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Jack Michael's Motivation

Caio F. Miguel, California State University, Sacramento

Among many of Jack Michael's contributions to the field of behavior analysis is his behavioral account of motivation. This paper focuses on the concept of *motivating operation* (MO) by outlining its development from Skinner's (1938) notion of *drive*. Conceptually, Michael's term helped us change our focus on how to study motivation by shifting its origins from the organism to the environment. Michael's account also served to stimulate applied research and to better understand behavioral function in clinical practice.

Key words: drive, establishing operations, Jack Michael, motivation, motivating operations

The topic of motivation is considered of utmost importance in the field of psychology (Carter & Seifert, 2013). Even though, a variety of theories have been proposed to explain what ''moves'' people into behaving in certain ways (e.g., Buss, 1995; Maslow, 1943; Weiner, 1972), they often assume motivation to be an internal process that makes people behave. In other words, the term motivation is used as a hypothetical construct derived from the observable behaviors that it is meant to explain. If a child does not complete her homework for example, one can infer that she was not motivated to do so, leading to circular reasoning.

Behavior analysts have traditionally dealt with motivation by invoking the principle of reinforcement (Michael, 1993). There is plenty of evidence suggesting that behavior is a function of its consequences, so if a behavior does not occur, it is likely that there is a lack of positive consequences being produced by it. But the presence/absence of consequences alone is not sufficient to explain one's ''inclination'' to behave, as we know that the value of consequences vary considerably across, and more importantly, within individuals (Skinner, 1938).

The principle of *establishing operations*, which was later renamed *motivating operations* (Michael, 1982, 1993) serves, among other things, to explain the transitory effects of reinforcing consequences. It does so in a fairly parsimonious way, by clearly identifying these motivational variables so they can be observed, measured, and manipulated. In this commentary dedicated to the 20th anniversary of Michael's (1993) seminal paper ''Establishing Operations,'' I will briefly describe the history of the behavior analytic approach to motivation,[1] beginning with the concept of *drive* and ending with motivating operations.

DRIVE

Learning theorists (e.g., Hull, 1943) used the term *drive* to suggest a physiological tension that would motivate action. Lack of water, for instance, would cause tension in our system that would drive us to behave in a way to satisfy the drive (by getting water). Skinner (1938) also used the term to account for the response variability observed during reinforcement. According to Skinner, ''A rat does not always respond to food placed before it, and a factor called its 'hunger' is invoked by way of explanation'' (p. 341). Differently from his contemporaries, Skinner was not interested in hypothetical states such as hunger, which are inferred from observing the behavior of eating, but with discovering the variables, such as feeding and fasting, which are responsible for the variability observed in this behavior. He applied this formulation to other drives such as thirst and activity, suggesting that each would be a function of different environmental operations,

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Address correspondence to Caio Miguel, Department of Psychology, California State University-Sacramento 6000 J. St., Sacramento, CA 95819-6007 (e-mail: miguelc@csus.edu).

[1] I have published a more detailed account of the history of the concept of establishing operations in a Brazilian psychology journal (Miguel, 2000).

such as ingestion/satiation of water or access/no access to activity.

Skinner (1938) used the term drive as a hypothetical state interpolated between these operations and behavior, since what was being observed and measured was behavior and not the drive. However, he suggested that the concept was useful ''as a device for expressing the complex relation … between various similarly effective operations and a group of co-varying forms of behavior'' (p. 368). It is important to note that despite using the term drive, Skinner suggested that it was ''not actually required in a descriptive system'' (p. 398). As a matter of fact, in his later works, Skinner abandoned the term drive for deprivation, satiation, and aversive stimulation (e.g., Skinner, 1957).

In their didactic summary of Skinner's (1938) work, Keller and Schoenfeld (1950) defined drive as a descriptor of ''certain operations … that have an effect upon behavior which is different from any other operations'' (p. 265). In other words, they emphasized that behavior may be a function of variables other than reinforcement. Like Skinner, they suggested that there may not be a need to infer an intervening state such as hunger between observable operations (i.e., food deprivation) and changes in behavior (i.e., lever presses), as it would add nothing to that ''which is contained in the observations themselves'' (p. 270). Nevertheless, the term drive was still used in their analysis of motivation, but with an emphasis on the environmental operations (i.e., deprivation, satiation, and aversive stimulation) that would establish it. They suggested that the concept of motivation or drive should be defined by the concomitant variation between establishing operations and behavior.

ESTABLISHING OPERATIONS OF DRIVE

In his book ''Principles of Behavioral Analysis,'' Millenson (1967) defined drive as a relation between a reinforcement-establishing operation and the reinforcing value of a class of stimuli. He made an analogy between the terms *drive* and *reflex*, suggesting that both ''stand for a certain relationship between variables'' (p. 366). In his treatment, Millenson emphasized the effects of environmental operations on the reinforcing value of unlearned reinforcers, by proposing that when holding reinforcement rates constant, and varying these other operations, the rate of behavior directly represents the strength of the reinforcer.

Millenson's treatment of motivational variables clearly emphasized the multiple control of operant behavior, in that both motivational variables and past conditioning served to explain the emission of a response. His book is still one of the few introductory behavior analysis texts to dedicate a whole chapter (two chapters, actually) to the topic of motivation. Subsequent texts omit chapters on motivation, while referring to deprivation and aversive stimulation when describing reinforcement (e.g., Catania, 1979; Mazur, 1986).

ESTABLISHING STIMULUS (S^E)

Even though the term *establishing operation* was already part of the behavior analytic vernacular (Keller & Schoenfeld, 1950; Millenson, 1967), Michael (1982) was concerned that these types of antecedent variables were not widely recognized as directly controlling (i.e., evoking) behavior. Thus, in his 1982 paper, Michael emphasized the distinction between the motivational and discriminative functions of stimuli. While discriminative stimuli (S^Ds) are correlated with the availability of reinforcers,[2] establishing operations (EOs) are correlated with their effectiveness. Thus, EOs would encompass all environmental variables that (1) alter (increase or decrease) the effectiveness of events as reinforcers (reinforcer-establishing effect), and (2) evoke (or suppress) behaviors that have produced such reinforcers in the past (evocative effect). This later effect is the same as the one exerted by the S^D, albeit developed through a different process. Note that Michael's (1982) use of EO includes not only events that establish, but also those that

[2] Like Michael (2004), I often use the term *reinforcement* and not *reinforcer* to refer to the stimulus changes responsible for the increase in behavior, as I do not consider static stimuli to have reinforcing value. However, to please the masses, I will be using the term *reinforcer* throughout this paper.

abolish another event as a reinforcer (i.e., abolishing operations).

Many of the previously described drive operations such as food, water, and activity deprivation, as well as aversive stimulation, would seem to have the two effects that define the EO. For example, water deprivation would increase the value of water as a reinforcer during operant conditioning and, after training, increase the frequency of the operant behavior reinforced by water. Michael's taxonomical reformulation allowed behavior analysts to group all variables with similar motivational effects upon behavior under the auspices of the EO. These variables include not only different forms of deprivation and aversive stimulation, but also salt ingestion and temperature changes.

In addition to (re)defining EOs and distinguishing them from S^Ds, Michael (1982) described how the value of conditioned reinforcers may also be conditional upon motivational variables. Although the value of conditioned reinforcers may depend upon the EO that has established the value of the unconditioned reinforcer with which the conditioned reinforcer has been correlated, there are some situations in which the presence of a stimulus (S1) establishes another stimulus (S2) as a conditioned reinforcer ''without altering the effectiveness of the relevant unconditioned reinforcement'' (p. 152). Michael referred to this antecedent variable (S1) as the *establishing stimulus* (S^E).

To illustrate the function of the S^E, Michael (1982) described the famous electrician example. In this example, an electrician needs to remove a slotted screw (S1) to complete his job. In order to do so, the electrician requires an appropriate screwdriver (S2) and thus requests one from his assistant. After receiving the screwdriver (conditioned reinforcer), the electrician continues engaging in a sequence of behaviors that leads to the completion of the job. According to Michael, the slotted screw does not evoke the request as an S^D since a screwdriver (conditioned reinforcer) is not more available in the presence of the slotted screw, and less available in its absence. The slotted screw establishes the screwdriver as a reinforcer and thus functions as an S^E evoking the request. The slotted screw may function as an S^D for other behaviors such as unscrewing, because the consequence produced by this behavior is not available in the absence of the slotted screw.

Michael's (1982) paper was extremely important as it introduced an elegant way for behavior analysts to talk about motivational variables, and clearly identify the different processes by which antecedent stimuli evoke behavior. With this publication, he re-emphasized that the three-term contingency is not effective unless there is an EO in place. In other words, the three-term contingency is always dependent on another (fourth) term, the EO. This is also the first time that Michael fleshed out the notion of a *conditional conditioned reinforcer* (i.e., S^E), later described as the *blocked-response CEO* (Michael, 1988), and finally, *transitive conditioned establishing operation* (CEO-T; Michael, 1993) as discussed below.

THE EO AND THE MAND

In 1988, Michael suggested that Skinner's (1957) definition of the mand be revised to include control by the EO. This is because the terms deprivation and aversive stimulation used to describe the variables controlling the mand were not inclusive of other motivational variables such as salt ingestion or temperature changes. According to Michael, the term EO is more comprehensive as it serves to describe any variable that momentarily alters ''(1) the reinforcing effectiveness of other events, and (2) the frequency of the kind of responses that have been reinforced by those other events'' (p. 6). His revised definition reads as follows: ''The mand is a type of verbal operant in which a particular response form is reinforced by a characteristic consequence and is therefore under the functional control of the establishing operation relevant to that consequence'' (Michael, 1988, p. 7). It is this definition of the mand that most behavior analysts adhere to presently (e.g., Bourrett, Vollmer, & Rapp, 2004; Petursdottir, Carr, & Michael, 2005; Shillingsburg & Valentino, 2011).

In his 1988 paper, Michael also distinguished between unconditioned and conditioned EOs (UEO and CEO, respectively) for the first time. This distinction was based on whether the reinforcer-establishing effect was unlearned or learned, since the evocative effect of the EO always depends on learning. Otherwise stated, the EO always evokes

behavior that has been reinforced by a stimulus whose value has been changed by the EO.

Michael (1988) mentioned two types of CEOs and suggested that they were previously identified as S^Ds. The first was the warning stimulus in the avoidance procedure. Although avoidance preparations that include the presentation of a warning stimulus (or conditioned aversive stimulus) have often been referred to as discriminated avoidance (Pierce & Cheney, 2008; Sidman, 1954), the warning stimulus whether unlearned or learned, is never correlated with the differential availability of the reinforcer (pain reduction), but with its effectiveness. An aversive stimulus alters the effectiveness of its own removal as a reinforcer (reinforcer-establishing effect) and evokes all behaviors that in the past have been followed by this removal (evocative effect). Thus, according to Michael, it would be incorrect to refer to the control exerted by the warning stimulus in an avoidance preparation as discriminative.

The second form of CEO that could also be easily confused with the S^D is what Michael (1982) previously referred to as the S^E. In the 1988 paper, Michael focused on mand responses whose forms were a direct function of S^Es, as when someone seeing something that needs to be written down mands for a ''pencil.'' In this case the situation establishes another stimulus (the pencil) as a conditioned reinforcer, thus evoking the mand (saying ''pencil'') that has produced the reinforcer in the past. Michael replaces the term S^E with blocked-response CEO, possibly under the influence of Hall and Sundberg's (1987) procedure for teaching mands to children with disabilities referred to as the *interrupted chain procedure*.

Although recognizing that there may be other types of CEOs, the focus of his 1988 paper was on those directly relevant to mand training. It was not until 1993 that Michael presented a fully developed behavioral account of motivation.

THE BEHAVIORAL ACCOUNT OF MOTIVATION

Twenty years ago, Michael (1993) published, in my view, one of his most important articles (possibly one of the most important articles in behavior analysis), titled ''Establishing Operations.'' The purpose of this paper was to summarize his approach to motivational variables that had evolved over the past 10 years or so.

In that paper, Michael (1993) described the two effects of the establishing operation: reinforcer-establishing and evocative and, once again, distinguished between the (evocative) effects of the EO and the S^D. Moreover, he described a third effect of the EO that seems to be often overlooked (Lotfizadeh, Edwards, Redner, & Poling, 2012), which is that it modifies the evocative effects of discriminative stimuli. In other words, by altering the value of consequences as reinforcers, EOs not only make discrimination training possible, but also change the evocative effect that S^Ds have upon behavior (Michael, 1993).

While the distinction between UEOs and CEOs was reintroduced, Michael (1993) also provided a detailed description of the different types of UEOs and CEOs. For UEOs, he listed deprivation and satiation of food, water, activity and sleep, temperature changes, variables relevant to sexual reinforcement, painful stimulation (escape), and emotional EOs. All of which would momentarily increase or decrease: (1) the reinforcer effectiveness of a stimulus, and (2) all behaviors that have been reinforced by this stimulus in the past. When discussing painful stimulation as an UEO, Michael described it as establishing its own removal as a reinforcer, as well as establishing other types of reinforcers specific to that EO, such as ''signs of damage.'' Thus, aggressive behaviors typically believed to be elicited by aversive stimulation (Azrin, 1970) could actually be interpreted as evoked by an UEO like any other emotional response. For example, the consequences associated with insulting someone may become more reinforcing (reinforcer-establishing effect) in the presence of some form of aversive stimulation (UEO), which would momentarily increase the frequency of this kind of behavior (evocative effect).

Moreover, Michael (1993) described three types of CEOs: the *surrogate*, the *reflexive*, and the *transitive*. Both the reflexive and transitive had been discussed previously (Michael, 1988) as the warning CEO (also threat CEO) and the blocked response CEO,

respectively. The new names were proposed as they seemed to better describe the processes of (1) establishing its own termination as a reinforcer or punisher (reflexive), and (2) establishing the effectiveness of another event as a reinforcer or punisher (transitive).

The surrogate CEO was defined as acquiring its properties through correlation or pairing with an UEO (and possibly another already established CEO), in a respondent-like preparation. Although dated experimental research on the learned drive may support the notion of the surrogate CEO (e.g., Calvin, Bicknell, & Sperling, 1953; Mineka, 1975), this phenomenon is mostly speculative. However, it is not difficult to imagine this sort of control, as when we go to a restaurant for drinks after dinner and decide to eat again. It is possible that the restaurant functions as a surrogate CEO since it has been paired with an UEO such as food deprivation (we typically go to restaurants when we are ''hungry''[3]).

Michael's (1993) detailed account of EOs highlighted the importance of motivational variables in the analysis of behavior. His treatment facilitated the ''identification of the various factors involved in the multiple control of human behavior'' (p. 205). Moreover, it provided behavior analysts with a way to manipulate and even create motivational variables to better predict and control behavior. In one of the many follow-up commentaries to Michael's paper, Sundberg (1993) predicted that, ''further research on the EO could lead to many theoretical and practical improvements in behavior analysis'' (p. 214). His prediction proved to be right.

RESEARCH ON EOS

Although only a few basic experimental studies have been conducted on the role of EOs on establishing reinforcers and evoking behavior (McPherson & Osborne, 1986, 1988; Ravagnani & Serio, 2006), there have been numerous applied studies involving both UEOs and CEOs. According to Iwata, Smith, and Michael (2000), there are three broad categories of applied research on EOs: ''(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'' (p. 411). Most notable is the work evaluating the control of the transitive CEO on teaching mands to children with disabilities, which over the past few years, has become quite sophisticated (e.g., Hall & Sundberg, 1987; Lechago, Carr, Grow, Love, & Almason, 2010; Rosales & Rehfeldt, 2007). This shows that the concept of EOs has undoubtedly become part of the arsenal of analytical tools of applied behavior analysis (Carbone, Morgenstern, Zecchin-Tirri, & Kolberg, 2007; McGill, 1999; Smith & Iwata, 1997; Wilder & Carr, 1998), especially when it comes to teaching verbal behavior to those who lack it.

FURTHER CLARIFICATIONS

The increased number of applied behavior analytic publications on EOs led Michael (2000) to address terminological implications that were being ''overlooked or misconstrued'' (p. 402). The first issue discussed in his 2000 paper was the nature of the evocative relation as being independent from the reinforcer establishing effect. In other words, the evocative effect is only observed after behavior has been reinforced by the consequence whose value was increased by the EO (the reinforcer-altering effect). Second, Michael suggested replacing terms such as deprivation and satiation that usually refer to periods of restricted access and organismic states, respectively with the terms establishing and abolishing operations. Third, he reminded the reader that behavior reduction achieved by manipulating EOs is temporary. Once the EO is again present, problem behavior would be evoked. Fourth, Michael argued that despite its possible status as an unconditioned reinforcer, attention should be considered a conditioned reinforcer, so a transitive CEO rather than an UEO (such as lack of attention) modulates its value.

[3] Note that I am using the term ''hungry'' quite loosely and would hope that no serious behavior analyst would consider it as an independent variable. ''Hunger'' is solely a tact of a private event resulting from food deprivation. It has no causal status.

Following up on his discussion of the transitive CEO, Michael (2000) described the different ways to weaken behavior evoked by this type of establishing operation as his fifth point. These include extinction of the conditioned reinforcer, unpairing of conditioned and unconditioned reinforcers, and undifferential availability of the reinforcer. He illustrated these processes with both an animal and a human example. Sixth, he emphasized the notion of multiple functions of stimuli by exemplifying a situation in which a stimulus, namely shock, can function as an UEO making pain reduction a reinforcer, and also as a transitive CEO, making the sight of the lever that is used to terminate the shock a valuable conditioned reinforcer. Seventh, Michael made an analogy between a demand situation in the applied setting and the warning stimulus in the cued avoidance preparation, suggesting that problem behavior may be evoked by demands functioning as reflexive CEOs.[4] Finally, he described three ways to reduce behavior evoked by these types of reflexive CEOs by giving both an avoidance and demand-escape example. One way to reduce behavior would be by omitting the warning stimulus or demand. Another way would be by continuing to present the aversive stimulus despite the avoidance response. A third way would be by terminating the demand sequence, or withholding the aversive stimulus at the offset of the warning stimulus, regardless of behavior.

In addition to clarifying the issues above, Michael (2000) concluded his paper by warning behavior analysts against ''mentalistic and cognitive interpretations of the EO phenomena … that surprisingly often slip into our own behavioral language'' (p. 409). This is often seen in the verbal behavior of untrained ''behavior analysts'' who may refer to hunger or thirst as controlling variables, rather than physiological corollaries of environmental operations.

[4] For a detailed analysis of the role of the reflexive CEO in applied settings see Carbone, Morgenstern, Zecchin-Tirri, & Kolberg (2007).

REFINED DEFINITION

Despite the widespread use of the EO concept as a descriptor of motivational variables in the behavior analytic literature, Laraway, Snycerski, Michael, and Poling (2003), identified elements of the terminology that could ''interfere with applied behavior analysts' efforts to predict, control, and understand behavior'' (p. 408). One of these issues was that not all motivating variables seemed to be described by the term EO. More specifically, the authors argued that the term implied an increase in the effectiveness of a consequence as a reinforcer, despite many motivational variables having the opposite effect (i.e., AOs). Using EO to refer to both EO and AO effects ''seems illogical and may lead behavior analysts to neglect operations with abolishing effects'' (p. 409). The authors also highlighted the fact that motivational variables not only affect reinforcers, but also punishers. So, an event that establishes a stimulus as a reinforcer, also establishes its removal as a punisher. Another issue raised by the authors was the use of evocative to suggest both a momentary increase or decrease in behavior. According to the authors, the term *abate* should be used as the antonym for evoke, as in abative and evocative effects (also see Laraway, Snycerski, Michael, & Poling, 2002).

With the aforementioned issues in mind, Laraway et al. (2003) proposed that the more comprehensive term *motivating operation* (MO) be used to refer to motivational variables. According to these authors, MOs have two defining effects: (1) *value-altering*, and (2) *behavior altering*. The first effect includes the (a) reinforcer establishing, (b) reinforcing abolishing, (c) punisher establishing, and (d) punisher abolishing effects; while the second effect includes the (a) evocative and (b) abative effects.

In a relatively recent book chapter, Michael (2007) described his new taxonomy in great detail by contrasting not only the discriminative and motivational function of stimuli, but also discussing their evocative and function-altering effects. He also introduced the new acronyms CMO-S, CMO-R, and CMO-T to refer to the surrogate, reflexive, and transitive CMOs,

respectively. Michael's (2007) chapter is probably the most complete and up-to-date description of the behavioral account of motivational variables. Despite the fairly recent change in taxonomy (from EOs to MOs), behavior analysts have had no problem adopting the new term (e.g., Call, Wacker, Ringdahl, & Boelter, 2005; Fragale, O'Reilly, Aguilar, Pierce, Lang, Sigafoos, & Lancioni, 2012; Howlett, Sidener, Progar, & Sidener, 2011).

CONCLUSION

Jack Michael's contributions to the field of behavior analysis have been many (Michael, 2004) but one of his most important is the detailed description of motivation as an independent variable in the study of behavior. Ever since his 1982 paper, behavior analysts have increasingly recognized the importance of MOs and adopted his terminology with little hesitation (although see Catania, 1993; McDevitt & Fantino, 1993; Whelan & Barnes-Holmes, 2010). It would be difficult to imagine whether applied behavior analysts would be as effective in understanding, predicting, and most importantly, changing behavior without a complete understanding of what makes people ''want'' certain things and then engage in behavior to produce those things. Thanks to Jack Michael, we do not have to imagine such a possibility.

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