JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1999, **32,** 393–418 NUMBER 3 (FALL 1999)

ESTABLISHING OPERATIONS: IMPLICATIONS FOR THE ASSESSMENT, TREATMENT, AND PREVENTION OF PROBLEM BEHAVIOR

PETER MCGILL

UNIVERSITY OF KENT AT CANTERBURY

This paper seeks to integrate Michael's (1982, 1993) discussion of the concept of the *establishing operation* (EO) with existing conceptual and empirical analyses of problem behavior in people with developmental disabilities. The paper begins with a summary of Michael (1993), which seeks to describe his concept of the EO and place it briefly in historical context. The role of EOs in evoking and establishing motivation for problem behavior is considered in some detail. A case is made for the greater consideration of EOs in the functional analysis of problem behavior, and specific suggestions for detecting the operation of *conditioned establishing operations* are offered. Turning to treatment, the paper considers the role played by EOs in existing procedures and discusses the development of treatment strategies that seek to modify EOs, extinguish EOs, and modify the responses evoked by EOs. Finally, consideration is given to the implications of EOs for the more systemic treatment and prevention of problem behavior.

DESCRIPTORS: problem behavior, establishing operations, assessment, prevention

Smith and Iwata (1997) have recently reviewed existing knowledge of the influence of antecedent events on problem behavior. They outlined the approaches of Skinner, Kantor, and Michael to the conceptualization of antecedent events, noting the particular potential of Michael's (1982, 1993) concept of the *establishing operation* (EO) to aid understanding of events that have previously been poorly understood. Smith and Iwata went on to review studies of the assessment and treatment of problem behavior in which antecedent events were recorded or manipulated, drawing attention, when possible, to the apparent discriminative or motivative function of such events. Noting the conceptual and methodological limitations of many studies and the degree to which antecedent influences have been understudied, Smith and Iwata proposed directions for future research, emphasizing particularly the experimental manipulation of antecedents while holding constant known response–reinforcer contingencies.

The current paper focuses exclusively on the relevance of EOs (rather than antecedent events more generally) to the assessment and treatment of problem behavior. This narrower focus allows the extension of Smith and Iwata's (1997) discussion in a number of ways. First, more attention is given to Michael's elaboration of *conditioned establishing operations* (CEOs). Second, the evidence for the relevance of specific EOs (e.g., deprivation of attention) to problem behavior is considered. Third, a number of specific treatments (e.g., extinction) are conceptually analyzed from an EO perspective. Fourth, the implications of an EO conceptualization for the treatment and prevention of problem behavior are discussed. And finally, previous analyses of EOs are extended through discussion of EOs associated with biological circumstances, and the extinction of EOs.

I am grateful to the reviewers, and to Joseph E. Spradlin and Jim Mansell for their very helpful comments on earlier drafts of this manuscript.

Correspondence concerning this article should be addressed to Peter McGill, Tizard Centre, University of Kent at Canterbury, Canterbury, Kent, United Kingdom CT2 7LZ (E-mail: P.McGill@tizard.ukc.ac.uk).

ESTABLISHING OPERATIONS

The variables incorporated in the concept of the EO played a significant part in early elaborations of behavior analysis. Skinner (1953) took the concept of *drive* as a starting point to consider the effects of deprivation and satiation at some length. Keller and Schoenfeld (1950) used the term *establishing operation* to refer to the "operations . . . of deprivation . . . or stimulation" that establish drives (p. 274). Michael has argued that this early interest in motivation declined to the point at which it was necessary to "reintroduce the concept of the establishing operation" (Michael, 1993, p. 191). In the intervening years, motivation was by no means completely neglected, but more often was incorporated in proposals for the conceptual expansion of behavior analysis (see, e.g., Bijou & Baer, 1961; Kantor, 1959; Morris, 1988; Wahler & Fox, 1981) than treated in its own right. In reviving the concept of the EO, Michael has elaborated a treatment of motivation that requires little such conceptual expansion, because it is systematically related to the basic three-term contingency and many of its tenets were present in early discussions. Michael has, however, elaborated the concept, most especially in its distinction from discriminative stimulus control, and in his description of CEOs.

Michael (1993) begins his account of EOs by noting that, in commonsense understanding, the occurrence of a behavior reflects both the ability (skill or knowledge) and the motivation (want) to produce it. He notes that motivation has recently been largely equated to reinforcement. Motivation (or its lack) has come to mean the presence (or the absence) of sufficient, appropriately scheduled reinforcement. However, the effectiveness of such reinforcement depends on the extent of deprivation or satiation (and other variables having similar effects) with respect to the reinforcer. In the case of escape from aversive stimulation, it similarly depends on the prior presentation of aversive stimulation. Such effects have been dealt with piecemeal and sometimes have been confused with discriminative stimulus control. Michael recommends a more systematic approach to the analysis of motivation and presents the EO as an appropriate unifying concept.

Michael defines the EO as an environmental event, operation, or stimulus condition having two conjoint functions. First, it alters the effectiveness of certain other events as reinforcers or punishers. Second, it alters the frequency of behaviors associated with these reinforcing or punishing events. Thus, to use Michael's example, food deprivation is an EO that increases the reinforcing effect of food and evokes behaviors that have a history of leading to food. Michael also uses the term *abolishing operation* (in passing) to refer to those EOs that reduce the effectiveness of certain other events as reinforcers and reduce the frequency of behaviors associated with those reinforcing events. Michael identifies food satiation as an example of an abolishing operation.

The most immediately visible effect of the EO is the altered rate of behaviors associated with the relevant reinforcer. This is manifested in three ways, as illustrated by the effects of food deprivation in the following examples. First, operant responses may be evoked directly by the relevant EOs. For example, the person deprived of food is more likely to eat. Second, discriminative stimuli (S^Ds) are more likely to evoke responses that have resulted in the relevant reinforcer in the past. For example, the person is more likely to respond to a restaurant sign by entering. Third, responses maintained by related conditioned reinforcers will be more probable. For example, the person is more likely to start preparing a meal. The evocative effect of the EO may be confused with the similarly evocative effect of the S^D, and Michael

pays careful attention to their distinction. The S^D evokes behavior as a result of a history of correlation with greater availability of the relevant reinforcer. If you are hungry, a sign saying "Eat here" may evoke behaviors such as entering and asking for something to eat. Such a sign does not make you hungrier. Long periods without food are likely to evoke behaviors that may lead to food, but their effect is not discriminative—food is no more likely to be available when you are hungry than when you are not. In short, EOs change how much people want something; S^Ds change their chances of getting it (Michael, 1982).

Unconditioned Establishing Operations

Many EOs are unconditioned or unlearned, even though the behaviors that they evoke are usually learned. Without any conditioning history, food will reinforce the behavior of the organism in a state of food deprivation even if the behaviors that reliably obtain food have not yet been learned. Deprivation of food, water, activity, sleep, and variables related to sexual reinforcement is likely to act as an unconditioned establishing operation (UEO). Satiation of the same events is likely to function as an unconditioned abolishing operation.

Using the example of pain arising from electric shock, Michael also argues that such aversive stimulation should be considered a UEO and seeks to distinguish this interpretation from that of aversive stimulation as an S^D. Electric shock (and other sources of aversive stimulation often used in animal experimentation) is not a frequent event in everyday human environments. Let us consider, therefore, the more common example of the aversive stimulation arising from entering a cold place. In the winter my office is typically cold when I enter it first thing in the morning. For the "coldness" to be considered an S^D it would be necessary that the reinforcer (reduced coldness or increased warmth) for specific responses was more available in the presence of coldness than in its absence. However, in the absence of coldness, reduced coldness is not less available but is, for the moment, not a reinforcer. My behavior of turning on the heater in my office is evoked, therefore, by coldness as an EO. Of course, such escape behaviors may also come under discriminative stimulus control. The heater in my office is on a time switch and will not switch on after a certain hour in the evening. When I enter my office late at night, therefore, I do not switch on the heater (the behavior has been extinguished) but, instead, engage in other behaviors evoked by the still-operative EO for which reinforcement (albeit less effective) remains available, such as keeping my coat on.

The notion of the UEO is closely related to the notion of unconditioned reinforcement. The former represents the environmental event or operation that alters the momentary effectiveness of the latter (e.g., food deprivation regulates the effectiveness of food as a reinforcer). In principle, therefore, there should be parallel lists of UEOs and unconditioned reinforcers.

Conditioned Establishing Operations

Michael describes three types of conditioned establishing operations (CEOs). Surrogate CEOs (so called because they act in the same way as another event) are previously neutral events that, through correlation in time with a UEO or an already-established CEO, acquire similar motivative effects. Reflexive CEOs (so called because they alter their own function) are previously neutral events whose termination comes to be reinforcing (or punishing) through systematically preceding "worsening" (or "improvement") when not terminated. Transitive CEOs (so called because they alter not their own function but that of another event) are previously neutral stimuli whose occurrence alters the reinforcing (or punish-

ing) effectiveness of another event and evokes responses that produce (or suppress) that event. The different types of CEO are now described in more detail.

A surrogate CEO involves the simple pairing of a previously neutral stimulus with a UEO, with the former developing the motivative effects of the latter. For example, stimuli correlated with a reduction in temperature (the UEO), such as the sight of snow out of a window, may evoke behaviors associated with an increase in temperature, such as putting on a sweater, independently of (or at least beyond that expected by) the current ambient temperature. Adelinis, Piazza, Fisher, and Hanley (1997) reported evidence of client location (being in a wheelchair) apparently functioning as an EO for attention-maintained self-injury. Being in a wheelchair may be correlated with deprivation of attention; indeed, the authors reported less noncontingent attention being provided while the person was in a wheelchair. Although described as an "establishing stimulus" by the authors, the wheelchair, therefore, meets the definition of a surrogate CEO. Despite these examples the inconclusive results of research conducted on the evocative effects of stimuli correlated with food deprivation should be noted (for a summary, see Michael, 1993, pp. 199–202). The existence of such CEOs thus remains putative, although they might be expected to be more prevalent and easier to detect with UEOs that change faster than food deprivation.

Reflexive CEOs are stimuli that acquire their motivative effect through correlation with worsening (e.g., the presentation of an aversive stimulus) or improvement (e.g., the presentation of a reinforcing stimulus). The first type is exemplified by the warning stimulus in a shock-avoidance procedure. The warning stimulus establishes its termination as reinforcing and evokes behaviors previously associated with its termination. Typically, such a CEO is generated by correlation with a UEO (such as painful stimulation) that can be avoided if a response (terminating the warning stimulus) is made after the onset of the warning stimulus but prior to the onset of the UEO. Although often seen as an S^D, Michael argues that the warning stimulus is a CEO because of the lack of correlation between its occurrence or nonoccurrence and the availability or nonavailability of reinforcement. To be an S^D the presence of a stimulus must be accompanied by the availability of effective reinforcement for a specific response or set of responses *and* its absence must be accompanied by the lack of (or reduced) availability of effective reinforcement for the same response. The warning stimulus fails on the second component of this correlation because, in the absence of the warning stimulus, its offset (even were it available) would not be effective reinforcement. That is, the response (that would otherwise remove the warning stimulus) does not occur, not because it no longer produces reinforcement but because there is no reinforcement to produce. Michael has also referred to this type of CEO as a "threat CEO." The second type involves stimuli whose onset is correlated with later reinforcement. Analogously, such stimuli establish motivation to prevent their termination and suppress behaviors associated with their termination. Michael has also referred to this as a "promise CEO." For example, stimuli (such as those associated with being tired) whose onset is correlated with my later falling asleep (reinforcement) may suppress behaviors (such as drinking coffee) associated with their termination. In the absence of such stimuli, the response (drinking coffee) is more likely to occur, not because it no longer produces punishment (avoidance of falling asleep) but because there is no punishment to produce (not falling asleep is only punishing if I am tired).

Transitive CEOs are stimuli in whose con-

text the reinforcing or punishing effectiveness of existing conditioned reinforcers or punishers is altered. In Michael's example, the sight of a slotted screw evokes a worker's request to his assistant for the appropriate screwdriver. The screwdriver is just as available with or without the presence of a slotted screw (so the relation is not discriminative) but it is more reinforcing in the presence of the screw (so the relation is motivative). In the analogous situation of conditioned punishment, the effect of the CEO would be to increase the effectiveness of the punisher and suppress (rather than evoke) behaviors associated with its occurrence. If, in the course of telling my daughter not to run around without shoes, I notice that she has cut her foot, my admonishing behavior is likely to be suppressed. The immediate consequences of my reprimanding her (perhaps her appearing upset) are just as available with or without the presence of the cut (so the relation is not discriminative) but are more punishing to me in the presence of the cut (so the relation is motivative).

ESTABLISHING OPERATIONS AND FUNCTIONAL ANALYSIS

Analyses of problem behavior have identified a range of reinforcers that have been commonly grouped into three categories: social-positive reinforcement, social-negative reinforcement, and automatic reinforcement. The events that may establish motivation for these categories of reinforcement are now considered.

Social-Positive Reinforcement

Considerable evidence exists that many different topographies of problem behavior are maintained by attention (self-injurious behavior: e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994; aggression: e.g., Mace, Page, Ivancic, & O'Brien, 1986). Iwata, Pace, Dorsey, et al. (1994) found that 23% of a series of 152 cases of self-injurious behavior were maintained by attention. Similarly, in a series of 79 cases of self-injurious or aggressive behavior, attention was hypothesized as the maintaining condition in 24% (Derby et al., 1992). It has been suggested (e.g., Durand & Crimmins, 1988b; McGill, 1993) that problem behavior maintained by attention is more likely to occur in environments characterized by low levels of social contact. In the design of experimental (analogue) conditions for the functional analysis of self-injurious behavior, Iwata et al. (1982/1994) systematically varied the level and distribution of available attention and later (Iwata, Pace, Dorsey, et al., 1994) explicitly referred to this as an EO as well as making adjustments to the methodology to maximize presession deprivation of attention. More direct evidence for the role of deprivation of attention comes from a number of sources. Taylor and Carr (1992b) found that children's problem behaviors followed by high levels of teacher attention were more likely to be preceded by the absence of attention. Hall and Oliver (1992) showed that bursts of self-injurious behavior were preceded by a reduced probability of social contact from staff and led to increases in the probability of social contact. A number of studies (Hagopian, Fisher, & Legacy, 1994; Iwata, Pace, Dorsey, et al., 1994; Mace & Lalli, 1991; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993) have demonstrated that eliminating deprivation through noncontingent access to attention substantially reduces a variety of problem behaviors.

Given Michael's account, deprivation of attention is recognizable as an EO that both increases the reinforcing value of attention and evokes behaviors previously associated with attention. We may conclude that deprivation of attention establishes motivation for some attention-maintained problem behavior. Motivation for attention, however, may be established or abolished by EOs oth-

er than deprivation or satiation of attention (Fischer, Iwata, & Mazaleski, 1997; Hanley, Piazza, & Fisher, 1997), and deprivation of attention may, perhaps, establish motivation for other "substitutable" (Iwata & Michael, 1994) reinforcers (e.g., children may be more likely to seek toys used in independent play when deprived of attention and attention-seeking responses produce no effect). We cannot conclude, therefore, that deprivation of attention is a specific or a universal EO for attention-maintained problem behavior. It seems reasonable, however, to suggest that EOs that establish motivation for attention are likely to be particularly involved in attention-maintained (rather than, say, escape-maintained) problem behavior, given the growing literature showing that interventions relevant to the identified consequences of problem behavior are more likely to be effective than irrelevant interventions (see, e.g., Carr & Durand, 1985a; Iwata, Pace, Cowdery, & Miltenberger, 1994; Repp, Felce, & Barton, 1988).

Although the supporting evidence is more limited, similar arguments can be constructed for other events considered to be social-positive reinforcers because their availability is frequently confounded with attention (Iwata, Pace, Dorsey, et al., 1994). Problem behavior has been found to be maintained by food or access to materials in a number of studies (e.g., Durand & Crimmins, 1988a; Marcus & Vollmer, 1996), representing 3.3% and 12%, respectively, of the series reported by Iwata, Pace, Dorsey, et al. (1994) and Derby et al. (1992). Wacker et al. (1996) found direct evidence of a relation between food deprivation and problem behavior in a single case study. Reductions in problem behavior have been reported when noncontingent access to tangible reinforcement was provided (e.g., Ayllon & Michael, 1959; Iwata, Pace, Dorsey, et al., 1994; Marcus & Vollmer, 1996). Deprivation of tangible reinforcement may then be seen as an EO evoking tangibly maintained problem behaviors.

Social-Negative Reinforcement

Considerable evidence also exists that many different topographies of problem behavior are maintained by escape from task demands (disruptive behavior: e.g., Carr & Durand, 1985a; stereotyped behavior: e.g., Durand & Carr, 1987; self-injurious behavior: e.g., Iwata et al., 1982/1994). Epidemiological studies suggest escape to be the most common reinforcer for problem behavior, representing 35% of cases of self-injurious behavior (Iwata, Pace, Dorsey, et al., 1994) and 48% of cases of self-injurious or aggressive behavior (Derby et al., 1992). Many authors (e.g., Smith & Iwata, 1997) have now pointed out that demands probably function as EOs (rather than S^Ds) evoking escape-maintained problem behavior. Consistent with this account, problem behavior is more likely to occur following demands (Edelson, Taubman, & Lovaas, 1983; Weeks & Gaylord-Ross, 1981) and is eliminated or substantially reduced by the removal of demands (Pace, Iwata, Edwards, & McCosh, 1986) or the provision of noncontingent access to escape (Vollmer, Marcus, & Ringdahl, 1995). Investigations of the properties of demands that establish escape motivation are limited. However, investigators have identified a number of dimensions that are salient in one or more cases, including task difficulty (Carr & Durand, 1985a; Weeks & Gaylord-Ross, 1981), type of required motor responses (Dunlap, Kern-Dunlap, Clarke, & Robbins, 1991), number of required responses (Mace, Browder, & Lin, 1987), task novelty (Mace et al., 1987), duration of instructional sessions (Dunlap et al., 1991), rate of task presentation (Smith, Iwata, Goh, & Shore, 1995), unpredictability of events (Flannery & Horner, 1994), and task preference (Dunlap et al., 1991; Foster-Johnson, Ferro, & Dunlap, 1994). In

Table 1
Reinforcers and Establishing Operations for Problem Behavior

Class of maintaining consequences	Specific consequence	Establishing operation
Social-positive reinforcement	Attention	Deprivation of attention
	Tangible items	Deprivation of tangible items
Social-negative reinforcement	Escape	Aversive events (e.g., new, difficult, high-rate, or nonpreferred demands)
Automatic reinforcement	Sensory stimulation	Deprivation of stimulation

addition, the probability of problem behavior following a particular demand may be reduced by prior or interspersed events such as storytelling (Carr, Newsom, & Binkoff, 1976), social comments (Kennedy, Itkonen, & Lindquist, 1995), demands highly likely to be complied with (Mace & Belfiore, 1990), and advance notification (Tustin, 1995).

Much of the literature on social-negative reinforcement has focused on escape from demands. It is clear, however, that escape from other kinds of aversive stimulation may also maintain problem behavior. Examples include attention (Taylor & Carr, 1992a, 1992b) and ambient noise (O'Reilly, 1997).

Automatic Reinforcement

Studies have also suggested the maintenance of problem behavior by automatic reinforcement (self-injurious behavior: e.g., Iwata et al., 1982/1994; stereotyped behavior: e.g., Sturmey, Carlsen, Crisp, & Newton, 1988). Epidemiological studies found automatic reinforcement in 26% of cases of self-injurious behavior (Iwata, Pace, Dorsey, et al., 1994) and 34% of cases of self-injurious or aggressive behavior (Derby et al., 1992). Although it is often difficult to identify the specific reinforcers involved (Iwata, Vollmer, Zarcone, & Rodgers, 1993), some kind of specific (e.g., oral stimulation: Piazza et al., 1998) or general (Iwata, Pace, Dorsey, et al., 1994) sensory stimulation has typically been reported. The absence or deprivation of such stimulation has been inferred as the relevant EO. Evidence consistent with this view comes from studies reporting more problem behavior in some individuals in stimulation-deprived environments (e.g., Berkson & Mason, 1964), the removal or substantial reduction of problem behavior by the provision of noncontingent stimulation (e.g., Berkson & Mason, 1964; Iwata, Pace, Dorsey, et al., 1994; Kennedy & Souza, 1995; Wells & Smith, 1983), and the greater reduction of problem behavior by noncontingent access to matched than to alternative stimulation (Piazza et al., 1998).

Including the Analysis of EOs in Functional Analysis

Conceptual issues. A summary of the events known to establish motivation for problem behavior is shown in Table 1 and illustrates, in line with Michael's suggestion, parallel lists of reinforcers and EOs. Although parallel, it should be noted that the two lists address different questions. The identification of the consequences of problem behavior answers the question typically asked by functional analysis: What maintains this behavior? The identification of EOs addresses a different question: Why does motivation for this consequence exist, or, why does the person "want" this consequence?

It has been argued (see, e.g., Neef & Iwata, 1994) that the first of these questions should be answered or at least considered before intervention. Thus, intervention should be directed by the results of a prior func-

tional analysis that either establishes clearly the reinforcer maintaining the behavior (Iwata, Pace, Dorsey, et al., 1994) or allows the development of an educated and testable hypothesis about the reinforcer (Carr & Carlson, 1993). Although knowledge of the relevant EO may accumulate during pretreatment analysis, this has not generally been seen as a requirement. However, there are good reasons for knowing about such EOs.

First, in the situation in which the EO is found to represent an unacceptable state of affairs, treatment that does not include its alteration might be contraindicated (Iwata, Vollmer, & Zarcone, 1990; Sturmey, 1995). Examples include levels of deprivation of attention or tangible reinforcers of an unacceptable degree (Emerson & Hatton, 1994; Hile & Walbran, 1991); levels of demand aversiveness that are symptomatic of abusive, unskilled, or ineffective programming (Iwata, 1987; Whittington & Wykes, 1996); other aversive events evoking escape behavior that are open to remediation (Horner, Vaughn, Day, & Ard, 1996); and levels of deprivation of general sensory stimulation that are incompatible with health or development (Lovaas, Newsom, & Hickman, 1987).

Second, knowledge of EOs may help to explain the frequently reported variability in the occurrence of problem behavior under, apparently, the same three-term contingencies (Carr, Reeve, & Magito-McLaughlin, 1996; Gardner, Cole, Davidson, & Karan, 1986). That is, "third variables" (Skinner, 1931) may be required to explain variability in responses to the same stimulus (see Morris, 1992). If a behavior is maintained by a particular reinforcement contingency and, with the contingency operative and in the presence of relevant S^Ds, the behavior sometimes occurs at high rates and sometimes at low rates, the operation of an EO might be suspected. A number of studies have now shown reductions in such variability when EOs are detected and manipulated (Horner, Day, & Day, 1997; Kennedy & Meyer, 1996; O'Reilly, 1995, 1997; Smith et al., 1995).

Third, knowledge of EOs may have differential implications for intervention. For each function of problem behavior derived from functional analysis, there are several possible treatments that have been demonstrated to be effective with some individuals in some circumstances. Given the identification of such sets of treatments, it is not clear how selection from within these sets should proceed. This decision may be facilitated by a knowledge of the relevant EOs. For example, attention-maintained behavior may occur in a context of generally low levels of attention, in which case increasing the density of attention (noncontingent reinforcement) may be indicated. Alternatively, attention-maintained behavior may occur in a context of generally high levels of attention distributed rather more to problem behavior than to adaptive behavior, suggesting the use of extinction.

Approaches to analysis. Approaches to the detection and discrimination of the environmental events influencing problem behavior have, broadly, been of two kinds: descriptive and experimental analysis (Emerson, 1995). Methods of descriptive analysis have included interviews with informants (e.g., O'Neil, Horner, Albin, Storey, & Sprague, 1990) and observations of the correlation of environmental events and problem behavior using either relatively simple approaches such as records of inappropriate behavior (Pyles & Bailey, 1990) and scatter plots (Touchette, MacDonald, & Langer, 1985) or more complex procedures for the detailed recording and analysis of event sequences (e.g., Emerson, Thompson, Reeves, Henderson, & Robertson, 1995; Lerman & Iwata, 1993; Mace, Lalli, Pinter Lalli, & Shea, 1993). Methods of experimental analysis have typ-

ically investigated sensitivity to various reinforcement contingencies (e.g., Iwata et al., 1982/1994) or the evocative effects of antecedent events (Carr, Newsom, & Binkoff, 1980).

Although these methods have been used primarily to detect reinforcement contingencies, they all, in principle, can be modified to detect EOs and, in many cases, have already been so used. Horner et al. (1997) interviewed the staff working with 3 individuals to identify putative EOs for their problem behavior and subsequently used an alternating treatments design to demonstrate their evocation of problem behavior. Although some approaches to the observation of correlations between environmental events and problem behavior (e.g., ABC charts) have limitations resulting from their focus on the immediate antecedents of behavior, they do typically enable the detection of EOs that immediately precede problem behavior (e.g., demands). Bodfish and Konarski (1992) used a scatter plot to identify periods when problem behavior occurred at high rates in a residential setting. The results suggested the hypothesis that lack of activity evoked problem behavior and led to the successful provision of structured activities. Emerson et al. (1995) conducted detailed direct observations of problem behavior in the natural environment and showed patterns of variation across different social contexts (e.g., when the person was alone or was subject to high-rate demands) suggestive of the operation of EOs. Smith et al. (1995) adapted their experimental analysis technique to identify the specific aspects of demands that functioned as EOs and suggested this approach as a useful strategy for the investigation of EOs more generally. Given the range of EOs that might be operating in the natural environment and their sometimes temporal distance from problem behavior, it seems likely that all approaches will be useful in some situations, although experimental analysis should be used when possible to identify the functional properties of putative EOs.

Michael's (1993) elaboration paid particular attention to the differentiation of UEOs and three types of CEOs. It might be asked, therefore, if developments in functional analysis methods could be identified that would enable a similar differentiation of the EOs that evoke problem behavior. It should be noted, first, that the distinction between UEOs and CEOs is not always easy to apply in practice. This can be illustrated by further consideration of Table 1. Deprivation of tangible items and deprivation of stimulation would appear to be UEOs, but it is difficult to describe deprivation of attention and aversive events such as demands in this way. Demands can be seen as reflexive CEOs because they may historically have been correlated with worsening. Deprivation of attention, however, does not seem to fit any of the CEO categories and, in many ways, appears to function very similarly to a UEO in that its effects do not appear to be dependent on the simultaneous operation of other, more obviously unlearned EOs (Gewirtz & Baer, 1958a, 1958b).

Different types of CEO may be more amenable to differentiation. Illustrative suggestions for the detection of reflexive and transitive CEOs follow.

Reflexive CEOs are stimuli that acquire their motivative effect through correlation with worsening (e.g., the presentation of an aversive stimulus) or improvement (e.g., the presentation of a reinforcing stimulus). Assume that problem behavior is maintained by the termination of demands and, further, that the presence or behavior of staff acts as a reflexive CEO. A test condition for social-negative reinforcement (escape and avoidance) could be conducted repeatedly using a design similar to that described by Smith et al. (1995, Study 3). The escape contingency would be standard (Iwata, Pace, Dorsey, et

al., 1994) but would be preceded, in each trial, by the presentation of stimuli thought to function as reflexive CEOs (e.g., approaching with materials, saying "let's start to work in a minute"). Problem behavior would be reinforced by the withdrawal of the stimulus (presence, materials, demand, etc.) most recently presented. The presence of a reflexive CEO would be shown by high rates of problem behavior occurring prior to the presentation of demands, that is, evidence that one function of problem behavior is to escape the stimuli preceding demands. In a variant of this procedure, different putative reflexive CEOs could be compared across conditions. In the natural environment, problem behavior would be expected to be evoked both by demands and by staff presence or features of staff behavior that warn of imminent demands. These threat CEOs would have an establishing rather than discriminative function because their onset establishes their offset as reinforcing (through a history of their correlation with later demands) rather than being correlated with the availability of reinforcement. That is, threats of imminent demands make escape from the threats more valuable rather than more likely. Such descriptive analysis would be an important way of identifying warning behavior that may be idiosyncratic in nature prior to formal experimental analysis.

Transitive CEOs are stimuli in whose context the reinforcing or punishing effectiveness of existing conditioned reinforcers or punishers is altered. Demands may sometimes act as transitive CEOs establishing motivation for attention. In the standard attention test condition (Iwata, Pace, Dorsey, et al., 1994), attention is provided contingent on the occurrence of problem behavior and at no other time while the person is allowed (but not required) to interact with recreational materials. If demands are suspected to increase motivation for attention, this condition could be modified so that the person is required to interact with materials (as in the standard demand test condition), with the attention contingency remaining the same. If a transitive CEO relation exists, problem behavior should occur in this modified condition at a higher rate than in the standard attention condition. Because demands would not be withdrawn or delayed, no escape contingency would be in effect and the occurrence of persistent problem behavior would distinguish the transitive CEO effect from the burst of extinction responding characteristic of escape-maintained behavior under these circumstances. In the natural environment, higher rates of attention-gaining problem behavior (as measured, e.g., by conditional probabilities) would be expected in situations of high-rate demands.

Although the above proposals remain to be tested empirically, they suggest that including the analysis of EOs in functional analysis does not require major changes to existing assessment methods. As a result, it might be hoped that, just as it has become routine to assess and report the function of problem behavior in both clinical practice and research, future studies will also report EOs. In addition to the benefits likely to arise directly from this practice, cumulative information about the relation of EOs to problem behavior would then become available in the same way that it has in respect of reinforcement contingencies (Derby et al., 1992; Iwata, Pace, Dorsey, et al., 1994), and (as illustrated by Horner et al., 1997) basic knowledge and conceptions of EOs and their relations to behavior would be considerably extended.

ESTABLISHING OPERATIONS AND TREATMENT

What significance might EOs have in successful treatment? To address this question, a number of existing treatments will be an-

alyzed from an EO perspective, and the implications of EOs for the development of new ideas about treatment will be considered.

Analyzing Existing Treatments from an EO Perspective

In what follows, no attempt is made to comprehensively review existing treatments from an EO perspective. Rather, selected treatments, commonly used and discussed in the recent literature, are considered. Treatments have been selected for consideration partly on the basis of having been little discussed from an EO perspective. Thus, noncontingent reinforcement, the effectiveness of which has been interpreted as at least partly the result of the modification of EOs (Hagopian et al., 1994; Marcus & Vollmer, 1996; Vollmer et al., 1993, 1995; Wilder & Carr, 1998), has not been considered. It should be noted that, in routine clinical practice, treatment procedures are often combined into a multicomponent treatment package (Carr, Robinson, Taylor, & Carlson, 1990; LaVigna, Willis, & Donellan, 1989; Meyer & Evans, 1989) in which they may interact in complex ways. For heuristic reasons, they are discussed below as single-component independent treatments.

Extinction. Extinction involves the termination of a previously existing contingency between problem behavior and its reinforcing consequence. In practice, this amounts to no longer delivering the reinforcer that previously maintained the behavior (Lerman & Iwata, 1996). Iwata, Pace, Cowdery, and Miltenberger (1994) have recently demonstrated that extinction's success depends upon the correct identification of the reinforcer and have suggested that extinction likely plays a role in a range of other treatments such as differential reinforcement of other behavior (Mazaleski, Iwata, Vollmer, Zarcone, & Smith, 1993) and noncontingent reinforcement (Vollmer et al., 1993, 1995). Extinction has been shown to reduce the occurrence of problem behavior, although reduction is sometimes preceded by an extinction burst in which the problem behavior temporarily occurs at rates higher than in baseline (Lerman & Iwata, 1995). The problems associated with this burst (health risks to self or others, threats to procedural integrity) have been seen as significantly limiting the potential of extinction for more widespread use (LaVigna & Donellan, 1986). This has led to its being combined with other techniques (such as instructional fading, e.g., Pace, Iwata, Cowdery, Andree, & McIntyre, 1993; Zarcone, Iwata, Vollmer, et al., 1993) designed to reduce the occurrence of an extinction burst, and to a call for programmatic research addressing the factors associated with its most effective use (Lerman & Iwata, 1996).

From an EO perspective, the most interesting feature (and main limitation) of extinction is its lack of explicit attention to the EOs that evoke problem behavior. This can be seen with the admittedly stark and unusual example of the extinction of self-injurious behavior maintained by food. When self-injury previously resulted (probably intermittently) in food, it will (during extinction) no longer lead at all to food. Self-injury, however, is likely to be evoked by food deprivation, and the nondelivery of food will leave the EO still in effect, at least until the next scheduled snack or meal. Under these circumstances, the likely extinction burst can be seen as a reflection of the modification of the response–reinforcer relation without an accompanying modification of the relevant EO. The person is still hungry but is no longer able to obtain food through self-injury.

It would be very unlikely, of course, that extinction would be used as a sole treatment under these circumstances. It has, however, been used frequently in this way in other, not conceptually different, circumstances.

For example, escape extinction (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990) typically involves preventing escape from demands and, thus, maintaining in place the EO (demands) that evokes escape responses. When such a state of aversive stimulation exists and reinforcement (escape from the aversive stimulation) no longer results, we might expect to see severe, long-lasting extinction bursts coupled with other problem behaviors that have a history of producing escape because, as originally suggested by Skinner (1953, p. 150), the number of responses that occur during extinction may reflect the current strength of the relevant EO. Indeed, extended bursts during escape extinction have been reported in the literature (Goh & Iwata, 1994; Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990). Nonetheless such extinction bursts are often transitory (Iwata, Pace, Kalsher, Cowdery, & Cataldo, 1990) or are not reported (Lerman & Iwata, 1995).

In practice, escape extinction may work not just because of its directly suppressive effect on previously reinforced responses but because it accidentally modifies the relevant EO. In the example of escape from demands, extinction exposes the person to the demands from which he or she previously escaped successfully by displaying problem behavior. Frequent contact with the demands is likely to directly change those aspects of the demands that make them aversive to the person. For example, novel demands will become familiar; difficult demands (with practice and help) will become easier. This argument leads to the conclusion that extinction, as commonly practiced, is both a treatment that changes the consequences of problem behavior and a procedure that may create conditions under which (in this example) the aversiveness of demands is reduced (i.e., the EO is modified). As such it would be expected that the procedural details of the use of extinction would be important predictors of its effectiveness in modifying the EO and, therefore, of the extent and strength of any extinction burst.

Behavioral momentum. High-probability command sequences (Mace & Belfiore, 1990; Mace et al., 1988; Singer, Singer, & Horner, 1987) involve the presentation of a sequence of commands with which the person is likely to comply (high *p*) immediately prior to the presentation of a command with which he or she has typically not complied (low *p*). Mace and his colleagues have shown that this procedure can result in both increases in compliance to the low-*p* command and reductions in problem behaviors previously evoked by this command. Increases in compliance have been discussed in terms of behavioral persistence or momentum (Nevin, 1996; Nevin, Mandell, & Atak, 1983), under which a response persists as a function of recently high response and reinforcement rates. The high-*p* command sequence then increases both rate of compliance to commands and obtained reinforcement for compliance, with compliance persisting despite the change in conditions resulting from the presentation of the low-*p* command. Various mechanisms for the accompanying reduction in problem behavior have been proposed, including topographical incompatibility (Mace & Belfiore, 1990), the interaction of concurrent operants (Parrish, Cataldo, Kolko, Neef, & Egel, 1986), functional incompatibility (Mace & Belfiore, 1990), and extinction (Zarcone, Iwata, Hughes, & Vollmer, 1993).

In analyzing this procedure from an EO perspective, it is important to remember the differentiation made between discriminative and motivative effects. High-*p* and low-*p* command sequences constitute EOs rather than S^Ds, because it makes no sense to talk of compliance (or escape-related problem behavior) in the absence of commands. In the initial situation, the low-*p* command may be seen as an EO evoking escape,

whereas high-*p* sequences constitute EOs evoking compliance. In the circumstance in which a series of high-*p* commands precedes a low-*p* command, the high-*p* commands may act as a reflexive CEO "promising" reinforcement for continued compliance and suppression of escape-producing behavior. Further, the pairing of these CEOs will result, over time, in the transfer of the motivative properties of one stimulus to the other, although it is not a priori clear in which direction the transfer will occur. Thus, besides evidence of increased compliance to low-*p* commands in the absence of the high-*p* sequence (Davis, Brady, Williams, & Hamilton, 1992; Ducharme & Worling, 1994), there is also evidence of reduced compliance to high-*p* commands (Davis & Reichle, 1996; Zarcone, Iwata, Hughes, & Vollmer, 1993; Zarcone, Iwata, Mazaleski, & Smith, 1994). The EO perspective, therefore, offers the possibility of an explanation for all outcomes of the high-*p*/low-*p* procedure in a relatively parsimonious way, and may also facilitate a coherent account of a wide range of antecedent manipulations similar in their effects to behavioral momentum but with widely differing origins and explanations (Kennedy, 1994).

Similar observations have been made by Smith and Iwata (1997) and Houlihan and Brandon (1996). It should be noted that these (and the current) accounts of the role that may be played by EOs in high-*p*/low-*p* procedures rely heavily on inference from observed changes in the probability of compliance to high-*p* and low-*p* commands. The results of studies reporting such observations have generally been interpreted in terms of behavioral momentum theory (Nevin, 1996), although no explanation of the reduction in compliance to high-*p* commands appears to have been offered. Further studies are clearly required. In particular, such studies might seek to confirm that the reduction in compliance to high-*p* commands is a function of their being repeatedly followed by low-*p* commands rather than a result of other variables such as simple repeated presentation. An EO interpretation would also predict that similar changes in compliance to high-*p* commands could be produced by procedures (e.g., satiation with social praise) that alter the reinforcing effectiveness of the typically scheduled consequences for compliance, and that changes in response to high-*p* commands, however produced, could be reversed by procedures that restore reinforcing effectiveness to these consequences.

Functional communication training (FCT). This treatment (Carr & Durand, 1985a) involves the replacement of problem behavior with a functionally equivalent communicative behavior. FCT has been shown to lead to rapid, durable, and generalized reductions in problem behavior without the occurrence of an extinction burst (Durand & Carr, 1991, 1992; Sprague & Horner, 1992). The success of FCT has generally been attributed to the notion of functional equivalence (Carr & Durand, 1985a) in which the strengthening (through FCT) of a socially desirable response leads to the weakening or elimination of problem behavior responses having the same function. It has been pointed out, however (Fisher et al., 1993), that FCT usually has been combined with other treatment procedures such as extinction, punishment, and antecedent assistance, and when FCT has been used without such accompanying procedures its effectiveness appears to be markedly reduced (Fisher et al., 1993). The lack of evidence for the general effectiveness of FCT as a single-component treatment has been explained variously as an issue of response efficiency (Horner, Sprague, O'Brien, & Heathfield, 1990), the effects of reinforcement of functional communication responses on other (problem behavior) members of the same response class, and the chaining of communicative responses to problem behavior (Fisher et al., 1993).

From an EO perspective, three points are noteworthy. First, when communication responses are emitted and reinforced (with the stimulus found to reinforce problem behavior), the EO that evokes both problem behavior and communication responses is only temporarily modified, although it may be more permanently modified by some of the procedures (such as antecedent assistance) typically used in parallel. That is, FCT seeks to modify the response evoked by the EO rather than the EO directly. Insofar as the EO is a reflection of aberrant environmental characteristics (such as inappropriate demands) and parallel procedures to directly modify such characteristics are not in place, FCT may raise ethical concerns (because it leaves a counterhabilitative environment in place) and may be limited in its effectiveness (because the circumstances evoking problem behavior still exist).

Second, the focus on the development of communication responses reflects FCT's theoretical origins in the communication hypothesis of problem behavior (Carr & Durand, 1985b). A focus on communication responses is unnecessary from an EO perspective. If FCT is conceptualized as modifying the response evoked by the EO, then a more general notion of the development of functionally equivalent responses including, for example, environmental control skills, appears tenable (Carr, 1988; Horner & Day, 1991; Steege, Wacker, Berg, Cigrand, & Cooper, 1989).

Third, a functional equivalence perspective is difficult to maintain regarding those instances of FCT that involve the development of assistance-seeking responses in the face of demands such as difficult tasks. The function of problem behavior in this context would usually be identified as escape, but getting help is not functionally equivalent to escape and may in fact lead to longer rather than shorter contact with the task. In this case, the difficult task may constitute a transitive CEO that makes the conditioned reinforcer of help more reinforcing. Under these circumstances, help is reinforcing because (like Michael's screwdriver) it changes the task into an easier one that does not establish motivation to escape. Help, of course, is one kind of attention so that, if such a transitive relation already exists, problem behavior in the context of demands may be attention rather than escape maintained (Iwata, 1994; Repp & Karsh, 1994; Rortvedt & Miltenberger, 1994).

Developing New Ideas About Treatment

The preceding discussion suggests the usefulness of the EO concept in the analysis of a number of commonly used treatments. The role of EOs may be more clearly understood, however, through a more thoroughgoing analysis of their implications for treatment. The intention in the following discussion is to consider the implications of a coherent EO-based approach to treatment. Inevitably, such a discussion will pay less attention to the importance of already well-established concepts such as reinforcement and discriminative stimulus control.

EOs and the treatment of problem behavior. It is already clear that much problem behavior can be seen as discriminated responses maintained by social-positive, social-negative, and automatic reinforcement. This notion has led to analysis and treatment strategies that focus on the reduction of problem behavior through the manipulation of the relevant three-term contingencies. The concept of the EO potentially extends this analysis because it can help to explain both the evocation of problem behavior and the reinforcing effectiveness of the maintaining consequences—why problem behavior is happening *now* and why the person "needs" or "wants" the reinforcer. It seems likely that clinically significant, long-term, generalized change in problem behavior can occur only if the EOs that evoke problem behavior are,

directly or indirectly, addressed in treatment. Problem behavior should then establish motivation in behavior analysts to identify the relevant EOs and the classes of responses evoked by these EOs. Following such investigation, treatment can focus on the modification of the EOs, the extinguishing of the EOs, or the modification of the class of responses evoked.

Modifying EOs. As listed in Table 1, the EOs most often implicated in the motivation of problem behavior are deprivation of attention, deprivation of tangible items, deprivation of stimulation, and demands. Treatment based on modification of EOs will then involve the provision of higher levels of attention, tangible items, and stimulation, and the modification of demands. In one sense this is noncontroversial and helps to make treatments such as noncontingent reinforcement and those based around the manipulation of antecedents more conceptually systematic. In another sense, however, it may extend considerably the purview of applied behavior analysis. Treatment involving the modification of EOs may not focus on the manipulation of contingencies at all but rather on the provision of a better quality of life, "reduced in stress, deprivation, and fear; enriched in those things that attract and engage the person's interest and repertoire" (Risley, 1996, p. 428). In short, treatment would focus on modifying the challenging environment (McGill, 1993; McGill & Toogood, 1994), which the literature on the quality of life of people with developmental disabilities tells us is still commonly found (Emerson & Hatton, 1994; Holburn, 1997).

Two cautions should be noted. First, it has been suggested that the modification of EOs carries the danger of failing to remove the functionality of problem behaviors (Iwata et al., 1993). In this perspective, when confronted with the same circumstances as previously prevailed (e.g., deprivation of attention), the person will display the problem behaviors that treatment has failed to extinguish. If such behaviors are dangerous to person, property, or reputation, their recurrence is clearly problematic. To the extent, however, that such reemergence indicates the likely breakdown or decay of the "life arrangements" (Risley, 1996) established in treatment, the preserved functionality of problem behavior may be a useful countercontrol that will lead to action that reinstates the previously effective arrangements.

Second, a focus on the modification of EOs clearly produced by external environmental arrangements (e.g., absence of attention) should not avert consideration of the role played by biological factors and the internal environment in the evocation and motivation of problem behavior (Carr, 1994). This issue appears to have been little addressed in the literature of applied behavior analysis, perhaps partly because of a lack of conceptually systematic approaches to its analysis (Romanczyk & Matthews, 1998). However, it is clear that problem behavior may arise from or be increased as a function of various internal or biological circumstances of a temporary or more permanent nature (Bailey & Pyles, 1989; Carr et al., 1996; Cataldo & Harris, 1982; Clements, 1987; Guess & Carr, 1991; Kennedy & Meyer, 1998; Lovaas et al., 1987; McGill, Clare, & Murphy, 1996; Murphy, 1997; Oliver, 1995).

At least some of these circumstances may be considered as EOs because they alter the effectiveness of certain other events as reinforcers or punishers and the frequency of behaviors associated with these events. For example, the reinforcing effectiveness of teacher attention may be temporarily increased by the administration of methylphenidate (Northup, Fusilier, Swanson, Roane, & Borrero, 1997) but enduringly lowered in people labeled autistic (e.g., Taylor & Carr, 1992a), the reinforcing effectiveness of food

may be enduringly raised in Prader-Willi syndrome (Clarke, Boer, & Webb, 1995), and the aversiveness of demands may be temporarily increased by physical illness (Horner et al., 1996) or sleep deprivation (Kennedy & Meyer, 1996; O'Reilly, 1995). Events such as autism and Prader-Willi syndrome do not entirely fit the definition of the EO, in that their impact on reinforcing effectiveness is enduring rather than momentary. Although it is an extension of the EO concept, consideration of the enduring motivative effects of genetic or biological circumstances is not new. Skinner (1989, pp. 50–51), for example, discussed the degree to which genetic susceptibilities to reinforcement have evolved, noting, as an illustration, the following of large moving objects by ducklings with reductions in the distance to the object being reinforcing. Deprivation resulting from biological impairment was also described as an EO by Epling and Pierce (1990). The probable relevance of such factors and our lack of knowledge of their effects suggest caution about the degree to which the modification of EOs associated with external environmental arrangements provides a universally applicable treatment for problem behavior.

Although clearly diverse, the putative EOs associated with biological circumstances share the characteristic of modifying (on a temporary or more enduring basis) the individual's satiation point for the relevant reinforcer independently of its more typical modification through variation in the availability of reinforcement. This suggests that the occurrence of problem behavior will, other aspects of the prevailing contingencies being equal, reflect the density of reinforcement available in the relevant environment and the current operation of other variables that affect the satiation point of the individual for (or sensitivity to, cf. Mulick & Meinhold, 1991; Oliver, 1993; Reiss & Havercamp, 1997) the relevant reinforcer. Further, the relation of density and satiation point should determine the focus given to the modification of environmental EOs in intervention.

Extinguishing CEOs. The possibility of extinction of CEOs is not one directly addressed by Michael's analysis. However, because Michael argues that some EOs are unconditioned or unlearned and some are conditioned or learned, it seems appropriate to consider examples of the extinction of the latter. The term *extinction* usually refers to the termination of the contingency between response and reinforcer with a resulting decline in the frequency of the previously reinforced response. In the following discussion, *extinction* refers instead to the reduction and removal of the motivative effects of stimuli that have previously functioned as CEOs.

Reflexive CEOs are stimuli that acquire their motivative effect through correlation with worsening (e.g., the presentation of an aversive stimulus) or improvement (e.g., the presentation of a reinforcing stimulus) and that establish their termination as reinforcing or punishing with consequent evocative or suppressive effects on behaviors associated with that termination. CEOs correlated with worsening may be common occurrences in escape- or avoidance-motivated problem behavior (Sundberg, 1993). The person who presents a difficult demand, the setting in which difficult demands are made, the materials used, and so on, may become CEOs that evoke problem behavior, successful both in escaping the conditioned aversive stimuli constituting the CEO and in avoiding the worsening (difficult demand). Of course this usually means that the person may also be avoiding demands with which they ordinarily would comply, or even all demands. Extinction of such CEOs must involve the presentation of the same stimuli without the worsening that has typically followed in the past. In the example of the person associated

with difficult demands, extinction might be accomplished in a number of ways; for example, by the person remaining (but not presenting difficult demands) despite any occurrence of problem behavior (analogous to escape extinction); by associating the person with the provision of positive reinforcement; or by the person's presence (also without difficult demands) being faded in (analogous to instructional fading). The key difference from more typical use of such procedures is that their purpose is to extinguish the CEO, not just the specific escape or avoidance response. Note also that the existence of such responses should occasion investigation of the demands made on the person because (as a result of content or presentation) they appear to act as EOs motivating escape. If, having extinguished a reflexive CEO of the kind described above, it is again paired with subsequent worsening (e.g., through the presentation of unchanged demands), rapid reestablishment of the reflexive CEO would be expected.

Transitive CEOs are stimuli that alter the effectiveness of existing conditioned reinforcers or punishers. Assume that problem behavior sometimes (but not always) occurs during a particular activity and is maintained by escape from the activity. Events that alter the momentary reinforcing effectiveness of escape from the activity and evoke escape-maintained problem behavior may be acting as transitive CEOs. For example, the instructor's saying "No!" during the activity may momentarily increase the reinforcing effectiveness of escape from the activity and evoke problem behavior that results in escape. If it can be shown that the problem behavior is reinforced by escape from the activity (rather than just from the instructor saying "No!"), then the correction procedure has the properties of a transitive CEO. It is a CEO (rather than an S^D) because escape from the activity is equally available whether or not the instructor says "No!" It is transitive in that it operates directly on an independent event (the reinforcing effectiveness of escape from the activity). Because error correction may be important to the development of independence in the activity, it might well be a reasonable goal to seek to extinguish such a CEO by methods analogous to those that extinguish reflexive CEOs. In this example, error-correction procedures might be withdrawn and gradually reintroduced, attending to their rate, intrusiveness, or other relevant features until procedures that previously evoked problem behavior can be used without such an effect.

Two general points about the extinction of CEOs are noteworthy. First, despite the relevant treatment procedures being similar to or the same as those involved in the extinction of problem behaviors, their rationale is quite different and their effects would also be expected to be different. In particular, successful extinction of a CEO will lead to the nonoccurrence of all responses (i.e., the operant class) evoked by the CEO (although topographically similar or identical responses may still be evoked by other EOs). Second, the extinction of CEOs should not proceed lightly because of the danger of adverse side effects. This is particularly the case when the CEO includes stimuli that would normally be regarded as aversive, when extinction may involve the person "putting up with" more aversive events than before.

Modifying the responses evoked by EOs. In some cases it may be seen as unreasonable to seek to extinguish the motivative effects of EOs, such as severe deprivation of attention, that evoke problem behavior. Because such stimulus conditions are not always detected or easy to alter, the immediate problem for the person is the damaging or self-damaging nature of the behavior that is evoked. Treatment should, therefore, include the development of functional responses that allow the person to temporarily modify the

EO other than through behaviors with damaging side effects. This may involve developing skills to communicate what he or she wants or to obtain it directly. However, the environment may not respond to communicative attempts (Carr et al., 1996), or the control skills required may be too complex to establish. Treatment may also consider, therefore, teaching the person to substitute one attainable reinforcer for another, temporarily unattainable reinforcer (cf. Smith & Iwata, 1997) and to cope (cf. Gardner et al., 1986) with the temporary continuation of what has historically constituted a state of deprivation or aversive stimulation. When coupled with the other treatment components discussed above, this may allow the person to avoid problem behavior even under conditions of "challenge" or "relapse" (Reiss & Havercamp, 1997) in environmental or biological conditions (see also Horner et al., 1996). On its own, however, such a treatment strategy would be fraught with the dangers associated with attempts to help "people adjust to a system that in itself is in need of change" (Winnett & Winkler, 1972, pp. 501–502).

ESTABLISHING OPERATIONS AND THE PREVENTION OF PROBLEM BEHAVIOR

Although the vast majority of behavior-analytic studies of problem behavior have focused on individual assessment and treatment, a small number of studies (e.g., Dunlap, Foster Johnson, & Robbins, 1990; McEachin, Smith, & Lovaas, 1993) have documented reductions in its prevalence as an apparent result of prophylactic intervention within relatively small, defined groups. The agenda for such efforts has been informed by the knowledge gained from studies of the events evoking and maintaining problem behavior in individuals. For example, Iwata, Pace, Dorsey, et al. (1994) concluded (with respect to self-injurious behavior) that "many individuals have not acquired socially appropriate means for gaining access to reinforcement through others or, alternatively, that the social environments of many individuals are not responsive to less aberrant forms of attention-seeking or escape behavior" (p. 235). Similarly, Durand (1990, p. 6) noted that "behavior problems . . . are reasonable behavioral adaptations necessitated by the abilities of our students and the limitations of their environments." An EO perspective suggests that, in addition, the deprivation and aversiveness found in some of these environments evoke problem behavior by establishing motivation for reinforcers that are not easily obtained in any other way, and that biological circumstances may serve a similar function. These "causes" of problem behavior suggest a multicomponent agenda (cf. Carr & Smith, 1995) for efforts that seek to reduce its prevalence through prevention.

Developing Adaptive Behaviors That Allow Access to Reinforcement

This is a common course of action in individual treatment when, as noted above, deficits in adaptive, reinforcement-accessing skills are commonly found, and their development may lead to successfully "replacing" problem behavior in the person's repertoire. As an agenda for prevention, it is consistent with programs (Dunlap et al., 1990; McEachin et al., 1993) that have sought to reduce the prevalence of problem behavior. Note that in neither individual nor systemic treatment does this approach require an awareness of EOs. Rather it can be derived entirely from analysis of the reinforcement contingencies commonly found to maintain problem behavior. As seen in the earlier discussion of functional communication training, however, an EO perspective may draw attention to possible limitations and extensions of such an approach.

Supporting Environments' Responsiveness to Adaptive Behavior

In individual treatment, the simple development of functionally equivalent alternatives to problem behavior reinforced by others may not be sufficient when existing reinforcement contingencies for problem behavior remain in place (Horner & Day, 1991; Shirley, Iwata, Kahng, Mazaleski, & Lerman, 1997). Reduction in problem behavior requires that staff or caregivers are at least as responsive (i.e., provide equivalently immediate, frequent, and high-quality reinforcement; Fisher & Mazur, 1997) for the alternative as for the problem behavior. Studies of the apparent escalation of problem behavior (Lalli, Mace, Wohn, & Livezey, 1995) or the apparent differential reinforcement of longer durations (Hall & Oliver, 1992) are consistent with a lack of such responsiveness prior to individual treatment. More systemic studies of caretaker–client interaction (Felce et al., 1987; Warren & Mondy, 1971) suggest that it is not uncommon to find higher rates of presumed reinforcement available for problem behavior than for appropriate behavior. It has been suggested that such patterns of interaction may help to shape the frequency or severity of problem behavior over time (Warren & Mondy, 1971) so that systemic interventions that seek to alter such patterns are of potential value (Felce, 1991; McGill & Toogood, 1994). Notably, for this paper's context, problem behavior has been hypothesized to be an aversive stimulus that either punishes caregiver behavior (Taylor & Carr, 1992b) or acts as an EO evoking caregiver responses (such as the provision of attention or the withdrawal of demands) that successfully, albeit temporarily, remove the problem behavior (Oliver, 1995).

Providing Reinforcing, Nonaversive Environments

It has been argued above that motivation for the reinforcers commonly found to maintain problem behavior is established by conditions of deprivation of attention, tangible items, and stimulation, and the occurrence of aversive events (see Table 1). The modification of such EOs has become an important part of conceptions of both individual treatment (e.g., Iwata et al., 1993) and a variety of specific treatments (e.g., Horner et al., 1997; Kennedy, 1994; Vollmer et al., 1993). Given that such EOs are commonly found in the environments of people at risk for problem behavior, their systemic modification holds the promise of reducing both the occurrence of problem behavior in individuals for whom it is already part of their repertoire and preventing its initial onset in others. Inevitably, such a project also has likely limitations. In particular, the general modification of EOs in this way is likely to interact with other influences on motivation (e.g., biological variables) with, in individual cases, an increase rather than a decrease in motivation for the reinforcers that maintain problem behavior. For example, an individual whose problem behavior is maintained by escape from social interaction may, in the presence of generally increased levels of social contact, display higher rates of problem behavior (Taylor & Carr, 1992a). Also, the impact of such EO modification on other behaviors and on the availability of other reinforcers should be considered. The frequent and noncontingent availability of the reinforcers that typically maintain problem behavior may lead to reductions in the rate of functionally equivalent, adaptive alternatives to problem behavior such as communication (Kahng, Iwata, DeLeon, & Worsdell, 1997; but see Marcus & Vollmer, 1996) and a reduction in the degree to which the individual controls the environment (Carr, McConnachie, Levin, & Kemp, 1993). The seriousness and prevalence of such side effects require empirical study.

Modifying Biological Circumstances

It has been argued above that temporary or more enduring biological circumstances may act as EOs that increase satiation points for the typical consequences of problem behavior. Although the importance of screening for biological and genetic abnormalities has long been recognized (Bijou, 1966; Carr, 1977), they have sometimes been seen as influencing behavior in a quite different way to the events typically investigated through functional analysis. This extension of the EO concept provides a way of considering the behavioral function of such states or events in a conceptually systematic way that allows their incorporation in individual analysis and intervention. Studies reporting such approaches in work with individuals have inevitably focused on those EOs that are relatively easy to define, measure, and directly modify; for example, premenstrual difficulties (Carr & Smith, 1995), otitis media (O'Reilly, 1997), and sleep deprivation (Kennedy & Meyer, 1996). Although individual treatment is clearly still developing in this area, the systemic treatment and prevention agenda is to begin to map the biological circumstances found to be implicated in instances of problem behavior, consider their possible prevalence, and, when practical, target intervention (the modification of EOs) at high-risk groups.

This analysis suggests that we are now at the point at which we can begin to think about the systemic treatment and prevention of problem behavior with the aim of substantially reducing its prevalence. Our understanding of what is needed in this task appears to be enhanced by the application of the EO concept and is consistent with developments in the behavior analysis of other applied problems in which the agenda is shifting from an exclusive concern with individual contingency management to a concern with systemic intervention and prevention through the changing of cultural practices (Biglan, 1995; Mayer, 1995).

CONCLUDING COMMENTS

Although EOs have been the focus of this paper, they should be considered in a more general behavior-analytic context. Much progress has been made in accounting for and treating problem behavior by primary reference to the reinforcing and discriminative functions of the stimuli to which it is related. The EO concept extends this account both by drawing attention to an additional function of previously recognized stimuli and by allowing additional stimuli (previously unrecognized or of unclear function) to be included in assessment and treatment. Considerable attention has been given in recent years to the importance of considering and analyzing the context in which three-term contingencies develop and are maintained (e.g., Carr, 1994; Morris, 1992). The EO allows the more conceptually systematic consideration of some aspects of this context but should not be seen as equivalent to all of the aspects discussed in the literature. For example, the concepts of setting factors (Kantor, 1959) and setting events (Bijou & Baer, 1961) include references to analogous operations but also refer to stimulus functions that do not appear to relate directly to EOs (Kennedy & Meyer, 1998).

In summary, the notions revived in Michael's (1982, 1993) treatment of the EO have been shown to have considerable relevance to conceptions of problem behavior and its assessment, treatment, and prevention. They enable a more complete account of problem behavior to be given, both generally and with respect to particular individuals. The pretreatment assessment of EOs seems likely to have important implications for treatment. Further, existing treatments can be usefully analyzed from an EO perspective, and the concept can guide the de-

velopment of frameworks for both treatment and prevention.

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Received November 18, 1997
Final acceptance April 30, 1999
Action Editor, Joseph E. Spradlin