainesville, Florida 32611.

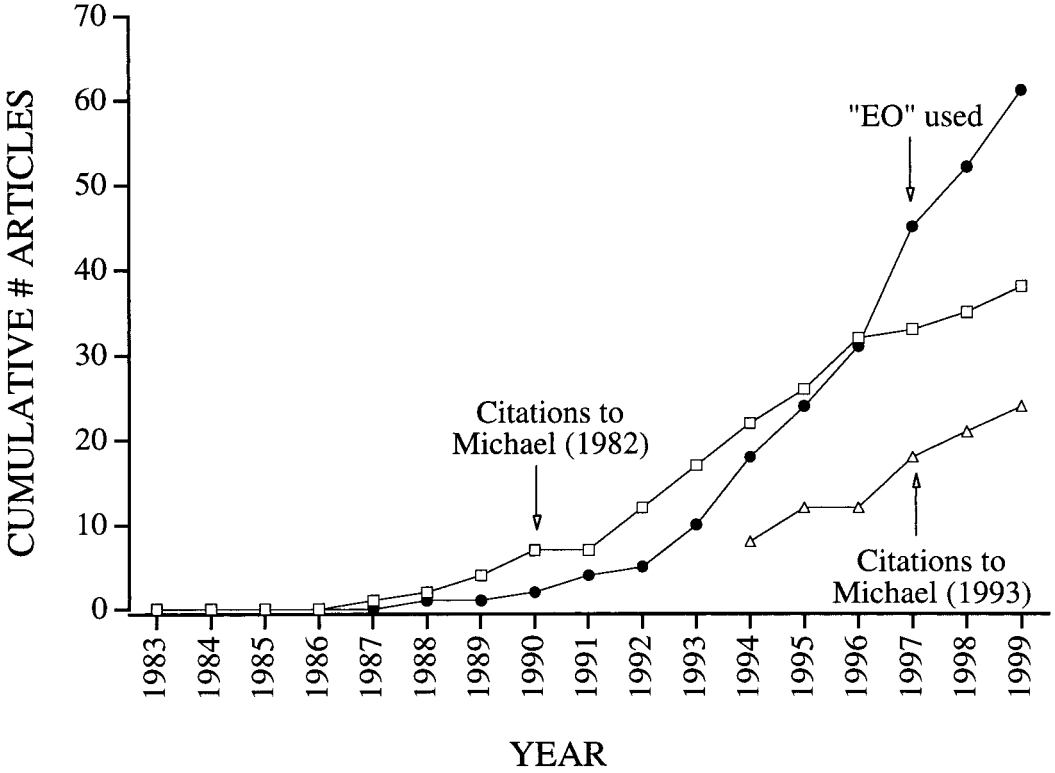

Figure 1. Cumulative number of articles published in *JABA* in which the term EO has been used or in which citation to Michael's (1982, 1993) articles has appeared.

ticles in this special issue illustrate all three types of research, although the boundaries between these categories are sometimes blurred because discovery of an EO effect often has immediate implications for assessment or treatment.

Identification of EO Influences

Two studies provide basic demonstrations of EO influences. Klatt, Sherman, and Sheldon present data showing that, when access to reinforcing activities is restricted, persons with developmental disabilities subsequently engage in those activities for longer periods of time. These results are helpful in suggesting ways to schedule leisure and educational activities so as to increase participation. A somewhat darker implication is that, when the occurrence of problem behavior is restricted, it too may increase subsequently. For example, if protective equipment is used to reduce stereotypic self-injury, individuals may engage in the behavior more often when the protective equipment is removed. Thus, extension of the Klatt et al. method to problem behavior may reveal a limitation of interventions that reduce behavior temporarily but do not alter EOs permanently or disrupt maintaining contingencies.

Another interesting aspect of the Klatt et al. study is that the dependent variable was *consumption* of a reinforcer rather than the rate of a response that produced that reinforcer. An analogous basic experiment might measure the effects of food deprivation on food consumption rather than on food-maintained bar pressing. This raises a conceptual question about the characteristic of the EO reflected in the Klatt et al. data. The evocative effect of the EO was not shown, which would require a change in the frequency of behavior that historically had been

followed by the reinforcer, because, in this case, the activities *were* the reinforcers. It could be argued that changes in reinforcer consumption reflected a change in reinforcer effectiveness. However, a test of reinforcer effectiveness—the extent to which behavior that has been followed by a reinforcer increases—was not conducted. It may be that increased consumption is specific to particular types of reinforcers rather than a general property of EOs. For example, although the sight of a slotted screw can serve as an EO for asking for a screwdriver, it is unlikely that receiving two screwdrivers would be more reinforcing than receiving one screwdriver.

Friman presents a demonstration that "transitional objects" (i.e., inanimate objects for which a strong preference is shown by young children) may occasion behaviors in a way that suggests the influence of an EO. Friman observed a child's thumb sucking when social stimulation was available and unavailable and when the child's favored object (a cloth) was available and unavailable (consequences for thumb sucking were held constant across conditions). Results show that thumb sucking occurred only in the presence of the cloth, suggesting that thumb sucking was neither maintained by social reinforcement nor occasioned by discriminative properties of the cloth. Instead, the mere presence of the cloth seemed to function as an EO for thumb sucking. Friman correctly notes that the process by which the presence of the cloth altered the reinforcing effects of thumb sucking was unknown. Because the relationship does not appear to be an unlearned one, it seems plausible to attribute its influence to the effects of a conditioned EO. In addition to expanding the scope of analysis and interpretation to areas more common in traditional child development, Friman hints at an interesting possibility for research by extending the concept of the EO to account for complementary reinforcer relationships (i.e., situations in which consumption of one reinforcer is correlated with increased consumption of a different reinforcer). For example, it is likely that access to certain reinforcers (e.g., television) creates a condition (inactivity) that increases the effectiveness of some reinforcers (consumption of snacks) but not others (exercise, which also could be performed while watching the television).

EO Manipulations During Assessment

As Michael (2000) noted, the EO has become an important focus in research on behavioral assessment, especially in functional analysis methodologies, which require careful consideration of and control over antecedent and consequent events. Four of the articles in this issue involve identification of EO influences within the context of functional analyses. Berg et al. present data indicating that the sequence of assessment conditions may create a situation in which exposure to an EO in one condition influences behavior in a subsequent condition. The authors illustrate this effect with attention as the reinforcer. Three participants were exposed to different test conditions in which attention was (a) delivered contingent on problem behavior, (b) withheld, or (c) available as one alternative in a concurrent-choice arrangement. Behaviors of interest were observed to occur at high levels during these conditions when they were immediately preceded by a condition in which attention was generally unavailable but not when they were preceded by a condition in which attention was delivered frequently. These results are important because they indicate that the reinforcing effects of consequences in a given condition may be strengthened (established) or weakened (abolished), respectively, by presession deprivation or exposure. As noted by the authors, their results are similar to those reported by Vollmer and Iwata (1991), but the implication of the

Berg et al. data is timely because the context in which their demonstration was conducted may exemplify certain types of functional analysis arrangements. It is important to note, however, that assessment conditions were very brief (5 min) and that the presession and test conditions were run back to back with no time separating the two. Thus, it is unclear if similar results would be obtained under other arrangements (i.e., longer sessions, breaks between sessions).

Worsdell, Iwata, Conners, Kahng, and Thompson also examine general EO influences during functional analyses but focus on the effects of within-session, rather than between-sessions, manipulations. They exposed 6 individuals whose self-injurious behavior (SIB) was maintained by social-positive reinforcement to functional analysis conditions in which the EO and reinforcement contingency were present and absent in various combinations. High rates of SIB were observed consistently (across all 6 participants) only when the EO and its relevant contingency were both present. None of the participants engaged in high rates of SIB when the contingency was absent, and inconsistent results were obtained when the EO was absent. These results underscore the importance of including contingency manipulations in tests of behavioral function; they also indicate that consistent performance is most likely to be observed when antecedent and consequent events are manipulated in concert. The authors are generally critical of assessment models in which EO influences are examined under extinction, although as Michael (2000) noted and as Berg et al. observed with 1 participant, EO exposures may evoke the behavior of interest regardless of the availability of reinforcement, at least temporarily.

McComas, Hoch, Paone, and El-Roy show that the conditions that establish escape as negative reinforcement may be highly idiosyncratic. Their results extend a growing body of research on a wide range of potential EOs for escape and highlight the utility of systematic EO (demand) assessments within functional analyses of problem behavior. The study also extends previous work in the area of treatment by showing positive effects with EO interventions that did not include extinction. The results of Charlie's analysis are particularly interesting. Whereas interventions for the other 2 participants involved the alteration of response requirements, Charlie was permitted to decide the order in which tasks would be performed. This was sufficient to decrease his escape behavior despite the fact that he always performed the same tasks in the same way. Thus, although task demands appeared to function as reflexive conditioned EOs for Eli and Ben because the demands reliably preceded aversive task requirements, a different and unknown process resulted in Charlie's sensitivity to predetermined task sequences as EOs for escape.

O'Reilly, Lacey, and Lancioni contribute another report in an interesting series of demonstrations of EO influences on problem behavior by showing that background noise exacerbated the escape-maintained problem behavior of a child with Williams syndrome. One of the characteristics of Williams syndrome, hyperacusis, or hypersensitivity to sound, was evidenced by the occurrence apparent pain-attenuating behaviors (e.g., placing hands over the ears) across assessment conditions. Problem behaviors, on the other hand, occurred primarily during demand conditions and increased dramatically in the presence of background noise. These results suggest that noise had multiple influences: It evoked pain-related behavior (probably as an EO) and also altered the effects of demands as an EO. This second effect suggests a relationship in which noise apparently strengthened further an existing EO, in that the effects of demands as an EO for escape behavior were enhanced in the

presence of noise. Subsequent work in this area might clarify the nature of relationships between independent EOs. In the present study, one EO strengthened another and evoked higher rates of problem behavior. It would be interesting to determine the extent to which the opposite arrangement might produce therapeutic benefit. That is, would exposure to an EO for appropriate behavior cancel out the effects of an existing EO for problem behavior?

Treatment of Problem Behavior with EO Manipulations

The final two studies in this special section illustrate attempts to determine, within the context of treatment, whether observed changes in behavior can be attributed to an EO manipulation. The studies by Kahng, Iwata, Thompson, and Hanley and by Hagopian, Crockett, van Stone, DeLeon, and Bowman are related in another way, in that the intervention of interest was noncontingent reinforcement (NCR), whose therapeutic effects have been attributed to both satiation (elimination of the EO for problem behavior via frequent reinforcer delivery) and extinction (termination of the contingency between the occurrence of problem behavior and the delivery of a reinforcer).

After determining (via functional analysis) that 3 participants' problem behaviors were maintained by social-positive reinforcement, Kahng et al. delivered the maintaining reinforcers under rich fixed-time schedules (NCR) but not as consequences for problem behavior (extinction), and observed rapid reductions in problem behavior. The authors continued to collect data during extinction periods (no reinforcement available) following each NCR session in an attempt to identify the functional properties of NCR (see the article for details on experimental logic). One participant showed no increase in problem behavior at the end of NCR sessions, suggesting that the behavior had been extinguished during those sessions. The other 2 participants, however, showed increases in problem behavior at the end of NCR sessions, suggesting that the transition from the availability (NCR) to the unavailability (extinction) of reinforcement reinstated an influential EO and, as a result, evoked problem behavior. Other interesting effects (an apparent transition from satiation to extinction and failure to obtain extinction even under thin NCR schedules) are reflected in the data for these 2 participants. Kahng et al. pose questions about data interpretation in their discussion that illustrate difficulties in attempting to identify processes by which NCR affects behavior and suggest that multiple influences related to both satiation and extinction might also account for behavior change under differential-reinforcement-of-other-behavior schedules.

Hagopian et al. present a more direct approach than that taken by Kahng et al. They implemented NCR without extinction (i.e., maintaining reinforcers were delivered under a fixed-time schedule and also were contingent on the occurrence of problem behavior) and observed immediate reductions in the problem behavior of 3 participants. These results suggest that behavior change was the result of satiation; however, no change was observed in reinforcer consumption, raising the question of whether satiation had, in fact, occurred. Hagopian et al. later suggest the possibility that NCR may decrease behavior by altering its EO yet may not produce some of the other behavioral effects associated with satiation. This seems quite plausible and consistent with Michael's (2000) comment that, whereas deprivation can be easily operationalized through reference to duration of restricted access, satiation cannot, due to its association with other behavioral effects. The Hagopian et al. data are thus helpful in illustrating the EO-altering effects of NCR in the apparent absence of satiation. The authors provide additional

data related to the consideration of extinction effects.

Some Suggestions for Future Research

We have attempted to interject questions for consideration in future research within our discussion of each of the articles that appear in this special issue. We fear that a more exhaustive attempt would be incomplete, given the extensive treatment of methodological and conceptual issues found in the reviews by McGill (1999) and by Smith and Iwata (1997). Instead, we close this introduction by suggesting several general themes for research that are raised through consideration of the articles as a group.

A methodological question arises in conducting research on EOs: Should their evocative effects be examined in the presence or absence of reinforcement? Although, as noted previously, the presence of an EO should evoke behavior regardless of the availability of reinforcement, EO evaluations under conditions of extinction may prevent detection of an EO influence if the unavailability of reinforcement is readily discriminated or if extinction occurs quickly (as has been observed in a number of studies). The absence of reinforcement also raises the question of whether the behavior of interest is, in fact, maintained by the putative reinforcer. For example, being left alone for a period of time may evoke behavior that has been maintained by nonsocial (automatic) as well as social reinforcement. Although the evocative effect on behavior of being left alone is unambiguous in this case, identification of the behavior's maintaining reinforcer requires a further demonstration: differential control over the behavior in the presence of the EO. For these reasons, we believe that EO investigations are best undertaken in the presence of relevant reinforcement contingencies.

A second general issue related to the identification of EO influences is specification of the historical basis of the EO, to the extent that it is possible. Given certain methodological controls (e.g., manipulation of antecedent and consequent events, ruling out discrimination as a source of influence), it is possible to attribute changes in behavior to the presence and absence of an EO with a relatively high degree of confidence. A more difficult yet helpful step would involve additional analysis to determine how the EO acquired and maintains its reinforcer-establishing and evocative properties. Was the EO unconditioned or conditioned? If conditioned, is its influence due to pairing with another EO or some other consequence? Does the influence appear to be reflexive or transitive? Answers to questions such as these would give applied researchers additional options for intervention as well as some helpful insights for prevention.

Antecedent manipulations that influence behavior by way of an EO are fairly straightforward when they involve the mere presentation or removal of an event whose structural features are invariant. However, because most EOs currently being studied in applied research have multidimensional characteristics (quality, magnitude, duration, rate, etc.), attempts to identify the influence of EOs might benefit from both qualitative and quantitative analyses. Social interaction provides a good example, and parallels can be drawn with other types of events. A conclusion that deprivation from social interaction does or does not function as an EO requires qualification: What kind of social interaction? With whom? For what duration? Researchers would do well to remember that identification of an apparent EO influence (or failure to find such an influence) may be a function of particular features of procedural implementation with respect to the class of variables being manipulated. Similarly, procedures that diminish the effectiveness of a positive reinforcer may involve reinforcer removal rather than presentation. Consider the reinforcing effects of

parental attention for a child who has just been put to bed. Is the child less likely to cry for parental attention after receiving a lot of it just prior to bedtime? Or would a period of diminished attention be more likely to attenuate its reinforcing effects, perhaps by strengthening the reinforcing effects of an alternative behavior (e.g., lying quietly, shutting one's eyes, etc.)?

Significant refinements in the functional analysis of behavior disorders have already been realized through incorporation of EO manipulations, which improve the accuracy or efficiency of assessment by increasing the likelihood that a target behavior of interest will occur in the presence of its maintaining reinforcer. However, technical details are too scattered, perhaps among dozens of reports, to be of much immediate use to those interested in clinical implementation. In addition, some EOs that influence behavior on either a within- or between-session basis are just now being investigated, as evidenced by articles in this issue. Thus, research in the area of functional analysis might benefit further from a series of simple demonstrations of how to maximize or minimize the influence of EOs during the course of assessment, followed by integration of this information with what is already known about maximizing contingency strength.

Research on the treatment of behavior disorders also has benefited from systematic EO manipulations. For example, the rapidly growing number of studies incorporating NCR as a treatment is directly related to conceptual and empirical work on the EO, and the same might be said more generally for the larger class of antecedent interventions. As an aside, the Hagopian et al. and Kahng et al. studies on NCR in this issue raise interesting questions with respect to terminology. As already noted, it is unclear whether NCR, as a result of diminishing the effectiveness of reinforcement for problem behavior, produces a state of satiation; if not, it may be better to merely refer to such an effect as an EO or "abolishing" operation. The other effect of NCR—discontinuation of the response–reinforcer relation—is also subject to terminological ambiguity. For purposes of improving procedural specificity, Michael (2000) prefers to distinguish between the operations of (a) discontinuing reinforcement altogether (the first type of unpairing that results in extinction of R2 in his example) and (b) delivering reinforcement irrespective of the occurrence of behavior (the second type of unpairing). Because NCR involves the latter procedure, adopting Michael's distinction means that NCR may disrupt a response–reinforcer relation by unpairing the two elements but that this does not constitute extinction. (It should be noted that Catania, 1992, prefers to call both operations *extinction*.) Regardless of whether Michael's distinctions lead to changes in terminological usage, they provide a useful framework for classifying operational differences.

Of greater concern than terminology is the fact that the procedural elements of certain treatments remain somewhat elusive. For example, independent variables continue to be described in rather global terms, such as curriculum revision, choice making, and simply antecedent intervention. Although data resulting from the use of these interventions often show evidence of behavior change, it is unclear how this change was effected or if it resulted from an antecedent manipulation rather than a change in behavioral consequences. For over 30 years, the *JABA* editorial process has been instrumental in promoting continued refinement in the specification of consequences. Now that research on EOs seems to have been firmly established in this journal, we look forward to further improvement in the specification, measurement, and evaluation of EO effects.

REFERENCES

Catania, A. C. (1992). *Learning* (3rd ed.). Englewood Cliffs, NJ: Simon & Schuster.

McGill, P. (1999). Establishing operations: Implications for the assessment, treatment, and prevention of problem behavior. *Journal of Applied Behavior Analysis, 32,* 393–418.

Michael, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior, 37,* 149–155.

Michael, J. (1993). Establishing operations. *The Behavior Analyst, 16,* 191–206.

Michael, J. (2000). Implications and refinements of the establishing operation concept. *Journal of Applied Behavior Analysis, 33,* 401–410.

Smith, R. G., & Iwata, B. A. (1997). Antecedent influences on behavior disorders. *Journal of Applied Behavior Analysis, 30,* 343–375.

Vollmer, T. R., & Iwata, B. A. (1991). Establishing operations and reinforcement effects. *Journal of Applied Behavior Analysis, 24,* 279–291.

Received August 29, 2000
Final acceptance August 29, 2000
Action Editor, F. Charles Mace