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SETTING THE STAGE FOR ACADEMIC SUCCESS THROUGH ANTECEDENT INTERVENTION

ALICIA M. KRUGER, WHITNEY STRONG, EDWARD J. DALY III, MAUREEN O'CONNOR, MACKENZIE S. SOMMERHALDER, JILL HOLTZ, NICOLE WEIS, ELIZABETH J. KANE, NATALIE HOFF, AND ALLISON HEIFNER

University of Nebraska-Lincoln

Behavior-analytic academic intervention research has gained popularity among school psychologists because it offers a unique combination of robust principles of behavior and a degree of clarity and precision about functional relationships that is unparalleled in other learning paradigms. This article reviews the literature for a type of antecedent manipulation that is well established in the field of applied behavior analysis, but which has been sorely neglected in the area of academic interventions: motivating operations (MOs). The existing literature suggests two strategies in particular that can be easily combined with existing interventions—choice and indiscriminable contingencies. These strategies can increase the relative strength of reinforcing consequences for correct responses to academic tasks. This article reviews the empirical support for the variety of ways in which each strategy can be implemented and ties their effects to the functional properties of MOs. To date, attempts to bring together in a single publication the most effective strategies falling under the conceptual umbrella of MOs and articulate their implications for academic interventions are lacking. The current article explains the potential role of MOs (and the associated intervention strategies) in academic interventions and provides guidance for their use as components that can be added to academic interventions. The application of MO manipulations is illustrated in a comparison of the effects of indiscriminable contingencies with high-preference consequences on the rate of math computation fluency for two elementary school children. © 2015 Wiley Periodicals, Inc.

Behavioral assessment witnessed a sudden and rapid increase in sophistication (e.g., Nelson & Hayes, 1986) in the 1970s and 1980s, as prominent behavior analysts such as Sidney Bijou (1970) offered clear and promising visions for the application of applied behavior analysis (ABA) in schools. Conditions at this time were ripening for school psychologists to see the relevance of ABA for a new task that was beginning to awaken a new interest—developing interventions for the problems they were diagnosing. ABA's unique methodology of single-case designs with repeated measures and strategic shifts in conditions possessed a design flexibility that allowed for individual analysis of a kind that had not been previously possible.

Yet, another virtue of ABA was its inflexibility in terms of its rigorous standards for the kinds of observable and measurable constructs it used to explain why behavior occurred or did not occur (e.g., reinforcement, stimulus control). Baer, Wolf, and Risley (1968) preached the necessity of being conceptually systematic, and the field heeded their advice. There may be no other group in psychology and education that squabbles as much as behavior analysts do over the correct use of terms (e.g., negative reinforcement, motivating operations). However, the clarion call of Baer et al. caused behavior analysts to fall in line when it came to assuring that terms were precise and anchored in directly observable and manipulable phenomena. As a result, ABA offered a unique combination of robust principles of behavior and a degree of clarity and precision about functional relationships that had great appeal to some notable school psychology researchers at the time.

Some prescient researchers in the field foresaw the utility of these methods and understood that the times were changing (Dylan, 1964). Alessi (1980) made a compelling case for the critical

Correspondence to: Edward J. Daly, III, University of Nebraska-Lincoln, Educational Psychology, 33 Teachers College, Lincoln, NE 68588-0345., Email: edaly2@unl.edu

importance of behavioral assessment and taught a generation of school psychologists how to do it. Lentz and Shapiro (1986) outlined how functional assessments could be conducted for academic performance problems. Lentz (1988) illustrated how reading interventions could be generated within a behavioral framework. Chris Skinner's work (e.g., Skinner, 2002, 2008; Skinner & Shapiro, 1989; Skinner, Turco, Beatty, & Rasavage, 1989), in particular, drew a lot of attention because the interventions were simple, creative and fun, and yielded good results. These contributions provided the conceptual underpinnings of later work that would illustrate how learning trials can improve academic responding (Skinner, Fletcher, & Hennington, 1996), how school psychologists could test simple intervention ideas prior to making recommendations (Daly, Witt, Martens, & Dool, 1997), and how existing reading intervention packages could be dissected in terms of active treatment ingredients that drew on behavior-analytic principles of behavior (Daly, Lentz, & Boyer, 1996).

This approach produced a series of testable hypotheses that gave practitioners a guiding framework for trying out interventions. ABA's contributions have been most attractive to school psychologists when they were translated into user-friendly descriptions of how and when to use particular academic intervention strategies. The Instructional Hierarchy became the preferred heuristic for prioritizing academic intervention components (see the special series in the *Journal of Behavioral Education*, 2007; Ardoin & Daly, 2007). Relying on the Instructional Hierarchy and other behavioral heuristics, Daly et al. (1997) boiled the reasons for academic difficulties down to five and showed how a simple analysis could be used to make treatment recommendations. Brief Experimental Analysis also achieved popularity as a useful assessment method for creating individualized academic interventions (see the special series in the *Journal of Behavioral Education*, 2009).

Controlling Variables for Academic Performance Problems

All behavior-analytic work begins with an analysis of behavioral function prior to treatment selection. When the problem is a *behavioral excess* (e.g., aggression, classroom disruption), it can be analyzed in terms of existing controlling variables (e.g., types of reinforcement such as social attention or access to a preferred item). In the case of academic performance, however, the problem is one of a *behavior deficit*: the child does not give a correct response when presented with an instructional task. The goal of intervention is to increase behavior in appropriate contexts—curricular exercises assigned by the teacher. For a behavioral deficit the *lack* of controlling variables is what the interventionist must address. As such, the analysis of behavioral function must identify the controlling variables that *should* cause behavior to occur at appropriate levels in appropriate contexts. Intervention then is directed towards designing conditions that will establish the necessary functional relationships between behavior (academic responding) and instructional exercises. The three-term contingency (antecedent-behavior-consequence) is an excellent starting point for conceptualizing effective instruction (Heward, 1994). The instructional exercise (e.g., a math problem written on the board) is an antecedent that should evoke a response on the part of the student, which should then be followed by a reinforcing consequence or error correction. Referred to by some as a learning trial, there is compelling evidence that academic performance improves when teachers increase the number of complete learning trials (Heward, 1994; Skinner et al., 1996).

This process is described more technically as differential reinforcement. Effective use of differential reinforcement brings responding under the stimulus control of the antecedents in whose presence responding is reinforced (Catania, 2007). When consequences (presumably positive consequences for correct responses and corrective feedback for incorrect responses) are delivered frequently and consistently in the presence of the antecedent that should control responding, those antecedent stimuli (e.g., the math problems) should evoke correct responses. For the child referred because of academic difficulties, however, the problem is that the instructional antecedent does not evoke a response. Thus, a skill deficit is a stimulus-control problem: academic performance is low because student responding is not yet under the stimulus control of curricular exercises (Vargas, 1984). A further complication, however, is that reinforcement alone is unlikely to improve performance when there is a true stimulus-control problem: a correct response is unlikely to occur when the instructional antecedent (e.g., a math worksheet) is presented to the student. Even the most powerful reinforcing contingencies will fail if the desired response does not occur frequently enough. Thus, a critical element in designing an effective academic intervention is the careful selection of additional antecedent strategies that will make a response more likely when the instructional item is presented so that it can then be reinforced. Effective antecedent intervention therefore makes responding more likely to occur in the presence of the natural antecedent (e.g., the math problem) so that consequences can then be applied to strengthen the behavior and produce appropriate forms of stimulus control.

The remainder of the article will be devoted to antecedents. Indeed, the purpose of the article is to describe how one type of antecedent control in particular (invoking motivating operations) can strengthen existing academic interventions and give well-supported and readily usable strategies to accomplish this purpose. We do not wish, however, to imply by this that consequences are somehow less important or should be set aside in favor of antecedent interventions. We strongly agree with Heward (1994) and Skinner et al. (1996) that consequences are an absolutely necessary part of any academic intervention, and antecedent interventions will only be effective if they are paired with effective consequences (Miltenberger, 2012).

Using Antecedent Control for Skill Building

Discriminative Control

When antecedent manipulations are strategically deployed, they can serve to strengthen academic interventions. Without them, a correct response is highly unlikely on presentation of an instructional item at the beginning of skill acquisition. For instance, prompting strategies are added to the instructional antecedent (e.g., saying *cat* to the student when presenting the word on a flashcard or saying the first phoneme, /*k*/) to increase the likelihood of a correct response so that it can then be reinforced. An important contribution of the Instructional Hierarchy (Ardoin & Daly, 2007; Haring & Eaton, 1978) is how it can be used to guide selection of antecedent strategies as a function of a student's changing proficiency with a task as he or she is learning it.

Haring and Eaton (1978) made keen observations about how responding changes as stimulus control and eventually stimulus generalization develop and used those insights to discern how prompting strategies should change as response strength grew. Modeling and prompting are needed during initial learning trials because accurate responding is low or even nonexistent. When accurate responding improves and becomes reliable, the instructor's efforts can turn from prompting individual responses to prompting frequent practice opportunities for fluency building. Fluent responding is an indication of well-developed stimulus control. Following fluency (and with effective instruction), responding should occur reliably over time and emerge under other relevant conditions, an indication that stimulus generalization has occurred. For example, the student who recently developed fluency with math computation problems may now respond more accurately and efficiently to word problems.

Haring and Eaton's (1978) view of generalization programming harmonizes nicely with Stokes and Baer's (1977) classic breakdown of generalization strategies, most of which involve prompting a variety of responses across a variety of relevant exemplars (e.g., different problem types, different contexts, prompting use of the response in more difficult or more elaborate response repertoires). Again, although consequences are critical (and Haring & Eaton, 1978, also give useful recommendations in this regard), the point is that the instructor or interventionist is progressively shifting how salient the correct response is until the newly acquired response occurs under natural conditions (e.g., fluently reading words in a novel text, performing correct math calculations in a word problem). For more on the Instructional Hierarchy, the reader is referred to the special section in the 2007 edition of the *Journal of Behavioral Education* (Ardoin & Daly, 2007).

One might think of antecedent strategies as "stage-setting" devices. Similar to the manner in which a director sets the stage for a successful dramatic performance—by arranging props, lighting, actors, scenery, and sound effects to cue actors' responses—an instructor or interventionist uses antecedent strategies to prompt students' responses. Consider the "balcony scene" from Shakespeare's *Romeo and Juliet*, in which Romeo, love-struck yet wounded from Mercutio's taunting, stumbles into the Capulets' orchard and below Juliet's window, utters, "He jests at scars that never felt a wound," the cue for the actress playing Juliet to appear at the window. The actress steps toward the window, and a light at the window flickers. This is the cue for the actor playing Romeo to look up and utter the famed lines, "But, soft! What light through yonder window breaks? It is the east, and Juliet is the sun."

When rehearsing this scene, the director blocks the actors' movements, and the actors are guided (e.g., through the use of verbal, visual, or physical prompts) through the scene as they respond to environmental cues on stage (e.g., dialogue, a flickering light, a sound effect). Over time, prompts are withdrawn so that the natural stimulus conditions on stage evoke the actors' responses (e.g., a light appears at Juliet's window, and the actor playing Romeo looks up). Like a director, an instructor or interventionist must prompt students' responses. The effective use of antecedent interventions sets students up to succeed when they are called on to perform: the teacher should be giving clear cues to the learner about how to respond next. When effectively done, responding comes under discriminative control; that is, it is effectively governed by antecedents and the natural schedule of responding.

A critical achievement of effective instruction is transferring stimulus control from instructional prompts to the natural stimuli that should evoke accurate and fluent responses so that maintenance and generalization can occur. A well-developed technology for prompt fading and transfer of stimulus control is described in several prominent textbooks on applied behavior analysis (Cooper, Heron, & Heward, 2007; Miltenberger, 2012; Wolery, Bailey, & Sugai, 1988). Instructional approaches, such as Direct Instruction (Carnine, Silbert, Kame'enui, & Tarver, 2010) and the Morningside Model (Johnson & Layng, 1992) that grew out of the tradition of ABA, are explicitly described as being designed to maximize stimulus control and ultimately stimulus generalization.

Motivational Control

Our behavior analysis is not complete, however, if we fail to acknowledge another type of antecedent that is very relevant to academic interventions—motivating operations (MOs; Michael, 1982). A more complete account of behavioral function requires an analysis of prior antecedent conditions that affect the potency of reinforcement instead of helping the learner form appropriate discriminations about the availability of reinforcement (the job of discriminative stimuli).

MOs affect behavior by temporarily altering the reinforcing value of the consequence, making them more (establishing operations) or less (abolishing operations) reinforcing (Laraway, Syncerski, Michael, & Poling, 2003; Michael, 1982; 2004). Just like prompts, they make the behavior that precedes the putative reinforcer more or less likely to occur. For example, offering a chocolate bar to an engineering student for completing differential equations will be more effective when offered before dinner than after dinner. Deprivation and satiation are establishing operations and abolishing operations, respectively. Prior deprivation establishes a consequence as momentarily more reinforcing, whereas satiation temporarily abolishes the potency of a reinforcing consequence.

The chocolate bar may be a more powerful reinforcer if the engineering student has been deprived of food for a long period. Conversely, if the engineering student is satiated because he just finished a large dinner, the chocolate bar will be less powerful as a reinforcer for completing differential equations. In the case of the actors playing Romeo and Juliet, the presumed reinforcers are applause and appropriate emotional responses by the audience (Spoiler alert! E.g., weeping at the death scene). If we tell the actors that there is a full house and that honored dignitaries and their parents are present, they are more likely to recite their lines crisply and perform with greater enthusiasm than if we tell them that there is a single audience member or that Genghis Khan and his ruthless band are the only ones occupying the seats.

MOs are relatively simple to understand, have a very different effect on behavior than discriminative stimuli, and have been well operationalized for experimental arrangements that are highly controlled (Axe, 2013; Edrisinha, O'Reilly, Sigafoos, Lancioni, & Choi, 2011). However, to date, their application for academic interventions has not been explicitly explored in the literature. One possible reason is that existing interventions have not yet been conceptualized in terms of their MO effects.

As the remainder of this article will illustrate, effective strategies are not lacking. Rather, the field of school psychology has not yet grasped the relevance of MOs for practical application. Another possible reason is that deprivation and satiation states are constantly in flux in such complex settings as classrooms. Children in classrooms are regularly alternating between excitement about a new event (e.g., a new class pet arrives, the principal enters the room with a stern look), fatigue after work, distractions (concurrent sources of reinforcement, such as a peer flashing a shiny object), and a host of other variables that are often difficult to control (e.g., tiredness due to staying up too late at night playing video games). What was an effective reinforcer on one day wanes in its effectiveness on another day as a function of habituation or newly emerging and more novel sources of stimulation or abolishing operations. It is time, however, to acknowledge their importance and take advantage of them rather than letting uncontrolled MOs torpedo otherwise strong academic interventions.

Setting the stage for academic success can be accomplished in two ways, through discriminative control and motivational control. To date, the Instructional Hierarchy has proven useful to researchers and practitioners alike for guiding how to vary prompting methods and response opportunities as skill proficiency progresses toward mastery. It is now time to advance a framework for guiding the selection of intervention strategies that capitalize on MOs to further expand school psychologists' academic intervention repertoires. Fortunately, MO manipulations are relatively simple and easy to add to existing interventions. If prompting strategies can help 'em do it correctly, effective use of MOs will help 'em wanna do it. Choice and mystery are two strategies that can set the stage for students' best performance.

Make 'Em Wanna Do It Through Choice and Mystery

Give Choices

Giving students choices prior to task assignment is a simple, effective antecedent strategy for heading off problems before they occur and increasing desired behavior under the appropriate conditions. The literature suggests that choice may influence MOs in several different ways, depending on how it is used. Its various MO effects have practical implications for how to best arrange choices in the classroom. Choice as an intervention component can be applied to the tasks or it can be applied to the consequences delivered for completing the assigned tasks. Both strategies alter the relative reinforcing value of consequences associated with completing the task, the former more subtly and the latter more directly.

Giving Choices of Tasks. A number of studies have established the effectiveness of task choice for improving problem behavior and task engagement (Dunlap et al., 1994; Dunlap, Kern-Dunlap, Clarke, & Robbins, 1991; Dyer, Dunlap, & Winterling, 1990; Kern, Mantegna, Vorndran, Bailin, & Hilt, 2001; Kern et al., 1998; Moes, 1998; Powell & Nelson, 1997; Romaniuk et al., 2002; Shogren, Faggella-Luby, Bae, & Wehmeyer, 2004; Umbreit & Blair, 1996; Vaughn & Horner, 1997). In these studies, participants were given nonpreferred tasks, which evoke problem behavior and/or low response levels for the desired behavior. Participants were sometimes given a variety of tasks and asked to choose (e.g., Dunlap e al., 1994), or they were given a list and instructed to choose the sequence in which they did the tasks (e.g., Kern et al., 2001). One noteworthy feature of these studies on choice is that they did not compromise the integrity of the instructional exercises. The tasks were not altered in any way to reduce the difficulty level or types of tasks. The interventions simply added choice and variety, in terms of either types or sequences of tasks, making it a relatively simple intervention component to add to an existing treatment package, one that does not require the teacher to lower curricular expectations.

Research suggests that giving a choice of tasks or the sequence in which they complete tasks can make a bad situation better for the students, which may then improve their behavior. Romaniuk et al. (2002) demonstrated that choice reduced problem behavior when it was controlled by escape (a negative reinforcement contingency), but not when it was controlled by social attention. It would appear therefore that choice operates by abolishing the potency of the negative reinforcement contingency, essentially removing the reason for escaping the task, presumably by reducing the aversiveness of the task. Yet, there may be another way of looking at how variables are operating: when faced with two or more alternatives, the student may be choosing the task that produces *greater* relative reinforcement, thus establishing the potency of the positive reinforcement contingency rather than eliminating a source of aversive stimulation. Either way one looks at it, choice produces a better consequence than would be otherwise produced if there was no choice in the first place. Pragmatically, when a choice of tasks is offered, the student is likely to choose the task with greater reinforcing properties than the less-preferred tasks, again, making a bad situation better.

Furthermore, because choice is always paired with higher-preference stimuli, it may develop conditioned reinforcement properties above and beyond the effects of offering a better alternative (Fisher, Thompson, Piazza, Crosland, & Gotjen, 1997; Kern et al., 2001). Several interesting findings in the literature suggest that there may be some validity to this additive effect of choice. Dunlap et al. (1994) used the same activities given in the no-choice as those in the choice condition, making the types of tasks equivalent in this study, meaning that the only difference between the conditions was choice. Several studies have demonstrated that the choice of sequence alone can improve responding (Jolivette, Wehby, Canale, & Massey, 2001; Kern et al., 2001; Moes, 1998; Ramsey, Jolivette, Patterson, & Kennedy, 2010) When tasks are controlled for and choice improves behavior in studies such as these, it suggests that choice adds something to the contingencies above and beyond the reinforcing properties associated with the preferred task. Thus, when you offer students a choice of tasks when they would rather be doing something else, you are subtly strengthening the contingencies for performance.

Simple alterations to the task, such as interspersing easy items, may make task choices more appealing and thus more effective. Cates and Skinner (2000) found that more students chose longer assignments containing interspersed items than shorter assignments containing only harder problems. Interspersal has also been shown to decrease off-task behavior (McCurdy, Skinner, Grantham, Watson, & Hindman, 2001), improve on-task behavior and academic engagement (Dunlap et al., 1991), and increase task completion and accuracy (McDonald & Ardoin, 2007; Rhymer & Morgan, 2005). Interspersing less difficult problems with regular instructional items may affect behavior in one of two ways. On one hand, if completing an easy task functions as a conditioned reinforcer, the longer task results in more reinforcement (Skinner, 2002). On the other hand, easier items interspersed among harder items may make the task less aversive. Either way, it is remarkable that, when given the option, many students choose a longer assignment with more problems than a shorter assignment with fewer problems. An additional benefit may be additional maintenance practice with easier problem types. The altered assignment appears to offer a more potent ratio schedule of reinforcement, which may compete more effectively with alternative sources of reinforcement for off-task behavior.

Task choice has yet another effect on the instructional context. It allows students to control how conditions are altered across sessions, resulting in more variation from session to session. Therefore, it may also reduce the risk of satiation with reinforcing consequences (Umbreit & Blair, 1996; Vaughn & Horner, 1997). Whatever the actual mechanisms are that make task choice work in a given situation, the moral of the story is that giving students a choice of tasks or even just the sequence in which they complete assigned tasks allows them to vary and arrange the instructional context in a way that may be less aversive and is probably more reinforcing for one reason or another, making assignment completion more likely than it would be if choice had not been offered. Therefore, task choice may be a useful way to improve an academic intervention when the student makes it apparent that he or she does not want to do the task.

Giving Choices of Consequences. Another way to use choice as an antecedent strategy is to target the programmed contingencies directly. This is done by offering the student a choice of contingent consequence prior to assigning the task. Systematically assessing potential reinforcers through a preference assessment will allow you to identify high-preference (HP) items that can be used as consequences for work completion or task engagement. The Multiple Stimulus Without Replacement (MSWO) method has been shown to be suitable and effective for use in schools (Daly et al., 2009). Providing students with a choice of reinforcer prior to assigning the task has been shown to increase assignment completion and accuracy (Cosden, Gannon, & Harding, 1995; Schmidt, Hanley, & Layer, 2009; Tiger, Hanley, & Hernandez, 2006). Giving students this choice immediately before an instructional task allows them to choose the most potent available reinforcer at that particular moment. Choice is effective mostly because it reflects preference (Fisher et al., 1997; Killu, Clare, & Im, 1999). Fisher et al. (1997) found that when preference level was controlled for, participants always favored choice. However, when they pitted choice against preference by comparing choice of low-preference (LP) items to no choice of HP items, preference always resulted in higher levels of responding. Killu et al. (1999) found that students had higher levels of task engagement on HP tasks regardless of whether or not they were given a choice of tasks. Although choice can make a bad situation better by increasing engagement during aversive tasks, it is still limited by student preference, because students are more likely to have higher levels of desired responding when given contingent access to HP stimuli than when they are given a choice between LP stimuli.

Preferences change over time, even on a moment-to-moment basis and often as a function of prior exposure to a reinforcer. Giving students a choice of reinforcer accounts for momentary fluctuations in motivational levels by increasing the likelihood that the chosen reinforcer will compete effectively with other concurrently available reinforcers (e.g., stimulation from playing with objects at their desk, peer attention) for undesired behavior (e.g., off-task, disruptions; Edrisinha et al., 2011; Kern et al., 2001; O'Reilly, Edrisinha, Sigafoos, Lancioni, & Andrews, 2006). In other words, allowing students to choose their reinforcer from a menu of preferred consequences prior to task assignment can minimize potential satiation effects (if the student has recently had abundant exposure to that consequence) and maximize potential deprivation effects (if the student has recently had limited exposure to that consequence). For example, a student who has just returned from recess may be less inclined to choose peer attention as a reward because of a possible satiation effect; similarly, a student who has not yet gone to lunch may be more inclined to choose an edible as a reward because of a possible deprivation effect.

When effective, choice, whether it be of the task or of the consequence associated with completing the task, increases the potency of reinforcement by altering existing reinforcement schedules, introducing variety across sessions, and accounting for momentary fluctuations in motivational levels. It is particularly appropriate when academic tasks appear to evoke escape-motivated behavior. Adding choice of task, choice of consequences, or both to an existing academic intervention may help you to get the most out of the consequences you plan to use for your academic intervention.

Add Mystery!

Behavior analysts work hard to make contingencies clear, knowing that, unless the learner discriminates contingencies correctly, responding may not increase or may come under the influence of the wrong stimuli, creating a different type of stimulus-control problem. Programmed consequences will not have their intended effect if their availability is not appropriately signaled to the learner from the very outset. Instructions, reminders, and cues are used to make it clear what will happen if the student completes the work correctly and completely. Many a behavior analyst has indulged his or her creative fancy by designing a colorful chart as a visual representation and proudly displayed it before the student while explaining what will happen if responding is more complete, accurate, and/or faster. These steps are absolutely critical at the beginning of an intervention plan. We want to motivate students—especially those who have had limited success to date with instructional tasks—by presenting them with a clear and enticing picture of how they can access a preferred activity or item if they meet the reinforcement criterion. As noted earlier, if the contingency is benefiting from a current deprivation state (e.g., the student has not had recent access to the computer and is "dying" to play her favorite game), we have a good shot at increasing responding if all of the other necessary components (e.g., prompts) are in place.

With this in mind, we fully recognize that our next recommendation may make you feel like a traitor to your finely honed professional repertoires. However, we think that there is good reason to believe that motivation can be improved by strategically making the contingencies unclear.

Stokes and Baer (1977) describe a generalization strategy—indiscriminable contingencies (IC)—that purposefully makes it difficult for individuals to discriminate when reinforcement is available or unavailable. Doing so makes reinforcement unpredictable. The lack of predictability creates an intermittent schedule of reinforcement, which makes behavior more resistant to extinction and facilitates generalization across conditions. Freeland and Noell (2002) provide a nice illustration of this strategy when they used common stimuli (color of worksheets) to maintain responding to math computation problems at high levels while they progressively thinned the reinforcement schedule. Freeland and Noell established a reinforcement effect for completing math problems with two third-grade girls under a fixed-ratio schedule of reinforcement using worksheets that differed in color between baseline and reinforcement conditions. They then implemented delay conditions in a sequential manner, first requiring a doubling and then a quadrupling of responding before reinforcement was delivered. In the delay conditions, they used common-colored worksheets as they increased response requirements over phases. They found that responding was maintained at high levels and at progressively thinner schedules of reinforcement when commonly colored worksheets were used (delay conditions), but dropped when a different color of worksheet (baseline) was used. Thus, Freeland and Noell purposefully made the reinforcement contingencies unclear to achieve response maintenance levels that were even higher than under reinforcement conditions. As a generalization strategy, the use of IC does require a prior reinforcement effect, as Freeland and

Noell demonstrated. This strategy will probably not work without prior contact with reinforcement contingencies; hence, the necessity of clearly signaling the availability of reinforcement and the use of potent consequences at the beginning of the intervention process.

A variation of this strategy has been investigated in the literature under the name of the "Mystery Motivator" (MM) intervention. With MM, it is usually the consequence itself that goes unnamed prior to a task demand, but the interventionist signals that something positive will happen if behavior changes in the desired direction. MM adds an element of intrigue to the reinforcement contingencies. The efficacy of MMs has been demonstrated in a number of studies with various populations, including students diagnosed with emotional disturbance (Kehle, Bray, Theodore, Jenson, & Clark, 2000; Theodore, Bray, & Kehle, 2004), Head Start preschoolers (Murphy, Theodore, Aloiso, Alric-Edwards, & Hughes, 2007), elementary school students (Kelshaw-Levering, Sterling-Turner, Henry, & Skinner, 2000; Kowalewicz & Coffee, 2014; Madaus, Kehle, Madaus, & Bray, 2003), and high school students (Schanding & Sterling-Turner, 2010). It has been used to reduce off-task and disruptive behavior (Kehle et al., 2000; Murphy et al., 2007) and to improve homework completion (Madaus et al., 2003; Moore, Waguespack, Wickstrom, Witt, & Gaydos, 1994). Kelshaw-Levering et al. (2000) used MM as an effective classwide intervention to improve compliance with classroom rules (e.g., staying in the seat, listening to the teacher, and being quiet unless given permission to talk). Students were first informed of the behaviors and required criterion levels for reinforcement, while the prize remained a mystery. Subsequently, the teacher randomized all features of the classwide intervention, including which behavior was targeted, which student was responsible, and the criterion for reinforcement. The classwide MM resulted in significantly reduced problem behavior. Classwide application of MM has at least a couple of advantages (Kelshaw-Levering et al., 2000; Murphy et al., 2007). First, it avoids disputes among students about which consequence the group will work for, while bringing everyone's responding under the contingency in the hopes of obtaining a prized reward. Second, students are less likely to sabotage a contingency than when a previously chosen reward is not personally reinforcing.

The key to effective use of MM is combining concealment (the specific consequence or the occasion on which it will be awarded) while making the availability of reinforcement explicit. Thus, although MM's effectiveness relies heavily on the use of effective consequences, MM adds an antecedent element that is not found in typical differential reinforcement procedures. In some studies, experimenters placed a written description of the consequence in an envelope or box stamped with a question mark and publically displayed the envelope or box while the students worked on the task, thereby shrouding it in mystery while making it clear that something good would happen if the criterion was met (Kehle et al., 2000). In other studies, experimenters displayed a jar full of slips of paper describing reinforcers that were randomly selected after students met their goal (Kelshaw-Levering et al., 2000; Kowalewicz & Coffee, 2014). Finally, in some studies, experimenters used MM to establish a variable schedule of reinforcement by secretly marking a calendar on random days to indicate that reinforcement was available, and then requiring students to meet the performance criterion before revealing whether reinforcement was available that day (Madaus et al., 2003; Moore et al., 1994). In this case, the calendar was on display, but the specific dates were kept hidden until students finished working on the task.

Stokes and Baer (1977) discussed IC as a means of shifting to intermittent reinforcement schedules (just as Freeland & Noell, 2002, did), which produce strong and enduring behavioral effects over time (Cooper et al., 2007). However, they appear to have an MO effect as well. All reinforcement effects occur as a result of a necessary prior deprivation state. When IC (MM) is used, the range of possible but unspecified consequences (signaled prior to the task demand) appears to establish the potency of reinforcers. Given the range of possible but unspecified consequences (which should be signaled prior to the task demands and cloaked in mystery), the learner now has a probabilistic chance of obtaining a reinforcer for which he or she is currently in a deprivation state, thus establishing the potency of reinforcement. The strategy is competing with other available reinforcement contingencies for things such as off-task and disruptive behavior. Therefore, just as with choice, preference is critical to its success. However, because specific preferences shift from moment to moment, for MM to work effectively, the learner must be in a deprivation state relative to at least one or more of the possible consequences. For skill repertoires such as reading, math, and writing, IC can be used to maintain productive practice with the instructional task and therefore bring responding under tighter stimulus control over time. Basically, it maintains exposure to the instructional task and thus may be effective for building accuracy, fluency, and generalization when the other necessary components (e.g., prompting, consequences for responding) are in place.

Choice, Mystery, and Preference: A Powerful Combination

Although MM has been investigated in a number of studies, to date, as far as we can tell, it has not been compared in the literature with more direct contingency manipulations, such as the use of explicitly chosen HP consequences. Therefore, we conducted an analysis with two second-grade students (Liz and Rob) referred for low academic performance in which an IC condition (essentially MM) was compared with an HP condition to determine whether IC could even compete with clearly established consequences for responding using HP activities.

In each session, students were given worksheets containing approximately 72 single-skills problems and 5 min to complete as many or as few problems as they wanted. Liz was given single-digit addition problems and Rob was given two-digit by two-digit addition problems (with no regrouping). Results were scored as correct digits per 5 min. (interobserver agreement (IOA) was 100% between scorers, for a random sample of 30% of the sessions.) Prior to experimental sessions, an MSWO preference assessment (Daly et al., 2009) was conducted to identify HP and LP items that would be used subsequently as consequences for meeting performance criteria (e.g., journaling, playing outside, playing board games). Baseline sessions with no programmed contingencies were conducted first (five for Liz and 10 for Rob). The results appear in Figure 1. During baseline, Liz had a slight increasing trend, and Rob's results were somewhat variable, with no apparent overall trend.

To make a valid comparison between IC and an HP condition, it was first necessary to establish that HP was truly high preference. This was done by pitting contingencies against one another using a concurrent-operants arrangement. With this design, different response options are offered, each of which is correlated with a different consequence. One can then examine both the choice of condition and behavior levels associated with each condition. Thus, in individual sessions the students were presented with multiple stacks of worksheets, with each stack associated with a particular consequence. There were four contingencies in all. There was a "Do Nothing" contingency, which was offered as a choice to control for possible negative reinforcement effects. Without this condition, it would be impossible to tell whether students increased responding to obtain a positively reinforcing consequence or simply to terminate the condition. In the LP contingency, the consequence offered was an LP item from the preference assessment. In the HP contingency, the consequence offered was an HP item from the preference assessment. In the IC contingency, the student was told that the consequence was written on an index card in a sealed envelope, which was shown to the student and would be revealed at the end of the session. The item had been randomly selected from the results of the MSWO assessment, including both HP and LP activities.

Two or more contingencies were offered in every session in all phases as a part of the concurrent-operants arrangement. The contingencies offered depended on the purpose of the phase (explained later). At the beginning of each session, the student was told that he or she could do as many

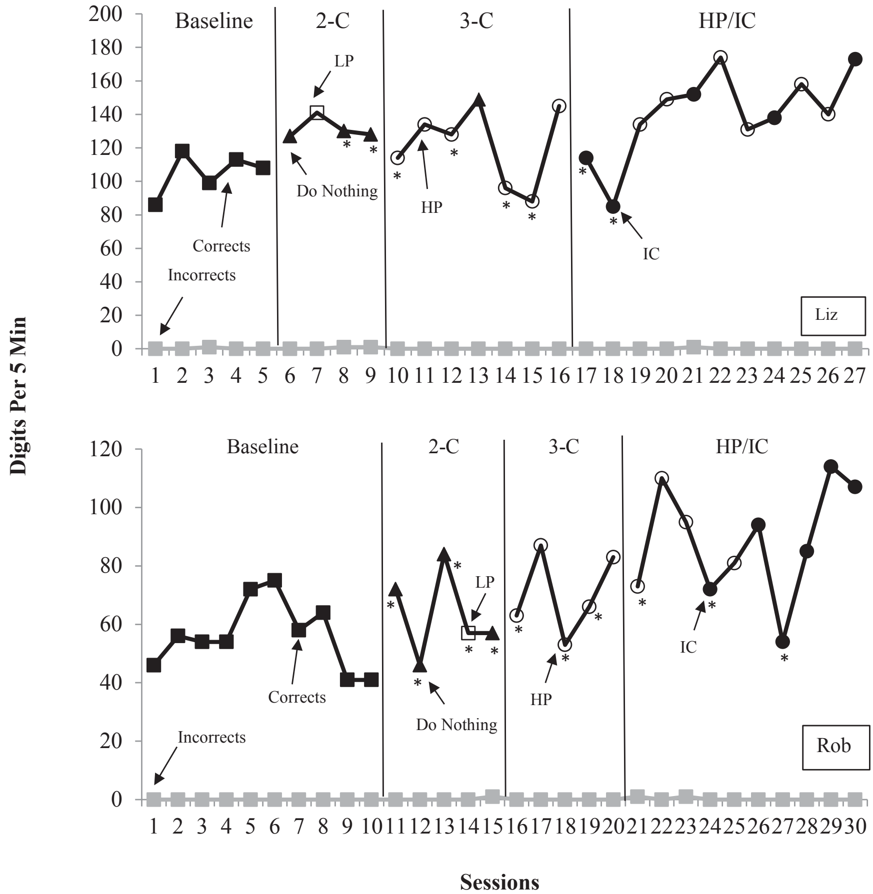

FIGURE 1. The number of correctly and incorrectly completed digits per 5 min for both participants. 2-C = two-choice phase; 3-C = three-choice phase; LP = low preference; HP = high preference; IC = indiscriminable contingencies. An asterisk (*) next to a data point indicates that the student did not meet the reinforcement criterion for the session.

problems as he or she wanted (condition protocols available from the corresponding author on request). Separate stacks of math worksheets (each associated with a different contingency) were placed before the student, who was informed that he or she could work on either stack of worksheets, but would receive the chosen consequence for the condition in which the most problems were completed. Criteria were established based on baseline levels of performance. Varying criteria were applied across sessions. Reinforcement criteria were selected within a range from +1.5 to +2.0 standard deviations above each student's baseline average.

For both students, the criterion for reinforcement varied randomly across experimental sessions. Prior to an experimental session, the experimenter randomly selected one performance criterion number for that session and placed it in a sealed envelope. Thus, the student did not know the criterion for earning the reward before working on math problems. At the end of each session, the experimenter counted the number of correct digits completed for the stack with the greatest number of problems completed, revealed the performance criterion and compared it with the student's score, and either withheld reinforcement (if the goal was not met) or allowed access to the chosen consequence. Impartial observers listened to audio recordings of a random sample of 30% of the sessions using condition-specific protocols and found that the average percentage of steps correctly followed was 93% (*SD* = 14.17).

Initially, two separate phases were conducted—a two-choice phase and a three-choice phase—to examine whether HP was superior to LP and Do Nothing as a contingent consequence. In the two-choice phase, the students were offered the choice of either “doing nothing” or an LP activity as a consequence for completing math problems. The results in Figure 1 indicate that both students preferred the Do-Nothing condition, meaning that LP functioned as an ineffective contingency, as one would expect. In the three-choice phase, a third stack of worksheets was placed in front of the student. This stack was associated with an HP item, which varied in every session. Otherwise, all of the conditions were the same as the two-choice phase. The results in Figure 1 show that Liz chose HP in six of the seven sessions and that Rob chose HP in all five sessions, indicating that HP appeared to operate effectively as an HP condition. It appeared at this point that HP was producing a reinforcement effect

The pertinent experimental phase comparing IC with HP was then conducted. In this phase (labeled “HP/IC” in Figure 1), the students had two stacks of worksheets placed before them. Each worksheet was associated with a different consequence, either HP or IC. Again, the criterion for performance was concealed. As in the other phases, students were given 5 min to work on whichever problems they wanted. If the chosen consequence was IC, the experimenter opened the envelope to reveal what was written on the index card. The results appear in Figure 1.

Both students switched between consequences across sessions, almost equally. Liz chose HP only once more than she chose IC. Rob chose IC two more times than he chose HP. What is particularly noteworthy about these findings is that “not knowing” the consequence competed well with a condition in which the students knew exactly what the consequence would be, using consequences for which the students had previously shown a strong preference. Liz alternated between choices, whereas Rob, after showing an initial preference for HP, allocated all of his responding to IC in the last five sessions. It is also noteworthy that, whereas performance had not increased much in the prior phases, both students showed elevated levels of responding by the end of the experimental analysis.

During baseline, Liz completed, on average, 105 correct digits per 5 min (*SD* = 12.64). During the last 4 sessions of the HP/IC comparison, she completed, on average, 152 correct digits per 5 min (*SD* = 16.5), representing an increase of 1.5 times in responding. During baseline, Rob completed, on average, 56 correct digits per 5 min (*SD* = 11.75). During the last four sessions of the HP/IC comparison, he completed 90 correct digits per 5 min (*SD* = 27), representing almost a doubling of responding. The reason for the increases is probably not because of the consequences per se, but rather, the repeated practice over time under appropriate motivating conditions, leading them to become progressively more fluent as the analysis proceeded. These results illustrate what one would expect when conditions favorable to establishing a consequence as more reinforcing are added to an intervention program.

This analysis demonstrates that under some conditions, mystery motivates. In other words, concealing the consequence and/or the criterion for performance is sometimes at least as effective and in some situations may be preferable to “knowing” the consequence ahead of time. Because concealing the consequence is an antecedent to behavior, it must invoke MOs, and we suspect that it has to do with having a probabilistic chance of receiving a consequence that might alleviate a deprivation state. The “not knowing” leads the individual to take a chance to obtain a favorable outcome.

The experimenters who conducted the sessions noted anecdotally that the students appeared to appraise the HP item that was offered and, if it did not look particularly appealing, chose the IC condition. If this is true, it means that IC’s effects in this analysis were at least partially a function of concurrently available sources of reinforcement. Of course, this would be true in any situation. However, this experimental analysis made one item in particular very salient (whatever the HP item was for that day). Further research is needed on the potential effectiveness of IC (MM) under other conditions. However, the current results suggest that adding mystery and intrigue may further enhance reinforcement effects when used in combination with preferred consequences and choice, even performing well when an HP consequence is concurrently available. The current results would probably not have been obtained if the students had not been previously exposed to HP consequences and given choices in all but the baseline phase. Therefore, no claim is made to have isolated IC effects; all reinforcement effects are relative, and that is no less true in these analyses. However, they do point to how choice and mystery can be used to set the stage for improving academic performance.

Conclusion

With academic interventions, all one can do is to try to maximize response rates. There is no way to "make" a student learn. By making 'em get it right more often, however, the chances of improving academic skills increases substantially. This article examined two strategies (and variations of each) that may make 'em wanna get it right. Use of choice and mystery can set the stage for maximizing the student's effort during academic intervention sessions. They work by increasing the potency of existing reinforcement contingencies for desired responding. Thus, they should be seen as strategies that can be added to existing intervention plans. In this paper, we sought to show how simple these evidence-based interventions are for application while pointing to a potentially productive line of future research for those of us committed to research on principles of behavior. Questions abound regarding questions such as how MOs interact with discriminative-control tactics (e.g., prompting) for skilled behaviors like reading, math, and writing, and how such antecedent strategies might be used even more effectively under natural classroom conditions.

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