Manipulating Motivating Operations Within and Across Classes of Reinforcers: Are There Differential Effects?

DISSERTATION

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By

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Abstract

The purpose of this investigation was to examine the evocative- and abative-effects of a functionally defined motivating operation (MO) on the frequency of a target behavior maintained by primary, conditioned, and token reinforcers. Furthermore, this investigation sought to determine if the classes of reinforcers were differentially influenced by MOs. A comprehensive literature review and an empirical study were conducted to address the aforementioned research questions.

An electronic search of the literature on MOs yielded 25 articles that met all of the inclusionary criteria. Articles were evaluated using an 11-item matrix. The effects of MOs were examined within and across the reinforcer classes. Serious procedural limitations were found in a majority of the articles. About one-third of the MO manipulations for primary and conditioned reinforcers produced positive results. The total number of MO manipulations for token reinforcers were too few to meaningfully compare the relative effectiveness. The results of the literature review were inconclusive with respect to documenting differential effects of an MO. The implications of these findings as well as guidelines for future research are discussed.

The interaction effects between MO and reinforcer class were evaluated using a superordinate multielement design with an initial baseline. Two teens with developmental
disabilities and one typically developing young child participated in this study.

Reinforcers were delivered according to a progressive ratio schedule of reinforcement. The results suggest that the effectiveness of each reinforcer class was influenced by changes in motivation. Furthermore, differential effects were evident for two of the three participants. These results are discussed as they relate to the advancement of MO theory, implications for practice, and directions for future research.
Dedication

This paper is dedicated to the shoulders upon which I stand and the hand that has sustained me throughout this endeavor. Thank you.
Acknowledgments

As a product of my experiences, I owe much to those who shaped my behavior. To Helen Hendy, who introduced me to behavior analysis, you started me down this path. If not for you, I may have ended up selling office equipment (not that there is anything wrong with that of course). To Kimberly Shcreck and Richard Foxx, my behavioral parents, you developed in me a love for this science as well as the tools necessary to affect meaningful change. You taught me how to be an applied behavior analyst.

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To my lab-mates, James and Neal, a doctoral student could not ask for better colleagues. For the last 2 years, I spent more time with you two than my wife. Thank you for your help. You are great friends.
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In Aesop’s fable, “The Fox and the Lion”, the first time the fox encounters the lion, the fox runs away and hides in the woods. During the second encounter, the fox musters the courage to briefly look upon the lion. Finally, at the third encounter, the fox approaches the lion, salutes him, and begins to converse with him. The fox then departs unceremoniously. The moral of this fable is “familiarity breeds contempt” (Aesop, p. 57, trans. 1866).

A behavioral interpretation of the fox’s behavior could go as follows: Sight of the lion initially alters the momentary value of being hidden, simultaneously increasing behavior related to that outcome. However, after repeated exposure to the lion, the value of being hidden diminishes because the fox sees that the lion does not give chase. By the end of the fable, the motivational value of the lion to establish being hidden as an effective consequence and evoke a flight response is non-existent. Thus, in colloquial terms, familiarity (or repeated exposure) can decrease the motivational value of certain stimulus events.

Early concepts of motivation, such as the fable above, pre-date the scientific study of behavior. Keller and Schoenfeld (1950), referring to these early concepts, noted that
“many historical observations of human and animal behavior have contained elements of
great accuracy and faithfulness to nature” (p. 274). In other words, Aesop’s fable clearly
illustrates basic axioms of motivation. Such observations have withstood the test of time
and, in the case of motivation, the test of experimental analysis. Similar observations of
human and animal behavior have led to a number of important discoveries, such as
Pavlov’s description and subsequent study of respondent conditioning.

The ballad “The Isle of Beauty” provides another historical observation that is
relevant to the study of motivation. In this ballad, Bayly (1844) writes, “Absence makes
the heart grow fonder” (p. 43). In behavioral terms, this means that a preferred stimulus
event increases in value when access is restricted below the level typically available.
Attention from a loved one, for example, would increase in value if contact to that event
was withheld. As the value of attention from the loved one increases behavior related to
that outcome also increases. Therefore, someone who misses a loved one is more likely to
call that person on the telephone or write a letter. It appears to be commonsense that
exposure to a stimulus, or lack thereof, could alter the motivational value of different
events as well as behavior related to contacting those events. There are numerous words
within the English language that are used to verbalize this relation (e.g., yearn, pine,
stuffed, and gorged). In this respect, motivation is a part of the everyday vernacular.

The abovementioned quotes by Aesop and Bayly describe the layperson’s
understanding of the ebb and flow of motivation. Although these quotes possess grains of
truth, they are inadequate descriptions of motivation from the perspective of the behavior
analyst. The scientific analysis of behavior requires a more complete understanding of
motivation and must therefore move beyond a commonsense understanding, to a scientific understanding. Aesop and Bayly described environmental-behavioral relations that, despite their importance, have only recently undergone thorough analysis. To best understand the contemporary analysis of motivation, a brief examination of the history of this concept is warranted.

**Historical Conceptualization of Motivation by Behavior Analysts**

Most seminal behavior analytic texts included chapters related to the topic of motivation. Although these early predecessors of the contemporary analysis of motivation were limited, they provided the foundation for later work that would ultimately result in a working technology of motivation. Two of these seminal works are described below.

In *Principles of Psychology*, Keller and Schoenfeld (1950) outlined a system of motivation in which environmental events, called *drives*, evoke behaviors that have successfully produced reinforcers corresponding to that drive in the past. The *hunger drive*, one of the drives identified by the authors, provides a good example of this concept in practice. As the degree of food deprivation increases, expressed in terms of the passage of time, so too does behavior that has resulted in contact with food. According to this system, there is a direct relation between the drive level and the current frequency of behavior. Therefore, high levels of deprivation will result in an increase in behavior that has produced food in the past, whereas low levels of deprivation will result in a decrease of behavior that has produced food in the past.
Another early account of motivation was detailed by Skinner (1953) in *Science and Human Behavior*. According to Skinner, the behavior altering property of a reinforcing stimulus is in constant flux. Skinner developed a *deprivation-satiation* framework of motivation. According to this framework, a stimulus will function as a reinforcer only if there is a sufficient level of deprivation to establish its value. On the other hand, if there is little to no deprivation from the stimulus it will not function as a reinforcer. This latter condition describes the concept of satiation. Thus, the effectiveness of a given stimulus to act as a reinforcer oscillates as a function of varying degrees of deprivation and satiation. When applied to hunger, the deprivation-satiation framework results in an analysis similar to Keller and Shoenfeld’s (1950) system of drives. Both theories of motivation predict an increase in behavior. However, in contrast to the drive model, the deprivation-satiation framework emphasizes the transient nature of consequent stimuli. An organism that has been deprived of food will likely engage in behavior that has produced food in the past and the acquisition of food is likely to function as a reinforcer. Conversely, food is not likely to function as a reinforcer after an organism has just eaten a large quantity. As a result, behavior that has produced food in the past is not likely to occur.

These models offer behavior analysts a more thorough account of motivation than was provided by either Aesop or Bayly. However, there are a number of limitations that make these models fall short of a working theory of motivation. First, motivation is conceptualized as acting solely on stimuli necessary for survival (i.e., primary reinforcers). According to Skinner (1953), behavior that “has been strengthened by a
conditioned reinforcer varies with the deprivation appropriate to the primary reinforcer” (p. 150). Although this may be true of some behavior, it is certainly not true for all behavior. There are numerous examples of conditioned reinforcers that function independent of the motivation for primary reinforcers and/or vary according to their own level of motivation. Video games, for example, act as a powerful conditioned reinforcer for many individuals. However, the effectiveness of video games as a reinforcer is only loosely related, if at all, to the motivation for some primary reinforcer. Restricting motivation to acting on only primary reinforcers is problematic to a technology of motivation.

Second, these theories account for motivation only as it relates to the passage of time. Time can have a profound impact on motivation, as in the passage of time since last eating. However, this is not the only variable that can influence motivation. For example, eating salty foods can establish water as a reinforcer. In this case, the motivation for water is not determined by time, but rather by the ingestion of sodium chloride. These theories do not fully account for this type of motivation. It would be inaccurate and misleading to say that ingestion of sodium chloride created a deprivation of water or a thirst drive. This particular limitation becomes even more pronounced when examining the motivation for conditioned reinforcers. For example, escape from task demands has been shown to function as a powerful conditioned reinforcer (Iwata et al., 1994). However, the presentation of a task demand does not create a deprivation of escape or an escape drive. Rather, the presence of the task establishes escape as a reinforcer.
Despite the limitations of Keller and Schoenfeld’s (1950) system of drives and Skinner’s (1953) deprivation-satiation model of motivation, these works set the stage for what has proven to be an empirically supported description of motivation.

**Contemporary Analysis of Motivation**

Although motivation was recognized as an important variable by behavior analysts, it did not receive much attention in the three decades following the writings mentioned above. Recently, however, interest in the effects of motivation has re-emerged. The *Journal of Applied Behavior Analysis* in 2009 published seven studies related to the topic of motivation, compared to four studies in 1999 and zero studies in 1989.

This renewed interest in motivation is due in large part to the conceptual framework established by Michael (1982; 1993; 2000), which was later revised by Laraway, Snycerski, Michael, and Poling (2003). According to this model, motivating operations (MOs) are a class of antecedent stimuli or events that (a) momentarily alter the value of consequent events and (b) simultaneously alter some dimension of the response class (hereafter *frequency*) related to those consequences (Laraway et al., 2003). Inherent in this concept is the bi-directional nature of consequent stimuli to function as reinforcers or punishers.

For example, attention from an adult can function as a reinforcer when an adolescent’s peers are not present. In this situation the adolescent would be more likely to engage in behavior that has produced attention in the past. However, when peers are present, the same attention can function as a punisher. In this situation, the adolescent is
not likely to engage in behavior that has produced attention in the past. Thus, the presence or absence of the peers can act as an MO that alters the value of attention and the frequency of behaviors related to attention.

The value of all consequence stimuli fall somewhere within the spectrum of reinforcer, neutral event, or punisher. It has been theorized that MOs are the mechanism by which the value and effectiveness of consequences is altered (Michael, 1993; 2000; 2007). This paper will focus exclusively on MOs as they relate to reinforcers and behaviors maintained by reinforcement. Although the relation between MOs and punishers is an important one, it is beyond the scope of this investigation.

**Three-Classes of Reinforcers**

Reinforcers can be categorized into three distinct classes (Cooper, Heron, & Heward, 2007; Mazur, 2002). The first class, called *primary reinforcers*, refers to stimuli that increase the future probability of behavior without requiring any previous learning experience. Stimuli such as food, water, and warmth fall into this reinforcer class. Primary reinforcers are associated with biological needs, and are therefore necessary for survival (Mazur, 2002).

The second class, called *conditioned reinforcers*, refers to stimuli that have acquired reinforcing properties through pairing with other reinforcers. Conditioned reinforcers originate from an organism’s interaction with the environment. A picture of a loved one, for example, can be conditioned to function as a reinforcer through pairing the stimulus with other, already established reinforcers (e.g., thoughts of the loved one). Although there may be some commonalities among stimuli that function as conditioned
reinforcers within a given species (e.g., attention is a ubiquitous conditioned reinforcer), this class of stimuli is highly idiosyncratic.

The third class, called token reinforcers, refers to stimuli that have acquired reinforcing properties through the act of exchange with other reinforcers (hereafter back-up reinforcers). Money, for example, can be exchanged for many different goods and services. Tokens represent a special type of conditioned reinforcer. The process of exchange differentiates token reinforcers from conditioned reinforcers.

The value of a token reinforcer is primarily determined by three factors. The first factor is the value of the token itself. In most token reinforcement systems, the inherent value of the token is negligible. Wolfe (1936) and Cowles (1937), for example, evaluated the effectiveness of tokens with and without back-up reinforcers. Chimpanzees were initially trained to exchange tokens for primary reinforcers. In a subsequent condition, the chimpanzees were given different tokens that when exchanged produced no back-up reinforcers. During test conditions, the chimpanzees showed exclusive preference for tokens that produced back-up reinforcers. Furthermore, when given the tokens that produced no back-up reinforcers, the chimpanzees did not attempt to exchange the tokens. The results of these studies suggest that the tokens had little to no reinforcing value.

The second factor is the value of the back-up reinforcers that can be accessed through token exchange. Contact with the back-up reinforcers conditions the value of the token. In this respect, high value back-up reinforcers will result in a high value token. Moher, Gould, Hegg, and Mahoney (2008), for example, paired a token to a high- and
low-preferred primary reinforcer. During a test condition, in which tokens were delivered contingent upon hand-raising, all of the participants raised their hands more when the token associated with the high-preferred reinforcer was available. The value of the token was shown to fluctuate as a function of the value of the back-up reinforcers.

The third factor is related to the number of back-up reinforcers. The number of reinforcing stimuli available as back-up reinforcers will vary according to the scope of the token economy. For example, the token economy in Fox, Hopkins, and Anger (1987) contained hundreds of back-up reinforcers, whereas the token economy in Malagodi (1967) included a single back-up reinforcer. The momentary effectiveness of any consequence to function as a reinforcer is dependent, at least in part, on the current level of motivation as it relates to that stimulus. In this respect, a token that has been paired to a wide range of back-up reinforcers is more likely to be effective, despite changes in motivation for the back-up reinforcers (Catania, 1998; Cooper et al., 2007; Skinner, 1953). However, the exact nature of the relationship between the number of back-up reinforcers and token effectiveness is not fully understood at this time (Hackenberg, 2009).

**Characteristics of Motivating Operations**

With regard to the effectiveness of reinforcing stimuli and the behavior maintained by those stimuli, MOs have two primary characteristics (Laraway, et al., 2003). The first characteristic, termed the *value-altering effect*, refers to the momentary change in the effectiveness of a consequent event to function as a reinforcer. This change is bi-directional; it can either increase or decrease the reinforcing value of a stimulus. The
reinforcer-establishing effect increases the effectiveness of a stimulus to function as a reinforcer, whereas the reinforcer-abolishing effect decreases the effectiveness of a stimulus to function as a reinforcer. For example, the value of an electrical outlet is established as an effective reinforcer for a graduate student when his/her computer is running low on battery. Once the computer is plugged in and completely charged, the value of the electrical outlet is abolished.

The second characteristic, termed the behavior-altering effect, refers to the change in some dimension (e.g., frequency or intensity) of the response class associated with a given consequent event. This change is not the result of contact with the consequence. Rather, it is an independent effect of the MO (Michael, 1993). A stimulus change that results in an increase in the frequency of behavior is referred to as the evocative-effect, whereas a stimulus change that results in a decrease in the frequency of behavior is referred to as the abative-effect. Building off the previous example, running low on computer battery is likely to have an evocative-effect on behaviors that have resulted in contact with an electrical outlet in the past (e.g., searching for an outlet, moving towards the outlet, and plugging the computer into the outlet). Furthermore, having plugged the computer into an outlet is likely to have an abative-effect on the behaviors of the graduate student related to finding a power source.

**Establishing and Abolishing Operations**

When the value- and behavior-altering characteristics of MOs are combined, two distinct classes of antecedent events become clear. The first class of antecedents, called establishing operations (EO), describes environmental events that have a reinforcer-
establishing and an evocative-effect. That is to say, these events both increase the effectiveness of a stimulus as a reinforcer and increase some dimension of behavior related to that stimuli. For example, being faced with a particularly difficult math problem can act as an EO for assistance from a skilled mathematician. The difficult math problem will establish help as an effective reinforcer. Behaviors, such as hand-raising, that have resulted in assistance in the past will simultaneously be evoked.

The second class of antecedents, called *abolishing operations* (AO) describes environmental events that have a reinforcer-abolishing and abative-effect. In other words, this class of stimuli or events decreases both the effectiveness of a stimulus to act as a reinforcer and some dimension of behavior related to that stimulus. For example, interacting with colleagues at a social event for several hours can act as an AO for attention. Behaviors that have resulted in attention from colleagues in the past, such as making a joke, will simultaneously be abated.

It is worth noting that the value- and behavior-altering effects of these antecedent events are temporary (Michael, 2007). MOs do not alter the future frequency of a response class. Instead, MOs alter the current frequency of the response class related to the given MO event. In contrast, consequences, such as reinforcement, by definition alter the future probability of the response class.

The specific variables that determine the duration of an MOs effects are not fully understood at this time. However, it is reasonable to assume that one of the variables would be related to the intensity (or magnitude) of the MO. Therefore, with respect to food, an EO in place for a long duration of time will have more pronounced value- and
behavior-altering effects, relative to an EO that is in place for only a short duration of time, all things being equal. However, not eating for too long a time would have behavior suppressive effects, as the organism would eventually become malnourished and starve. Another variable that appears to be related to the duration of the value- and behavior-altering effects is contact with the specific stimulus that the MO establishes or abolishes. An MO that establishes food as a reinforcer, for example, will be mitigated if the individual is given free access to food.

**Unconditioned and Conditioned Motivating Operations**

The value- and behavior-altering effects of some MOs do not require prior learning. Such events, which were first described by Michael (1993), are referred to as *unconditioned motivating operations* (UMO). All UMOs are related to biological needs. For instance, becoming too warm or cold can act as an UMO. This particular UMO alters the effectiveness of certain temperatures as reinforcers and alters behaviors that have been paired with that temperature change in the past. The behaviors that are evoked or abated by an UMO are not necessarily unlearned; rather it is the value- and behavior-altering effects of the UMO that are unlearned. Michael (2007) identified a total of nine UMOs, which include food deprivation, water deprivation, sleep deprivation, activity deprivation, oxygen deprivation, sex deprivation, becoming too warm or too cold, and increase in painful stimulation.

Antecedent events that require prior learning to act as MOs are called *conditioned motivating operations* (CMO; Michael, 1993). CMOs acquire value- and behavior-altering characteristics through pairing with other MOs. Michael (1993) described three
types of CMOs. The first type of CMO, called a *surrogate CMO*, refers to a neutral event that acquires MO characteristics after being paired with an already established MO. The second type of CMO, called a *reflexive CMO*, refers to a stimulus condition that is associated with some form of worsening or improving from the organism’s perspective. The third type of CMO, called a *transitive CMO*, refers to stimuli in the presence of which other stimuli are altered.

Although it would appear that maintaining the distinction between UMO, CMO, and each type of CMO would be helpful in a technical discussion of MOs, the current theory of motivation falls short of adequately describing these separate events. The distinction between UMO and CMO is based largely on the assumption that some antecedent stimuli can alter both the effectiveness of the stimuli to function as a reinforcer as well as some dimension of behavior without any prior learning. However, within the behavioral literature there is no empirical evidence to support this claim. In fact, the notion of an unlearned behavior-altering effect seems counter to basic operant conditioning. Some prior learning would be necessary for a stimulus condition to evoke an operant response class (i.e., stimulus control). The only stimuli that are known to alter some dimension of a response class without previous learning are associated with respondent conditioning. Although this inconsistency was noted by Michael (2004), it makes accurate identification of CMOs and UMOs difficult.

Additionally, the different types of MOs are not mutually exclusive categories. A single antecedent event can function as both an UMO and CMO (Michael, 2004). The same can be said for the three types of CMOs described above. For example, not eating
for several hours can act as a UMO for food. This same stimulus event can also function as a reflexive CMO, which signals a worsening of the situation. Thus, making distinctions between these stimuli post hoc is cumbersome and lacks practical utility.

Lastly, there are a number of well documented CMOs, such as attention deprivation, that do not fall into any of the abovementioned CMO categories (McGill, 1999). Attention deprivation appears to function similar to a UMO, in that restricting access to attention acts as an EO and giving access acts as an AO. In this regard, there appear to be CMOs that have not yet been identified. Therefore, attempting to make accurate distinctions between these MO events seems premature.

These limitations do not put into question the veracity or utility of MOs, rather the current classification system. For this reason, despite calls to adopt these distinctions (e.g., Michael, 1993; Langthorne & McGill, 2009), this paper will use the omnibus term, MO, and the event specific terms, EO and AO, to refer to all of the abovementioned antecedent events. Before discussing the implications of MOs, it is important to examine the relation between MOs and discriminative stimuli, another type of antecedent events.

**Distinguishing Between Motivating Operations and Discriminative Stimuli**

Discriminative stimuli ($S^D$) refer to events that signal the differential availability of reinforcement. In other words, reinforcement of a specific behavior is more likely to occur in the presence of an $S^D$ relative to when the $S^D$ is absent. Note that this does not necessarily mean that when the $S^D$ is absent reinforcement is completely withheld; rather, reinforcement is quantitatively less than it would otherwise be in the presence of the $S^D$. Whether the $S^D$ is present or absent has no bearing on the effectiveness of the consequent
event. It then follows that even if the $S^D$ is absent, the consequent event would still function as an effective reinforcer (Michael, 1982; 2007).

Consider the example of driving through an intersection with a traffic light. To the experienced driver, a green traffic light signals the availability of reinforcement (i.e., $S^D$) in the form of driving safely through the intersection, whereas a red traffic light signals the unavailability of this consequent event. Although the red light signals the unavailability of reinforcement, this does not mean the value of the reinforcer has changed. Being able to drive safely through the intersection is equally effective under both antecedent conditions. It is in this regard that the distinction between MO and $S^D$ is most evident. The green traffic light is not an MO, as this stimulus event does not alter the value of the consequent event.

MOs modify the value of reinforcers as well as the frequency of behavior related to those stimuli. For a green traffic light to function as an MO, driving through the intersection would have to be a more effective reinforcer compared to when the light was red. This is not to say, however, that motivation has no impact on this situation. Running late for an important meeting can function as an MO, increasing the value of a green traffic light, relative to when on a leisurely drive. When an MO is in effect, it alters the value of reinforcers in both the presence and absence of the $S^D$. Thus, MOs determine the momentary effectiveness of reinforcers, whereas $S^D$ describes the availability of reinforcers.
Implications of Motivating Operations and Relation to Reinforcement

Although the technology of motivation is a relatively recent development, it has had a profound impact on behavioral research and practice (Iwata, Smith, & Michael, 2000). MOs have permeated into nearly every aspect of behavior analysis. Behavioral researchers have examined the effects of MOs on preference assessment results (Gottschalk, Libby, & Graff, 2000), functional analysis results (Fischer, Iwata, & Wordsdell, 1997), engagement with activities (Klatt, Sherman, & Sheldon, 2000), within-session responding (Roane, Lerman, Kelley, & Van Camp, 1999), social initiations towards peers (Taylor, et al, 2005), and challenging behaviors (O’Reilly, Edrisinha, Sigafoos, Lancioni, Cannella, et al., 2007). Perhaps the most important impact, however, has been to the principle of reinforcement.

Reinforcement is a basic principle of learning (Cooper, Heron, & Heward, 1987) and a key component of any plan designed to increase behavior (Northup, Vollmer, & Serrett, 1993). Although the technology of reinforcement is well developed, it is incomplete without a thorough understanding of motivation (Michael, 2007). The reinforcing value of a stimulus is in constant flux and it is MOs that determine the current effectiveness. What functions as a reinforcer in one setting or time may not function as a reinforcer in another setting or time. Neglecting MOs in the analysis of reinforcement represents a failure to recognize the transient nature of reinforcers.

Noncontingent reinforcement as a motivating operation. The behavior altering mechanism of noncontingent reinforcement (NCR) has been conceptualized as MOs (Iwata et al., 2000; McGill, 1999; Wilder & Carr, 1998). In this respect, response-
independent reinforcement is thought to abolish the effectiveness of a given reinforcer and decrease the frequency of behavior associated with that consequence. However, experimental analysis has suggested that reinforcement of alternative behaviors is responsible, at least in part, for the suppressive effects of NCR. In a study designed to test this hypothesis, Ecott and Critchfield (2004) demonstrated that response-independent reinforcement resulted in increased rates of an alternative behavior, relative to a target behavior. Similar findings, with regards to increased rates of alternative behaviors under NCR conditions, were reported by other researchers. Madden and Perone (2003), for example, examined the effects of different point-delivery schedules on the time allocated to a target response, moving a joystick in one of four directions. When point delivery followed moving the joystick in only one direction, time allotted to the target response increased. However, when point delivery occurred independent of behavior time allotted to the previous position decreased and time allotted to the alternative positions increased. The effects of NCR appear, at least in part, to be the result of adventitious reinforcement (Madden & Perone, 2003). This makes it difficult to tease out the possible effects of MOs. Because the exact behavior altering mechanism of NCR remains unclear, studies that use NCR as an MO (e.g., Wordsdell, Iwata, Conners, Kahng, & Thompson, 2000) were excluded from this analysis.

**Differential Effectiveness of Motivating Operations**

In a classic study, Cowles (1937) compared the effects of primary and token reinforcers on the acquisition of a discrimination task with chimpanzees. Although all of the chimpanzees learned the discrimination task regardless of the class of reinforcer used,
training occurred more rapidly with the primary reinforcer. More recently, DeLeon, Iwata, and Roscoe (1997) reported that food items displaced leisure reinforcers during a multiple-stimulus preference assessment. These results underscore possible differences in the effectiveness of the classes of reinforcers. Imagine a situation in which an individual was deprived of a primary reinforcer, such as food, and a conditioned reinforcer, such as attention, for a long period of time. If the individual was then given free choice to select one type of reinforcer, it would be safe to assume that the individual would select the primary reinforcer, all things being equal. When an EO for a reinforcer is in full-effect, it is possible to examine the unmitigated effectiveness of that reinforcer.

Following this logic, it stands to reason that the value- and behavior-altering effects of MOs vary, in terms of effectiveness, across the classes of reinforcers. In this regard, the momentary value of a primary reinforcer appears to have the most direct relationship to the current level of motivation. For instance, being in a cold environment will act as an EO for warmth. In this situation, moving to a warmer environment will function as a reinforcer. However, the stimulus change of the warm environment can in turn establish the value of a cooler environment. In sum, the value of primary reinforcers is highly sensitive to changes in motivation. Because primary reinforcers are related to biological needs, this relation has clear survival value. Exposure to many stimuli that function as primary reinforcers past the point of the biological need will eventually have adverse side-effects, as in eating too much and getting sick. In addition, the stimulus will also act as a primary punisher, decreasing the future frequency of the behavior. In
contrast, overexposure to a stimulus that functions as a conditioned reinforcer (e.g., attention) is unlikely to have similar adverse side-effects.

On the other end of the spectrum, the value of token reinforcers has been assumed to be relatively free from the effects of motivation (Catania, 1998; Cooper et al., 2007; Skinner, 1953). This is because tokens are commonly paired with a wide variety of back-up reinforcers. The momentary value of a token is largely dependent on the collective effectiveness of the reinforcers that can be accessed through token exchange. Therefore, despite momentary fluctuations in the MOs for the back-up reinforcers, tokens are assumed to retain their value because some back-up reinforcers still function as reinforcers. For example, after eating a large lunch, a student who earns tokens exchangeable for snacks, attention, and games is likely to engage in high levels of the target behavior even though snacks are no longer an effective reinforcer. In this regard, tokens appear to have a unique relationship to MOs. However, the relation between MO and token reinforcer has not yet been thoroughly examined (Hackenberg, 2009).

Although a number of comprehensive reviews (e.g., Iwata et al., 2000; Langthorne, McGill, & O’Rielly, 2007; McGill, 1999; Wilder & Carr, 1998) and empirical investigations (e.g., Gottschalk et al., 2000; Roane et al., 1999; North & Iwata, 2005) on MOs are now available, the effects of MOs across classes of reinforcers (i.e., primary, conditioned, and token) has not yet been examined. This gap in the research is problematic, as reinforcement is the cornerstone of behavioral interventions. Reinforcement theory and technology are incomplete without a thorough account of MOs. Information regarding the possible differential effectiveness of MOs across the
classes of reinforcement has important implications for research and practice. For example, suppose one class of reinforcer produces a steady level of responding across varied MO conditions, whereas another class of reinforcer produces very high levels of responding under EO conditions and very low levels of responding under AO conditions. In this situation, the class of reinforcer that produced steady levels would be well suited to maintaining behavior throughout the day and the class of reinforcer that produced very high levels of responding would be well suited to teaching new skills under specific EO conditions.

**Purpose of this Investigation**

The purpose of this investigation was twofold: first, to examine the evocative- and abative-effects of a functionally defined MO on the frequency of a target behavior maintained by primary, conditioned, and token reinforcers; second, to determine if the classes of reinforcers were differentially influenced by MOs. Furthermore, if the reinforcer classes were differentially influenced, this study sought to determine which reinforcer class was most affected by MO changes and which reinforcer class was least affected by MO changes. The effectiveness of each class of reinforcer was examined under conditions where the EO and AO were functionally defined. A comprehensive literature review (See Chapter 2) and an empirical study (See Chapters 3 & 4) were conducted to address the abovementioned research questions. Finally, the results of the study are discussed, along with the implications for practice and direction for future research (See Chapter 5).
Article Selection

An empirical literature review was conducted in order to examine the relationship between MOs and each class of reinforcer. Figure 1 provides a diagram of the article selection process. An electronic search of two databases, PsychInfo and ERIC, was completed by the author using the following keywords: motivating operation(s), establishing operation(s), and abolishing operation(s). Even though the terms used to describe motivation have changed in recent years (e.g., Laraway et al., 2003), the phrase “establishing operations” has been in use since the inception of the discipline (e.g., Keller & Schoenfeld, 1950). The reference list of each article was examined in order to find studies that contained keywords, but were not identified during the electronic search.

In addition to containing one of the keywords, articles had to meet the following requirements to be considered for this review: (a) Be published prior to January 1, 2011 in an English language peer reviewed journal, (b) actively and explicitly manipulate an MO for a specified reinforcer and target behavior, and (c) demonstrate functional control of the MO using a single subject experimental design. An article would be excluded if the authors simply described the results in terms of MOs, without conducting an
experimental analysis. For example, Hall and Sundberg (1987) compared the effects of different training procedures on the requests made by two students with hearing loss. Materials necessary to complete a behavioral chain were withheld from the participants, a putative MO. However, the MO was in place across all conditions and was never systematically manipulated. Therefore, this study was excluded from the analysis.

Figure 2.1. Flowchart of article selection process and results.

Lastly, MO manipulations that occurred as part of a packaged intervention were not included, as it was not possible to isolate the effects of the MO from the other intervention components. Brown et al. (2000), for example, evaluated the effects of functional communication training (FCT) in the presence and absence of MOs on the challenging behavior of four individuals with developmental disabilities. Participants were taught two different requests, “more” and “done”, one for each of the MO
conditions. However, because of the FCT component, which included prompting and time out, it was not possible to determine the independent effects of the MO on challenging behavior. As a result, this study and others like it were excluded from this analysis.

**Article Analysis Procedures**

Following the article selection process, the author read each article that met the inclusionary requirements. Articles were analyzed using an 11 item matrix. The components of the matrix are shown in Figure 2.2. Descriptive information about the study (e.g., authors, number of participants, and setting) as well as variables related to the class of reinforcer (e.g., type of reinforcer) and MO manipulated (e.g., type of MO) were entered into the matrix. The quantifiable variables, such as the number of participants, were tallied and summed in order to yield totals. Each item of the matrix was coded with information from the article. If information was not included or not explicitly stated the relevant matrix item was coded as “information not available”.

**Matrix Components**

- First authors last name
- Year of publication
- Name of journal
- Number of participants
- Participant age
- Participant descriptive information
- Setting
- Target behavior
- Reinforcer class
- Description of MO
- Analysis of results

Figure 2.2. List of the 11 matrix items. Each article was examined using the matrix.
Articles included in the review were examined in terms of the following definitions:

**Establishing operation.** EOs were defined as antecedent events that were described as having a reinforcer-establishing and evocative-effect. Additionally, restricted access to the reinforcer prior to the start of the experimental session was considered an EO. Because the reinforcer-establishing effect is not readily observable, it was assumed to co-vary with the evocative-effect. The specific EO was recorded in the matrix (e.g., pre-session restricted access to the reinforcer) as was the relevant quantifiable variable (e.g., duration of time the stimulus was withheld).

**Abolishing operation.** AOs were defined as antecedent events that were described as having a reinforcer-abolishing and abative-effect. Additionally, pre-session access to the reinforcer prior to the start of the experimental session was considered an AO. Because the reinforcer-abolishing effect is not readily observable, it was assumed to co-vary with the abative-effect. The specific AO was recorded in the matrix (e.g., pre-session access to the reinforcer) as was the relevant quantifiable variable (e.g., duration of contact with the stimulus prior to the start of the session).

**Primary reinforcer.** Primary reinforcers included stimuli such as edible items (e.g., pretzels) and drinks (e.g., juice). Edibles and drinks that were described by the authors as “tangible items” (e.g., O’Reilly et al., 2008) were counted as primary reinforcers.

**Conditioned reinforcer.** Conditioned reinforcers included social interaction (e.g., statements of praise), non-edible tangible items (e.g., toys), and access to activities (e.g.,
playing a game). Stimuli described as being “sensory” or “automatically reinforcing”, which were not biologically necessary for survival (e.g., music; Vollmer & Iwata, 1991), were recorded as conditioned reinforcers.

*Token reinforcer.* Token reinforcers referred to any stimuli that were exchangeable for other reinforcers. The back-up reinforcers accessible through token exchange, however, were not included in this analysis. For example, plastic chips that could be exchanged for food items were recorded as tokens. The food items that the individual received following exchange were not included in the analysis of primary reinforcers.

*Results.* Results were categorized as positive, negative, or mixed. Positive results refer to outcomes in which there was a clear differentiation, evident by the proportion of overlapping data points (i.e., less than 10%), between baseline and/or MO conditions for all participants. Negative results refer to findings that showed no change as a result of the MO manipulation for all of the participants. Lastly, mixed results refer to outcomes that involved a combination of positive and negative results, or results that showed some differentiation but contained a high proportion of overlapping data points.

*Positive MO Findings.* In addition to the system described above, the findings for each participant were evaluated and categorized as either positive or negative. Positive MO findings were defined as results in which the behavior-altering effect of the MO was clearly evident. Positive MO findings contained little to no overlapping data points. An all-or-nothing system of classification was selected in order to reduce the subjectivity of
interpreting graphical results through visual analysis. This coding system was used in the analysis of MOs across classes of reinforcers.

**Structure of Review**

The results of this review are organized into five sections. The first section summarizes the general findings of the literature review. Sections two through four examine the MO literature as it relates to each type of reinforcer. Finally, the fifth section contains the analysis of the effects of MOs across classes of reinforcers. Within each section, selected articles are discussed in greater detail.

**Results and Analysis**

**General Findings of the MO Literature**

**Search results.** The keyword search identified over 150 articles related to the analysis of motivation. However, only a small proportion of these articles contained empirical demonstrations or active manipulations of MOs. The article selection process yielded 25 articles that met all of the inclusionary criteria. Figure 1 depicts the article selection process as well as results during each phase of the search. Most of the articles were published in the *Journal of Applied Behavior Analysis* (64%), followed by *Research in Developmental Disabilities* (16%), *Behavioral Interventions* (12%), *Behavior Modification* (4%) and *Education and Treatment of Children* (4%).

The chronological distribution of articles is presented in Figure 2. Over half of the articles (52%) were published within the last five years. Prior to this time, experimental research on the effects of MOs was sporadic. However, the dearth of research during the 1990’s and early 2000’s is not surprising as the current theory of motivation was still in
development. This period of time was rich in conceptual articles (e.g., Michael, 1982; 1993; 2000; Laraway et al., 2003). Additionally, many behavior analysts were making the transition from the Skinnerian system of satiation-deprivation to the current system of MOs. Advances in theory often precede advances in practice by several years (Greenwood & Abbott, 2001). Since 2005, the number of published experimental articles that actively manipulate an MO for a specified reinforcer have been stable at around three per year.

![Figure 2.3. Chronological distribution of publications included in this review.](image)

**Participants and settings.** The individuals who participated in these 25 studies represent a diverse and varied population. A total of 80 individuals participated, including individuals who participated in multiple experiments (e.g., the same participant was used in O’Reilly, Edrisinha, Sigafoos, Lancioni & Andrews, 2006 and O’Reilly, Edrisinha, Sigafoos, Lancioni, Machalicek et al., 2007). Age ranged from 2- to 49-years old, with
34% of the participants being over 20 years of age, followed by pre-teens (7–12 years old) at 30%, young children (2–6 years old) at 19%, and teens (13–19 years old) at 17% of the total population. The most common disability noted by the authors was mental retardation, within the moderate to profound range, followed by autism. Although most participants had some type of disability, seven participants were described as typically developing.

Experimental sessions occurred in a number of locations, including university laboratories, residential living quarters, classrooms, and vocational programs. Within these locations, 56% of the articles used an analog or therapy room as the primary experimental setting. Analog or therapy rooms include only the materials and stimuli necessary to address the experimental question. Such settings are not usually reflective of the individuals’ natural environment. However, these highly controlled settings are well suited to studying complex environment-behavior relations. The remaining studies were conducted within the participants’ natural environment, such as a kitchen, living room, or classroom. Overall, the studies included in this review represent a broad spectrum of environments.

**Target behaviors.** The range of target behaviors examined by the authors of these studies was relatively diverse. Fourteen of the 25 studies (56%) examined some topography of challenging behavior as the dependent variable. Common challenging behaviors reported by the authors included hitting, kicking, head-hitting, hand-biting, and yelling.
Choice with respect to preference was analyzed as a dependent variable for 3 of the 25 studies (12%). These studies attempted to demonstrate the behavior- and value-altering effects of MOs on the momentary preference for putative reinforcers. Choice is a target behavior well suited to this line of research, as it may be used to isolate the two independent effects of MOs. In other words, the behavior- and value-altering effect could be conceptualized as the occurrence of choice behavior and the variable responsible for the specific selection, respectively.

Given the relevance of MOs to language and language development, it is surprising that only 2 of the 25 studies (8%) used mands as the dependent variable. First described by Skinner (1957), a mand is a verbal operant that specifies a reinforcer and is under the functional control of an MO. These studies used MOs to evoke mands for specific reinforcers. Although the keyword search yielded many studies related to the analysis of verbal behavior, very few contained experimental manipulations of MOs.

The dependent variables for the six remaining studies included stereotypy, activity engagement, hand-raising, play, and non-functional motor tasks as dependent variables. With respect to the target behaviors described in this section, the effects of MOs have been examined in a wide array of response classes.

**Descriptions of MO manipulations.** In sum, the articles included in this review contained 101 individual manipulations of MOs (see Figure 2.4). The most frequently used MO manipulation involved controlling the participants’ access to the reinforcer prior to the start of the experimental session. O’Reilly, Edrisinha, et al. (2006), for example, exposed a man who engaged in attention maintained bizarre speech to 15 min
of continuous social interaction. In a subsequent assessment, in which attention was made contingent upon bizarre speech, the individual engaged in very low levels of the challenging behavior compared to session in which access to attention was restricted. These results suggest that pre-session access to attention abolished the reinforcing value of this stimulus event. Furthermore, restricting access to attention appeared to establish the value of attention as a reinforcer. This type of MO manipulation (hereafter referred to as pre-session access and pre-session restriction) was used in 21 of the 25 articles (84%).

![Figure 2.4](image.png)

**Figure 2.4.** Distribution of MO manipulations across classes of reinforcers.

An important variable related to pre-session access and restriction is the duration of time that the reinforcer is controlled. The range of pre-session access durations was relatively narrow (10 to 20 min), in comparison to the range of pre-session restriction durations (15 to 8640 min). More important than the duration of pre-session access, however, is how that duration was determined. Most of the pre-session access durations
reported by the authors were determined in a seemingly arbitrary manner. In other words, the selected duration of time had no empirical basis. In the example described above (O’Reilly, Edrisinha, et al., 2006), participants were given 15 min of continuous access to attention. However, the extent to which this level of pre-session access would function as an AO was unclear until a decrease in the target behavior was evident. Suppose a decrease in the target behavior did not occur. In such a situation it would be impossible to meaningfully interpret these results. Such results could indicate that the putative MO was really not an MO or that the MO was insufficient to alter the value of the consequence and subsequent frequency of behavior. Because MOs describe a functional relation between the environment and behavior, it is essential that the duration of pre-session access and restriction have some empirical basis. Furthermore, the development of a technology of MOs necessitates these events be treated functionally. Making assumption about what events function as MOs could hinder the scientific analysis of motivation.

The duration of pre-session access was determined through empirical observation in only 4 of the 21 articles (19%) that manipulated this type of MO. For example, O’Reilly et al. (2009) determined the duration of pre-session access by giving participants’ continuous access to the reinforcer until it was rejected. In a comparison condition, participants were given brief (5 min) pre-session access. The duration of time participants contacted the reinforcer during this brief access condition was arbitrarily determined. The results of this parametric analysis demonstrated that pre-session access until rejection was superior to an arbitrarily selected duration in terms of producing clear abative-effects.
The remainder of the studies each analyzed a different type of MO. Carey and Halle (2002) manipulated the MO for escape by introducing preferred stimuli into work sessions. Horner, Day, and Day (1997) gave participants access to “neutralizing routines”, a putative MO, designed to abolish the value of reinforcers associated with challenging behavior evoked by unanticipated schedule changes. Smith, Iwata, Goh, and Shore (1991) examined the behavior- and value- altering effects of task novelty and task rate on self-injurious behavior. Finally, Northup, Fusilier, Swanson, Roane, and Borrero (1997) evaluated the value-altering properties of methylphenidate on commonly used reinforcers. In the next section, the articles that relate to MOs for primary reinforcers will be examined.

**Motivating Operations and Primary Reinforcers**

The findings of the MO and primary reinforcer literature review are displayed in Table 2.1. The effects of MOs on primary reinforcers were examined in nine articles. These articles contained 39 MO manipulations (see Figure 2.4). For example, O’Reilly, Edrisinha, Sigafoos, Lancioni, Cannella, et al. (2007) demonstrated that the cumulative frequency of food-maintained challenging behavior varied as a function of pre-session access and restriction. During pre-session access conditions, the participant was given 15 min of free access to edible items prior to the start of an instructional session. Following these conditions, challenging behavior was stable at near zero levels across all instructional sessions. During pre-session restriction conditions, the edible items were withheld for 2 hr before the start of the instructional session. Following these conditions, over 250 cumulative instances of challenging behavior were observed during
instructional sessions. The results suggest that pre-session access and restriction functioned as an AO and EO, respectively.

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>N</th>
<th>MO Type</th>
<th>MO Manip.</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chappell</td>
<td>2009</td>
<td>3</td>
<td>Pre-Session Control</td>
<td>3</td>
<td>Mixed; MO effects varied across participants.</td>
</tr>
<tr>
<td>Edrisinha</td>
<td>2010</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>1</td>
<td>Positive; clear differentiation between EO and AO conditions.</td>
</tr>
<tr>
<td>Gottschalk</td>
<td>2000</td>
<td>4</td>
<td>Pre-Session Control</td>
<td>4</td>
<td>Mixed; MO effects varied across participants.</td>
</tr>
<tr>
<td>O’Reilly*</td>
<td>2006</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>2</td>
<td>Mixed; EO had little effect during first manipulation, clearer effects during second.</td>
</tr>
<tr>
<td>O’Reilly**</td>
<td>2007</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>1</td>
<td>Positive; clear differentiation between EO and AO conditions.</td>
</tr>
<tr>
<td>O’Reilly</td>
<td>2008</td>
<td>2</td>
<td>Pre-Session Control</td>
<td>2</td>
<td>Positive; clear differentiation between EO and AO, only one overlapping data point.</td>
</tr>
<tr>
<td>North</td>
<td>2005</td>
<td>9</td>
<td>Pre-Session Control</td>
<td>20</td>
<td>Mixed; MO effects varied across participants, with some participants showing no change.</td>
</tr>
<tr>
<td>Taylor</td>
<td>2005</td>
<td>3</td>
<td>Pre-Session Control</td>
<td>3</td>
<td>Positive; mand occurred more during EO conditions relative to AO conditions.</td>
</tr>
<tr>
<td>Vollmer</td>
<td>1991</td>
<td>3</td>
<td>Pre-Session Control</td>
<td>3</td>
<td>Mixed; highly variable responding, some EO-AO differentiation, many overlapping data points.</td>
</tr>
</tbody>
</table>

*Note. N = number of participants that contacted a primary reinforcer, MO Manip. = number of motivating operations manipulated within the article. *O’Reilly, Sigafoos, et al. **O’Reilly, Edrisinha, Sigafoos, Lancioni, Cannella, et al.

Overall, the results of the articles that manipulated an MO for a primary reinforcer were mixed. The findings were inconsistent and contained frequent overlapping data points. Pre-session access and restriction was the only MO evaluated in this set of articles. Furthermore, all but one of the articles (Edrisinha, O’Reilly, Sigafoos, Lanciona,
& Choi, 2010) used arbitrarily determined pre-session durations. It is worth noting that North and Iwata (2005) were responsible for over half of the total MO manipulations.

North and Iwata (2005) examined the effects of three different MO conditions on the frequency of pressing a switch that resulted in the delivery of preferred edible items. The first MO condition was pre-session access lunch and food restriction. The second MO condition was pre-session access in the form of repeated sessions. The third MO condition was a combination of pre-session access and restriction, as well as repeated sessions. A total of nine individuals participated in the study. All of the participants experienced the first and second MO conditions, and only two of the participants experienced the third MO condition. Responding was highly variable across these MO conditions. Pre-session access and restriction to lunch had little effect on the target behavior for 6 of the 9 participants. The results appear to suggest that eating lunch did not abolish the value of edible reinforcers.

Because the duration of the lunch period or the amount consumed was never described, these findings are difficult to interpret. The effects of a given stimulus condition are idiosyncratic. In other words, a lunch of a certain proportion may have been sufficient to abolish the reinforcing value of preferred edibles for 3 of the 9 participants but was not sufficient for the remaining six participants. Furthermore, the size of the lunch may have varied across days. In this regard, the behavior- and value-altering properties of lunch would have fluctuated. The variables related to pre-session access and restriction were not fully described. Therefore, it is not clear if the results should be
attributed to the resistance of preferred edible items to be altered by MOs or lunch not being sufficient to abolish the value of edible items for the participants in this study.

Although the results for most of the studies included in this section were mixed, four of the studies contained clearly positive outcomes. In other words, the results showed a clear differentiation between the MO conditions across all participants. O’Reilly et al. (2008), for example, exposed two participants who engaged in food-maintained challenging behavior to either a 15 min pre-session access or restriction condition. In the subsequent leisure session, the percentage of intervals with challenging behavior varied according to the MO. Sessions that followed pre-session access contained very few instances of challenging behavior, whereas sessions that followed pre-session restriction contained relatively more challenging behavior. Although the duration of pre-session access and restriction was arbitrarily selected, it was apparently enough to alter the value of the reinforcer and the frequency of behavior to a meaningful degree. These results should not be interpreted to mean that 15 min (the duration used in this study) is a sufficient duration to establish or abolish a primary reinforcer. Rather, the results validate the potential effectiveness of pre-session access and restriction to act as an MO for primary reinforcers. The next section will examine the relation between MOs and conditioned reinforcers.

**Motivating Operations and Conditioned Reinforcers**

Table 2.2 and 2.3 display the results of the conditioned reinforcer and MO literature review. The effects of MOs on conditioned reinforcers were evaluated in 17 studies. Contained within these articles were 49 MO manipulations (see Figure 2.4).
Carey and Halle (2002), for example, reduced the escape-maintained challenging behavior of a 12-year old boy by altering the aversive properties of instructional sessions. Within an alternating treatments design, academic sessions occurred with and without music, a putative reinforcer. Overall, fewer intervals with challenging behavior were observed when music was present, relative to when it was absent. These results suggest that music functioned as an MO, altering the effectiveness of escape as a reinforcer. This is one of the few studies included in this review to examine an MO other than pre-session access and restriction.

Within session access, the MO used in the study described above, has similarities to NCR, in that participants are given access to the putative reinforcer independent of responding. The main difference, however, is that NCR is most often delivered on a time-based schedule of reinforcement, whereas the putative reinforcer is continuously available during within session access. The continual availability of the reinforcer addresses the problem discussed in the introduction with the use of NCR as an MO; namely, that response independent reinforcement on a time-based schedule functions to increase other behaviors (e.g., Ecott & Critchfield, 2004). For example, if reinforcement is delivered every 2 min independent of behavior, it is likely that the temporal contiguity between the delivery of reinforcement and whatever behaviors are occurring at the time will act to increase that response class in the future. This problem of NCR, as it pertains to evaluating the effects of MOs, is mitigated by giving the participant continuous access to the putative reinforcer.
<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>N</th>
<th>MO Type</th>
<th>MO Manip.</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berg</td>
<td>2000</td>
<td>3</td>
<td>Pre-Session Control</td>
<td>3</td>
<td>Positive; clear differentiation between MO conditions for each</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>assessment type.</td>
</tr>
<tr>
<td>Carey</td>
<td>2002</td>
<td>1</td>
<td>Within-Session Access to Preferred</td>
<td>1</td>
<td>Mixed; differences between conditions are unclear in later parts of the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stimuli</td>
<td></td>
<td>study.</td>
</tr>
<tr>
<td>Edrisinha</td>
<td>2010</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>1</td>
<td>Positive; clear differentiation between EO and AO conditions.</td>
</tr>
<tr>
<td>Horner</td>
<td>1997</td>
<td>3</td>
<td>Neutralizing Routine</td>
<td>3</td>
<td>Positive; clear differentiation between neutralizing routine presence</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and absence.</td>
</tr>
<tr>
<td>Klatt</td>
<td>2000</td>
<td>3</td>
<td>Pre-Session Control</td>
<td>6</td>
<td>Mixed; highly variable responding, some EO-AO differentiation, many</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>overlapping data points.</td>
</tr>
<tr>
<td>Lang</td>
<td>2009</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>1</td>
<td>Positive; clear differentiation between EO and AO, some overlapping data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>points.</td>
</tr>
<tr>
<td>Lang</td>
<td>2010</td>
<td>4</td>
<td>Pre-Session Control</td>
<td>4</td>
<td>Mixed; some EO-AO differentiation, many overlapping data points.</td>
</tr>
<tr>
<td>McAdam</td>
<td>2005</td>
<td>6</td>
<td>Pre-Session Control</td>
<td>6</td>
<td>Mixed; MO effects varied across participants.</td>
</tr>
<tr>
<td>McComas</td>
<td>2003</td>
<td>3</td>
<td>Pre-Session Control</td>
<td>7</td>
<td>Mixed; highly variable responding, some EO-AO differentiation, many</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>overlapping data points.</td>
</tr>
<tr>
<td>O’Reilly⁰</td>
<td>2006</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>2</td>
<td>Positive; clear differentiation between EO and AO, no overlapping data</td>
</tr>
</tbody>
</table>

Note. N = number of participants that contacted a conditioned reinforcer, MO Manip. = number of motivating operations manipulated within the article. ⁰O’Reilly, Sigafoos, et al.

Conditioned reinforcers are acquired throughout the lifetime of an organism. As a result, this class of reinforcers is typically the largest. Consistent with this theory, a wide variety of conditioned reinforcers were included in these articles, such as escape from task demands (Smith et al., 1995), attention from adults (Berg et al., 2000), access to music (Vollmer & Iwata, 1991), and tangible items (McAdam et al., 2005). This
particular cross-section of MO and reinforcement research was the most established in terms of the number of published studies and total number of MO manipulations.

Table 2.3. Summary of Articles that Manipulated an MO for Conditioned Reinforcers

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>N</th>
<th>MO Type</th>
<th>MO Manip.</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>O’Reilly</td>
<td>2006</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>2</td>
<td>Positive; clear differentiation between EO and AO, no overlapping data points.</td>
</tr>
<tr>
<td>O’Reilly</td>
<td>2007</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>1</td>
<td>Positive; clear differentiation between EO and AO, no overlapping data points.</td>
</tr>
<tr>
<td>O’Reilly</td>
<td>2008</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>1</td>
<td>Positive; clear differentiation between EO and AO, no overlapping data points.</td>
</tr>
<tr>
<td>O’Reilly</td>
<td>2009</td>
<td>2</td>
<td>Pre-Session Control</td>
<td>2</td>
<td>Positive; clear differentiation between EO and AO, no overlapping data points.</td>
</tr>
<tr>
<td>Roantree</td>
<td>2006</td>
<td>1</td>
<td>Pre-Session Control</td>
<td>1</td>
<td>Positive; clear differentiation between MO present and absent conditions.</td>
</tr>
<tr>
<td>Smith</td>
<td>1995</td>
<td>4</td>
<td>Novel Tasks and Rate of Demands</td>
<td>4</td>
<td>Mixed; substantial variations within and across participants.</td>
</tr>
<tr>
<td>Vollmer</td>
<td>1991</td>
<td>3</td>
<td>Pre-Session Control</td>
<td>4</td>
<td>Mixed; highly variable responding, some EO-AO differentiation, many overlapping data points.</td>
</tr>
</tbody>
</table>

Note. N = number of participants that contacted a conditioned reinforcer, MO Manip. = number of motivating operations manipulated within the article. bO’Reilly, Edrisinha, et al. cO’Reilly, Edrisinha, Sigafos, Lancioni, Machalicek, et al.

The majority of these studies, 10 of 17 (59%), had positive results, in that there was a clear differentiation between conditions with relatively few overlapping data points, if any. For example, Berg et al. (2000) designed a study to examine the effects of MOs on the outcomes of assessments of attention as a reinforcer. Participants were exposed to different pre-session conditions immediately prior to the reinforcer
assessment. The results showed that pre-session access and restriction influenced behavior during the subsequent reinforcer assessment. These findings have major implications for many of the assessments (e.g., functional analyses) conducted within the course of developing programs to change behavior. Although behavior analysts have been aware of such variables for a long time, the behavior-altering effect of these variables is just now being experimentally evaluated.

Although most of the studies reported positive findings, taking into account the number of MO manipulations resulted in a different interpretation of the findings. More than half of the total manipulations, 32 of 49 (65%), had mixed effects. For instance, McComas, Thompson, and Johnson (2003) reported that 10 min of pre-session access or restriction had little behavior altering-effect on the attention-maintained challenging behavior of the four participants. Klatt, Sherman, and Sheldon (2000) examined the effects of three different levels of pre-session restriction on engagement with high preference items. The results showed no difference between 2 hr and 1 to 4 days of pre-session restriction on the level of engagement. The smallest duration of pre-session restriction, 15 min, resulted in the least amount of engagement. However, for two of the three participants the level of responding overlapped with the levels reported following the larger durations of restriction.

In the final analysis, the results of this section are best characterized as mixed, with a subset of the articles containing clearly positive outcomes. Based on a thorough analysis of these articles, it is not clear what accounts for this discrepancy. There were no noticeable differences in the duration of pre-session access and restriction reported in
studies that showed positive versus mixed effects. These differences could be a function of the idiosyncratic nature of MOs coupled with the practice of arbitrarily selecting pre-session access and restriction durations. Two of the 3 studies that determined the pre-session access duration through empirical observation, O’Reilly et al. (2009) and Lang et al. (2009), reported positive findings.

The remainder of studies that examined MOs other than pre-session access and restriction were too few to make any reasonable statements as to why the results were mixed or positive. Smith et al. (1995), for example, examined the effects of high- versus low-rate task demands as an EO for escape-maintained challenging behavior. The comparative difference between these conditions was negligible for both participants. Additionally, one of the participants engaged in more challenging behavior in the high-rate demand condition, whereas the other engaged in more challenging behavior during the low-rate demand condition. It is unclear why the MO manipulation resulted in seemingly contradictory effects. In their discussion, the authors do not address these disparate findings. As this is the only study that manipulated the rate of task demands, interpreting these results is difficult. The next section will examine the literature related to MOs and token reinforcers.

**Motivating Operations and Token Reinforcers**

The results of the token reinforcer and MO literature review are depicted in Table 2.4. Despite the prevalence of token based reinforcement programs, only two studies examined the relation between MOs and token reinforcers. These studies are described below.
Table 2.4. Summary of Articles that Manipulated an MO for Token Reinforcers

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>N</th>
<th>MO Type</th>
<th>MO Manip.</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moher</td>
<td>2008</td>
<td>3</td>
<td>Pre-Session Control</td>
<td>6</td>
<td>Positive; clear differentiation between EO and AO, few overlapping data points.</td>
</tr>
<tr>
<td>Northup</td>
<td>1997</td>
<td>3</td>
<td>Medication</td>
<td>3</td>
<td>Mixed; some differentiation between MO conditions, many overlapping data points.</td>
</tr>
</tbody>
</table>

Note. N = number of participants that contacted a token reinforcer, MO Manip. = number of motivating operations manipulated within the article.

Northup, Fusilier, Swanson, Roane, and Borrero (1997) evaluated the effects of methylphenidate on various reinforcers commonly found in a classroom setting. Three pre-teen boys who had a diagnosis of ADHD participated. Following the completion of a fixed number of easy math problems, participants were given the opportunity to select a token coupon. Token coupons were exchangeable for specific reinforcers commonly found in the classroom setting, such as edible items, activities, and attention from staff. A placebo and methylphenidate were administered according to an ABAB design. The results were examined in terms of the number of completed math problems associated with each type of reinforcer coupon the participant selected.

The authors reported that token coupon selection varied as a function of the MO manipulation (i.e., the presence or absence of methylphenidate). For instance, one of the participants completed 165 math problems associated with the coupon for edible items during the placebo condition. When methylphenidate was administered, the number of math problems completed decreased substantially to only 10. However, selection of coupons related to tangible items and activities increased dramatically. Similar results were observed for the two remaining participants. Overall, methylphenidate had a
profound impact on the token reinforcers participants selected. These results suggest that methylphenidate had a powerful value-altering effect on many different types of common reinforcers. This is the only study included in this review to examine medication as an MO.

Moher, Gould, Hegg, and Mahoney (2008) conducted two experiments relevant to MOs and token reinforcement. In the first experiment, the authors examined the influence of pre-session access and restriction on token effectiveness. Two pre-teen girls and one adolescent male participated in this study. Tokens exchangeable for a high preference edible item were delivered contingent upon hand-raising. Pre-session access and restriction were manipulated within an ABA design. During pre-session access conditions, the participants were given the opportunity to consume the edible item associated with the token. Pre-session access continued until 2 min elapsed with no consumption. During pre-session restriction conditions, the specific edible item associated with the tokens was withheld for at least 24 hr.

The results showed a clear differentiation between the EO and AO conditions. Participants’ engaged in low, near zero levels of hand-raising following pre-session access. In comparison, following the pre-session restriction period the rate of hand-raising was high. This study clearly demonstrates how the value of a token co-varies with the value of the back-up reinforcer. Once the value of the edible item was abolished, the token lost its reinforcing properties.

In the second experiment the authors attempted to reduce the sensitivity of the token to changes in motivation. The procedures were similar to those used in the first
experiment, except that tokens were paired with one to two additional edible reinforcers. The same individuals described above participated in this experiment. Participants were given pre-session access to one of the edible back-up reinforcers. Pre-session restriction sessions were unchanged.

The results showed that when tokens could be exchanged for two to three back-up reinforcers, the abolishing effect of pre-session access was greatly diminished. In fact, during the final sessions of the study, hand-raising occurred at levels that either matched or exceeded those observed during the pre-session restriction conditions. This finding supports the idea that tokens, associated with a variety of back-up reinforcers, are relatively free from the effects of motivation when participants are given pre-session access to some of the back-up reinforcers. Furthermore, the value of a token may be greater than the sum of its parts. For example, a token exchangeable for a snack, break, and movie may be more valuable than the same items combined without the token. This effect may be even more pronounced in a situation where there are limits imposed on the number of back-up reinforcers an individual can contact during a given exchange opportunity. However, further research would be needed to support this claim. The next section of the results presents the research that contained mixed classes of reinforcers.

**Analysis of Motivating Operations Across Classes of Reinforcers**

Although many of the studies included in this review contained multiple classes of reinforcers, the procedures were such that these classes were separated by experiment, condition, or participant. For example, Vollmer and Iwata (1991) included primary and conditioned reinforcers in their study. However, these different classes were examined
within separate experimental designs. As a result, it was not possible to compare the effects of the MO on the different classes of reinforcers.

The effects of MOs on multiple classes of reinforcers were examined in two studies. However, it should be noted that comparing the effects of MOs across classes of reinforcers was not the primary purpose of these studies. Rather, it was a byproduct of the experimental design. The two studies are discussed below.

Guitierrez et al. (2007) used within-session control to manipulate the MO of a mand. Three young children and one adolescent participated in this study. Participants were trained to mand for two items by handing the experimenter a picture card. For each participant, one item was a primary reinforcer (e.g., chips or drink) and the other item was a conditioned reinforcer (e.g., radio or TV). To evaluate the effectiveness of the mand training, the authors gave the participants within-session access to one of the items, while the other item was withheld. Participants were then presented with picture cards representing both items. Handing one of the cards to the experimenter resulted in brief access to the corresponding item.

Three of the 4 participants showed a clear differentiation in responding as a function of within-session access by the end of the study. In other words, these participants requested the withheld item. However, the level of requesting for the remaining participant was not affected by changes in the MO. For example, this participant selected chips at the same level in both the putative EO and AO conditions. The lack of response differentiation for the one participant could be a result of the initial mand training procedures or possibly a weak MO.
Although this study contained multiple classes of reinforcers, it was not possible to determine if the MO had differential effects on the value of the reinforcers and the subsequent level of behavior. The participants had continuous access to one of the items during all MO sessions. Therefore, the current effectiveness of that item to function as a reinforcer could not be assessed. Additionally, selecting the withheld item maximized reinforcement for the individual. In this regard, a selection of one item over the other cannot be taken to mean that the selected item was more valuable or effective as a reinforcer. The procedures used by Guitierrez et al. (2007) are well suited to accessing correspondence between MOs and mands. However, these procedures do not provide sufficient information on the value of the reinforcer under AO conditions necessary to determine if MOs have differential effects.

Moher et al. (2008), described in detail above, compared the effects of pre-session access and restriction on token reinforcers and the corresponding primary back-up reinforcers. According to a multi-element design, participants earned tokens or primary reinforcers on a FR schedule of reinforcement. Tokens and primary reinforcers were accumulated during the session and were exchanged, in the case of tokens, or delivered, in the case of primary reinforcers, at the end of the session.

The results suggest that both types of reinforcers were equally affected by pre-session access and restriction when the back-up reinforcer and primary reinforcer were the same. However, this result is not surprising as the token and primary reinforcer had a one-to-one correspondence in terms of the terminal reinforcer. The only difference between the conditions was participants either accumulated tokens or back-up
reinforcers. Once a participant learned that one token equals one back-up reinforcer, these conditions became functionally equivalent to one another.

Table 2.5. Results of the Analysis of Motivating Operations Across Classes of Reinforcers

<table>
<thead>
<tr>
<th>Reinforcer Class</th>
<th>Total MO Manip.</th>
<th>Positive MO Findings</th>
<th>% of Positive MO Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>39</td>
<td>13</td>
<td>33%</td>
</tr>
<tr>
<td>Conditioned</td>
<td>49</td>
<td>17</td>
<td>35%</td>
</tr>
<tr>
<td>Token</td>
<td>9</td>
<td>7</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Note. Total MO Manip. = number of motivating operations manipulated within a class of reinforcers, Positive Findings = number of MO manipulations within a class of reinforcers that showed a clear differentiation between MO conditions, % of Positive Findings = Positive Findings/Total MO Manip, NA = not enough MO manipulations to meaningfully calculate a percent.*

To examine possible differences in the effects of MOs across the classes of reinforcers, the proportion of positive MO manipulations in the articles included in this review was analyzed. The results of the analysis of MOs across classes of reinforcers are presented in Table 2.5. Of the three classes of reinforcers, two were sufficiently researched to meaningfully compare the percent of positive findings. The percentage of positive MO findings for token reinforcers was not calculated due to the dearth of total MO manipulations. Thirty-five percent of the MO manipulations for conditioned reinforcers showed positive findings and 33% of the MO manipulations for primary reinforcers showed positive findings. Overall, the results suggest that MO manipulations for conditioned and primary reinforcers were equally successful. The difference in the percent of positive findings was nominal.
Discussion

The purpose of this empirical review was to examine the effects of MOs within and across classes of reinforcers. Reinforcement theory is well-established but remains incomplete without a thorough understanding of MOs. Although there has been recent interest in the topic of motivation, no review has yet summarized this information according to the classes of reinforcers.

An electronic search of the behavioral literature resulted in the identification of 25 articles that met all of the inclusionary criteria. Articles were then analyzed using an 11 item matrix. The major findings of this review are discussed below.

Major Findings

Significant procedural and technological limitations made analyzing the effects of MOs difficult. As stated previously, pre-session access and restriction was the most common MO manipulated in the studies included in this review. However, the specific parameter whereby this type of MO derives its effectiveness (i.e., time) was determined arbitrarily in the majority of articles. Thus, it is not clear if mixed or negative results were a function of the MO not being sufficient to clearly establish or abolish the reinforcer. Alternatively, it could be that the class of reinforcers was not sensitive to that particular type of MO manipulation. Because most of the MOs included in this review were defined in a topographical manner (e.g., some length of time), as opposed to a functional manner (i.e., a given effect on behavior), the results must be interpreted with caution.

Although there were problems related to the use of pre-session access and restriction, this is the only type of MO with empirical support across each class of
reinforcer. This MO is particularly useful when the variable of concern is access to the putative reinforcer. For example, the repeated delivery of a reinforcer can act as an AO. In applied settings, stimuli assumed to be reinforcers are often delivered without much thought to the current effectiveness. Accessing reinforcers following pre-session access periods can provide practitioners with information about value- and behavior-altering effects of repeated exposure. Furthermore, manipulating pre-session access and restriction can be a powerful MO.

Greater emphasis should be placed on identifying and studying other types of MOs. A working technology of motivation is sorely limited if only one type of MO contains ample empirical support. This review described a number of MOs that warrant investigation. Furthermore, the works of Michael (1982; 1993; & 2000) are rich with examples of MOs that have yet to be fully analyzed, such as conditioned MOs.

**Analysis of motivating operations within classes of reinforcers.** Analysis of the MO literature for each class of reinforcer yielded nine articles related to primary reinforcers, 17 articles related to conditioned reinforcers, and two articles related to token reinforcers (note that some articles contained multiple classes of reinforcers). Overall, the effects of MOs on each class of reinforcer were mixed. The majority of the outcomes contained some discernable differentiation between MO conditions. However, these effects were either unclear for all participants or contained frequent overlapping data points.

**Primary reinforcers.** The only MO manipulated for primary reinforcers was pre-session access and restriction. This specific type of MO may be of limited utility in
altering the effectiveness of primary reinforcers. First, ethical concerns limit the extent to which primary reinforcers can be manipulated in applied settings. For example, although withholding lunch would act as an EO for edible reinforcers during work sessions, such a practice would violate the rights of the student. To address this concern, practitioners and researchers should take advantage of naturally occurring MOs. For example, in Edrisinha, O’Reilly, Sigafoos, Lanciona, and Choi (2010), EO sessions were conducted prior to lunch, whereas AO session were conducted after lunch. Additionally, in the AO condition, participants were given 15 min of pre-session access. Using a combination of naturally occurring MOs (e.g., lunch) and functionally defined MOs (e.g., pre-session access until rejection) may provide researchers with a reliable means of establishing and abolishing the value of primary reinforcers. This approach may also be useful when manipulating MOs for conditioned reinforcers.

Second, primary reinforcers are likely to be highly substitutable. Substitutable reinforcers refer to stimuli that share topographical and functional properties (Hursh, 1984). For example, a red M&M is substitutable for a green M&M. When a substitutable reinforcer is withheld, the individual will seek out other stimuli that have similar properties. These limitations could have contributed to the mixed findings. When practitioners or researchers are manipulating pre-session exposure, great care should be taken in selecting primary reinforcers that do not have readily available substitutes.

It may be necessary to examine other types of MOs for primary reinforcers that do not include manipulating pre-session access and restriction. For example, individuals who engage in primary reinforcer-maintained problem behavior could be given within-session
access to preferred edible items. Continuous access to the reinforcer maintaining the problem behavior would render the target behavior non-functional, essentially creating a window of opportunity to reinforce the desired behavior.

**Conditioned reinforcers.** Research related to the effects of MO manipulations on conditioned reinforcers had the largest body of empirical support. These studies examined the effects of four different types of MOs across a variety of conditioned reinforcers. Although a majority of the studies reported positive findings, examining the proportion of positive to mixed/negative MO manipulations suggested otherwise. A conservative analysis of this cross-section of studies is that the types of MOs examined by researchers have mixed effects on conditioned reinforcers and the target behaviors maintained by conditioned reinforcement. Once again, these limitations are likely due to the practice of using arbitrarily selected pre-session access and restriction durations.

Lastly, there are a number of MOs that act primarily on conditioned reinforcers. For example, a transitive CMO is a stimulus event that establishes the value of other stimulus events to function as reinforcers. The value of Tylenol is established as an effective conditioned reinforcer in the presence of a headache. Unfortunately, none of the studies included in this review examined these types of MOs.

**Token reinforcers.** One of the surprising findings of this analysis was the dearth of research related to the effects of MOs on token reinforcers. Tokens have a unique relation to MOs, as changes in MOs do not appear to act upon the token itself. Rather, MOs alter the effectiveness of the back-up reinforcers, which in turn can alter the value of the token. It has been suggested that the reinforcing value of tokens is relatively free
from the effects of MOs (Catania, 1998; Cooper et al., 2007; Skinner, 1953). However, this assumption has yet not undergone thorough analysis. Given the prevalence of token-based reinforcement systems, more research is needed to understand just how MOs influence this type of reinforcer.

**Analysis of motivating operations across classes of reinforcers.** Although two studies examined the effects of MOs on different classes of reinforcers, the results were inconclusive in terms of documenting differential effects of the MO. In Guitierrez et al. (2007), continuous access to the reinforcer made it impossible to determine the value of that item. Within-session access to the reinforcer concealed possible differential effects of the MO. When examining the effects of MOs across the classes of reinforcers, pre-session access and restriction would allow for the experimenter to determine the effectiveness of the reinforcer in both EO and AO conditions. Future research should investigate the effects of this MO on the different classes of reinforcers.

Moher et al. (2008) provided a good model for analyzing MOs across reinforcer classes. Reinforcers were alternated in a multielement design under EO and AO conditions. Unfortunately, the reinforcer classes under examination were essentially functionally equivalent. Future research could build off this study and use a token that is related to a variety of back-up reinforcers as well as other reinforcer classes. Under such an arrangement, differential effects of the MO may be more apparent.

Comparing the percent of positive results reported in the literature did not reveal any differential effects. The analysis of MOs across the classes of reinforcers suggest that attempts to manipulate MOs for primary and conditioned reinforcers were equally
effective. About one-third of the primary and conditioned reinforcer MO manipulations produced positive results. The overall low success rate makes it difficult to interpret these findings. It is possible that these results are a function of the abovementioned procedural limitations. Examining the effects of MOs across classes of reinforcers is ultimately an empirical endeavor. This literature review sought to lay the groundwork for such an investigation.

**Limitations**

This review contains a number of limitations that should be considered when evaluating the findings. First, this review included only studies that explicitly manipulated an MO for some identified reinforcer. As Langthorne and McGill (2009) demonstrated, many instances of behavior change can be put into terms of MOs post hoc. In other words, a study need not include the terminology of MO to apply the concept. Not including this body of research limits the overall findings. However, the purpose of the present review was to examine the current state of MO research. Therefore, only including studies that explicitly manipulated an MO was justifiable. Additionally, locating articles that manipulated MOs but did not include the terminology of motivation would be a highly subjective endeavor.

Second, the distinction between primary and conditioned reinforcers, although clear in concept, can be ambiguous in practice. For example, caloric intake functions as a primary reinforcer (e.g., Mazur, 2002). However, the specific food items that an organism eats, which provides caloric intake (e.g., spinach), may not strengthen behavior without some prior conditioning. In this regard, the distinction between a food item that has
acquired reinforcing value and a conditioned reinforcer is ambiguous. It was for this reason that the term primary reinforcer was used instead of unconditioned reinforcer, as it appears some conditioning may be involved. This paper categorized stimuli topographically, based in the definition provided above. Because the learning history of an organism is largely unknown, determining whether a reinforcer is unconditioned or conditioned takes some degree of guesswork.

Lastly, categorizing the results as positive, mixed, or negative is an oversimplification of the actual outcomes. These categories were selected and defined in such a way as to reduce subjectivity. A quantitative method of analyzing the results (e.g., nonoverlap of all pairs, Parker & Vannest, 2009) would have provided more detailed information about the findings of each article. However, providing this degree of information about the results was tangential to the purposes of this paper.

**Implications for Practice**

A working technology of motivation has two major implications for practitioners of behavior analysis. The first implication is primarily conceptual. MOs can be used to interpret environmental-behavioral relations. For example, escape-maintained challenging behavior is best understood within the context of MOs. Identifying the stimulus events that establish escape as a reinforcer may prove to be just as important as determining the function of the behavior. This type of analysis could be used to develop comprehensive programming in which both antecedent events and consequence events are altered in a systematic fashion to improve behavior. MOs should be included in the conceptual analysis of behavior. Current MO theory is well suited to this set of tasks.
The second implication involves the active manipulation of MOs, such as providing a student with pre-session access to attention in order to reduce attention-maintained challenging behavior during instructional times. Although such practices are supported by theory, the specific technology of manipulating MOs requires further investigation. Actively manipulating an MO for the purposes of treatment should be done with caution. It is important that such programs be carefully monitored and frequently evaluated. Manipulating MOs can have a number of iatrogenic effects, such as inadvertent reinforcement of problem behavior or a decrease in the effectiveness of a stimulus class to function as reinforcers. That being said, MOs are naturally occurring events and should be taken into consideration when developing intervention programs. However, at this time it seems premature to use MOs as a primary behavior change strategy. Instead, MO manipulations should be used in conjunction with other procedures. As the technology develops, MOs will ultimately become an important component of programs designed to change behavior. Individuals interested in manipulating MOs should consider the guidelines and recommendations for future research discussed below.

**Guidelines and Directions for Future Research**

Regardless of the type of MO, the value- and behavior-altering parameters (e.g., duration of pre-session restriction) should be determined empirically whenever possible. A technology of motivation will be slow to develop if such variables are arbitrarily selected. O’Reilly et al. (2009) provided a framework for empirically determining the duration of pre-session access. Future research examining this type of MO should adopt these procedures, or variations thereof. Furthermore, researchers should develop
procedures to empirically determine pre-session restriction durations. One approach would be to give participants continuous access to the putative reinforcer (e.g., edible items). The putative reinforcer could then be withheld for a pre-specified period of time, followed by a test condition in which the individual can contact the reinforcer on some schedule of reinforcement. The length of time that the reinforcer is withheld could be varied to yield an average duration necessary to establish the stimulus as a reinforcer. Unfortunately, the control necessary to determine the duration of pre-session restriction empirically may be difficult to achieve in an applied setting. Additional research is also needed to identify procedures for empirically determining the parameters of other types of MOs, such as rate of instructional demand.

Within-session access is a useful MO for researchers interested in examining NCR. This MO is free from the problems associated with time-based schedules of NCR, namely the reinforcement of other behaviors (Ecott & Critchfield, 2004). Research that used NCR as an MO was excluded from this review because the results were difficult to interpret. To the greatest extent possible, researchers should discontinue the use of time-based NCR when studying MOs. However, this may be difficult with certain reinforcers, such as attention. In this situation, time-based NCR schedules may be necessary, even though the results will be difficult to interpret. Comparing the effects of within-session access and time-based NCR on the frequency of a target behavior, as well as other response options may provide researchers and practitioners with valuable information. If such a study were conducted, it may be necessary to yoke the time-based NCR schedule to reinforcer consumption (or contact) during the within-session access condition.
MOs should be examined within the context of an experimental design with a baseline condition. When comparing MOs without a baseline (e.g., O’Reilly, Edrisinha, Sigafoos, Lancioni, Machalicek, et al., 2007) it is not clear if the AO levels represent a decrease in responding or if the EO levels represent an increase in responding relative to a free operant condition. Therefore, establishing a baseline is necessary to clearly demonstrate the effects of the AO and EO. Future research should always include a baseline or control condition so the independent effects of the AO and EO are readily observable.

Reviewing the MO research within and across classes of reinforcers revealed gaps in the literature that would have been difficult to identify through a standard literature review. First, more research regarding the effects of MOs on token reinforcement is needed. Second, researchers should examine a greater variety of MOs. Lastly, the effects of MOs on different classes of reinforcers should be directly compared.

If MOs are determined through functional means, it should be possible to compare the effectiveness of each class of reinforcer under EO and AO conditions. This line of research could reveal important information, such as the class of reinforcer that is most affected by changes in motivation and the class of reinforcer that is least affected by changes in motivation. Because such a study would involve manipulating two independent variables – the class of reinforcer and MO condition – a superordinate multielement design (Hains & Baer, 1989) with an initial baseline would be well suited to address this experimental question. Furthermore, the use of progressive ratio schedules of reinforcement and demand functions would allow for a thorough analysis of reinforcer
effectiveness. The proceeding chapter describes the methods used to evaluate the effects of MOs across each class of reinforcer.

Conclusion

The study of motivation has come a long way from the pre-scientific observations of Aesop and Bayly. Behavior analysts now possess a working theory of motivation with strong conceptual support and emerging empirical support. Although many of the studies included in this review had mixed results, future attempts to manipulate MOs hold much promise if they build thematically on the studies described in this review. Incorporating MOs into the analysis and treatment of behavior represents a major advancement in behavioral technology. Behavior analysts are on the cusp of making significant improvements. However, additional steps must be taken before the technology of motivation is fully actualized.
Chapter 3

METHODS

Participants

Three individuals participated in this study. Prior to involvement in the study, permission was obtained from a parent or guardian and each participant provided assent (See Appendix A). Jack was a 14-year-old male diagnosed with PDD-NOS, bipolar disorder, attention deficit hyperacidity disorder, and type II diabetes. Jack was ambulatory and spoke in complete sentences. Staff reported that Jack had a history of engaging in problem behavior, such as yelling and aggression, when presented with work demands. Jack had a total composite score of 61 on the Wechsler Individual Achievement Test (WIAT) III.

Michael was a 12-year-old male diagnosed with PDD-NOS. Michael was ambulatory and spoke in complete sentences. Although Michael did not engage in problem behavior, staff reported that he required frequent prompting to complete work tasks. Michael had a total composite score of 65 on the WIAT III.

Cheeto was a 5-year-old typically developing female. Cheeto spoke in complete sentences appropriate for her age. Staff reported that Cheeto was highly energetic and
enjoyed working for rewards. Five days a week, Cheeto attended a pre-kindergarten program in the morning and a childcare program in the afternoon.

**Experimenter and Research Assistants**

The experimenter was a third year doctoral candidate at The Ohio State University in the Applied Behavior Analysis and Special Education program. He had 10 years of experience developing and implementing interventions based on the principles of Applied Behavior Analysis at the time of this project. The experimenter was awarded a Bachelor’s degree in Psychology and a Master’s degree in Applied Behavior Analysis from The Pennsylvania State University. This project was completed in partial fulfillment of the requirements for a doctoral degree. The experimenter implemented all of the procedures described below, with the exception of the procedural integrity and interobserver agreement assessments.

One doctoral student, in the same program as the experimenter, served as the research assistant. He was responsible for conducting the procedural integrity and interobserver agreement assessments. The research assistant had extensive experience and training with data collection procedures similar to those used in this study. The experimenter trained the research assistant by describing and modeling the procedural integrity and interobserver agreement assessment procedures. The research assistant was asked to then describe the procedures to the experimenter in his own words. Training continued until the research assistant fully described both the procedural integrity and interobserver agreement procedures.
Setting

All sessions for Jack and Michael were conducted in a 9 ft by 10 ft therapy room in a private suburban school for children with autism. The therapy room contained two tables, three chairs, and the materials necessary for the given session. The school, located in central Ohio, served 72 students (63 males and 9 females). The students ranged in age from 4- to 21-years of age. Forty-four percent of the students were identified as Caucasian, 4% as African American, 3% as multi-racial, and 21% did not indicate an ethnicity.

Jack and Michael took part in a school-wide token economy program. About once a week, students were able to exchange points for back-up reinforcers, such as trading cards, snacks, or toy trucks. The students were required by staff to take the back-up reinforcers home. Students were not permitted to play with the back-up reinforcers during most school hours.

The sessions for Cheeto were conducted in a 10 ft by 12 ft section of a basement in a private after-school childcare program. The area of the basement, where sessions occurred, contained two chairs, a small table, and the materials necessary for the given session. The after school childcare program was located in a suburban community in central Ohio. At the time of this research, the after-school program served two children (1 male and 1 female).

Materials

The materials included the items necessary to engage in the dependent variable (e.g., math sheets and pencil), reinforcers (e.g., action figures and string cheese), a digital
timer, and data sheets (See Appendix B). Data sheets were created for each of the assessments (e.g., preference assessment and baseline). A Kodak EasyShare DX7630 digital camera, with a two-gigabyte memory card and tri-pod, was used to record sessions for the purposes of assessing procedural integrity and interobserver agreement. Finally, three different colored pieces of paper (white, green, and orange) were used to aid in the discrimination of each reinforcer class.

Preliminary Procedures

Preference assessments. A multiple stimulus without replacement (MSWO) preference assessment was conducted according to the procedures described by DeLeon and Iwata (1996) in order to identify two potential primary and conditioned reinforcers. Five stimuli from each class were selected for the MSWO preference assessments. These stimuli were items that the participant did not have regular access to during school hours. Separate MSWOs were conducted for primary and conditioned stimuli. The stimuli available to each participant were individually determined through direct observation of the participant in his/her natural setting and interviews with the participant as well as relevant staff members. Table 3.1 shows the stimuli selected for each participant. Prior to the start of the first MSWO preference assessment, participants were given the opportunity to sample each of the items. The participants were given two samples of each primary stimulus, and two 30 s opportunities to contact each conditioned stimulus. MSWO preference assessments occurred one to three times per day. Each stimulus class was assessed no more than twice per day.
At the start of each session, the five primary or conditioned stimuli were presented in a horizontal array on the table about 5 cm apart. The order of the stimuli was randomized across MSWO trials. The participant was instructed to pick one of the stimuli. Attempts to pick more than one item were blocked by the experimenter. Following the selection of a stimulus, the participant was allowed to consume the item in the case of a primary stimulus, or to engage with the item for 30 s in the case of a conditioned stimulus. The remaining stimuli were removed and then represented in a different order. Again the participant was instructed to pick one of the items. This process continued until all of the stimuli in the array were selected or until 30 s elapsed from the start of the trial without a selection.

Table 3.1. Primary and Conditioned Stimuli Selected for Preference Assessment

<table>
<thead>
<tr>
<th></th>
<th>Jack</th>
<th></th>
<th>Michael</th>
<th></th>
<th></th>
<th>Cheeto</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary</td>
<td>Conditioned</td>
<td>Primary</td>
<td>Conditioned</td>
<td>Primary</td>
<td>Conditioned</td>
</tr>
<tr>
<td>Diet Coke</td>
<td>Science Project</td>
<td>M &amp; M</td>
<td>Lego Set</td>
<td>Cheese Popcorn</td>
<td>Barbie Dolls</td>
<td></td>
</tr>
<tr>
<td>Pork Rinds</td>
<td>Action Figures</td>
<td>Trix Cereal</td>
<td>Action Figures</td>
<td>Goldfish</td>
<td>Wooden Dress-Up Doll</td>
<td></td>
</tr>
<tr>
<td>String Cheese</td>
<td>Toy Cars</td>
<td>Reece’s Cereal</td>
<td>Toy Cars</td>
<td>Wheat Thins</td>
<td>Books</td>
<td></td>
</tr>
<tr>
<td>Cashews</td>
<td>Microscope</td>
<td>Fruit Loops</td>
<td>Microscope</td>
<td>Jello</td>
<td>Play Dough Set</td>
<td></td>
</tr>
<tr>
<td>Jello</td>
<td>Car Track</td>
<td>Fruit Snack</td>
<td>Car Track</td>
<td>Cheetos</td>
<td>Wooden Pizza Toy</td>
<td></td>
</tr>
</tbody>
</table>
Five MSWO preference assessments were conducted for each stimulus class. Each of the stimuli was rank ordered within the respective class (primary or conditioned) according to the participant’s selection (Ciccone, Graff, & Ahearn, 2005). The total rank score maximum was 25. The top two stimuli from each class were selected for inclusion in the MO analysis.

**Functional skills assessment.** A two-stage functional skills assessment was conducted to identify a socially significant dependent variable for each participant. The functional skill assessments followed the guidelines for selecting a target behavior established by Cooper et al. (2007). In the first stage, the experimenter observed the participant in his/her natural setting and interviewed the participant as well as relevant staff members concerning a skill in need of improvement. The purpose of this stage was to identify two to three potential dependent variables. To be considered, the behavior had to (a) be an already acquired skill, (b) be discrete, with a clear onset and offset, and (c) occur with sufficient frequency to allow for observation in the appropriate context.

In the second stage of the functional skills assessment, each of the potential dependent variables was performed by the participant in a controlled setting. The purpose of this stage was to determine the dependent variable of best fit; that is to say, the dependent variable was functionally meaningful to the participant and had characteristics suited to the research study. The experimenter selected the dependent variable that best characterized the aforementioned qualities. The functional skills assessment took place over the course of one school week.
Conditioning the token reinforcer. The procedures used to condition the token as a reinforcer were adapted from those described by Sran and Borrero (2010). Tokens (colored plastic chips) were paired with the putative primary and conditioned reinforcers identified during the MSWO preference assessments in a series of two 3-block trials. During each trial, the participants were given tokens non-contingently. Jack and Michael were given four tokens and Cheeto was given two tokens. Participants were then prompted to exchange the tokens, by handing them to the experimenter. When all of the tokens were exchanged, the participant was given access to the back-up reinforcer. Finally, because a verbal explanation of the relation between the token and back-up reinforcer is often enough to establish the token as a reinforcer (Kazdin & Bootzin, 1972), the contingency was described to each participant during the first trial of each block. Token conditioning took place during one school day.

Motivating Operations Across Reinforcer Class Analysis Procedures

Most of the sessions for Jack and Michael occurred once a day. During the final two AO conditions, Jack and Michael participated in up to two sessions a day, due to time constraints. Sessions occurred during normal schools hours up to five days a week, Monday through Friday. Sessions for Cheeto occurred one to two times a day, up to six days a week, Monday through Saturday. A number of the procedures for Cheeto were modified due to the participant’s responding during the functional skills assessment (e.g., Cheeto had difficulty remaining in-seat for even short durations of time). These changes are noted below in the respective sections.
In an attempt to minimize changes in motivation as a result of unanticipated events, the time of day that sessions occurred was held relatively constant for each participant. The experimenter escorted each participant to and from the therapy room. Session duration varied according to the condition. Sessions ranged between 1 and 130 min in length. Interaction between the participant and the experimenter was kept to a minimum. No verbal praise was provided in any of the conditions. To aid in discrimination of the reinforcement conditions, a different colored piece of paper was associated with each reinforcer class (primary reinforcer = green paper, conditioned reinforcer = white paper, and token reinforcer = orange paper).

**Baseline.** A baseline was conducted to determine the frequency of the dependent variable in the absence of a programmed contingency. At the start of each baseline session, the participant was given the instruction, “You can do as much work as you like. You don’t have to do any work if you don’t want to. There are no rewards to earn this session.” This instruction served multiple purposes. First, the participants were previously taught to complete work tasks that were given to them. Second, the participants had a history of receiving intermittent reinforcement for task engagement. Third, the instruction made the differences between each condition more salient and may have aided in discrimination across conditions.

Following the instruction, the participant was given the appropriate task materials. There was no programmed consequence for engaging in the dependent variable. Baseline sessions lasted 10 min or until 30 s elapsed without an occurrence of the dependent
variable or behaviors related to the completion of the dependent variable (e.g., looking at math problems on the sheet, holding a pencil, and counting).

The baseline sessions for Cheeto included a discrete termination response. Along with the instructions stated above, Cheeto was told, “If you are done working, put your pen in the cup.” The cup was located about 2 ft in front of the participant. When Cheeto put the pen in the cup the experimenter asked, “Are you sure you are done working?” If she said “yes”, the session was terminated. If she said “no”, the experimenter took the pen out of the cup and handed it to her.

**Pre-session access.** This condition was designed to abolish the value of the reinforcers and decrease the current frequency of the dependent variable. During the pre-session access condition, participants were given continuous access to the reinforcers until the stimuli were rejected. The specific reinforcer class under examination varied across sessions according to the multielement design.

During primary and conditioned reinforcer sessions, the participant was given free access to the top two preferred stimuli in that class. Primary reinforcers were presented on a plate, one at a time. After the participant consumed one of the items, the item was replaced by the experimenter. During token reinforcer sessions, the participant was given free access to the top two preferred stimuli in both the primary and conditioned reinforcer classes. To take advantage of naturally occurring AOs, sessions occurred after participants ate their lunch or dinner and were given free time (Edrisinha, O’Reilly, Sigafoos, Lancioni, & Choi, 2010).
At the start of each pre-session access period, the participant was given the instruction, “Here are some things for you to play with (and/or eat). You can have as much as you want. When you are done say ‘I am done’ or just wait a few seconds.” The participant was asked to repeat the phrase to terminate the pre-session access period. There was no time limit imposed on the duration of pre-session access. Pre-session access was terminated after approximately 30 s (± 3 s) elapsed without active engagement with the putative reinforcer or the participant said something to the equivalent of “I am done”. The pre-session access condition for Cheeto included verbal prompts delivered on a fixed time schedule. Every 2 min the experimenter said, “When you are done say ‘I am done’ or just wait a few seconds.” The MO analysis sessions occurred immediately after the participants were given pre-session access.

**Pre-session restriction.** This condition was designed to establish the value of the reinforcers and increase the current frequency of the dependent variable. During the pre-session restriction condition, access to the reinforcers was withheld, to the greatest extent possible, for about 24 hr (± 2 hr). A 24 hr restriction period was selected because observations conducted during the preference assessments and functional skills assessments suggested that this period of time was sufficient to establish the value of the reinforcer. Additionally, a 24 hr restriction period meant sessions could occur at roughly the same time each day. Although a period of less than 24 hr may have been sufficient to establish the value of the reinforcer, having sessions occur at different times of the day would introduce a potential confounding variable.
Parents and staff were asked to not provide access to the specific stimuli used in this investigation during the pre-session restriction condition. As a precautionary measure, reinforcers were selected that the participant did not have regular access to during school hours. For example, although the school Jack and Michael attended had a few toys for the students to play with, none of the toys resembled the car track or action figures used in the MO analysis sessions. Pre-session restriction occurred in the participants’ natural environment (e.g., school and home). Motivating operation analysis sessions occurred immediately following the pre-session restriction period.

**Motivating operations analysis.** The purpose of the motivating operations analysis sessions was to examine the effects of pre-session access and restriction on the frequency of the dependent variable. Therefore, these sessions occurred after participants experienced pre-session access or restriction. At the start of each session, the participant was given the instruction, “You can do as much work as you like. You don’t have to do any work if you don’t want to. You can earn food (and/or toys to play with) this session when you do your work.” Following the instruction, the participant was given the appropriate task materials.

Reinforcement was delivered according to a progressive ratio (PR) schedule of reinforcement. When using a PR schedule, the response requirements increase progressively with each successive reinforcer or trial (Hodos, 1961; Hodos & Kalman, 1963). For example, if the PR was two and set to increase after each trial, the organism would be required to emit two responses for the first reinforcer, four responses for the second reinforcer, and six responses for the third reinforcer. PR schedules are useful in
determining the effectiveness of a reinforcer. When two or more reinforcers are compared using a PR schedule, the reinforcer that maintains behavior under the highest response requirement level is deemed to be the most effective (Hodos & Kalman, 1963).

The PR schedule for each participant was set to increase after the completion of a trial. For Jack and Michael, a trial consisted of four PR schedules followed by access to the reinforcer. For example, with a PR 2 the participant would be required to complete eight target responses before contacting the terminal reinforcer. For Cheeto, a trial consisted of two PR schedules followed by access to the reinforcer. At the trial level, the reinforcement schedule resembled a chain schedule for tokens and a tandem schedule for primary and conditioned reinforcers. The number of responses required to complete the schedule was determined by the PR schedule. A PR 1 was used for all of the participants. However, the maximum PR value was determined individually by using the information gathered during the functional skills assessment. Initially, the participants had to complete one response to fulfill the PR response requirement, after the reinforcers were delivered, the ratio requirement increased by one, such that two responses were required. The maximum PR value was 7 for Jack, 6 for Michael, and 6 for Cheeto.

The class of reinforcer available at any given session varied according to the multielement design. Sessions continued until the maximum PR value was met or 30 s elapsed (± 3 s) without an occurrence of the dependent variable or behaviors related to the completion of the dependent variable. If the participant said he/she wanted to leave, the experimenter repeated the initial instruction.
The MO analysis sessions for Cheeto included a discrete termination response. Along with the instructions stated above, Cheeto was told, “If you are done working, put your pen in the cup.” The cup was located about 2 ft in front of the participant. When Cheeto put the pen in the cup the experimenter asked, “Are you sure you are done working?” If the participant said “yes”, the session was terminated. If the participant said “no”, the experimenter took the pen out of the cup and handed it to the participant.

**Primary reinforcers.** During the primary reinforcer sessions, both of the primary reinforcers identified through the MSWO were delivered immediately following the completion of four PR response requirements for Jack and Michael, and two PR response requirements for Cheeto. The participants were given approximately 30 s to consume all of the items. The two primary reinforcers were string cheese and Jello for Jack, Reece’s cereal and fruit snacks for Michael, and popcorn and Cheetos, for Cheeto. The portion size of each edible item was held constant across trials and sessions (e.g., two fruit snacks and two pieces of Reece’s cereal for Michael).

**Conditioned reinforcers.** During the conditioned reinforcer sessions, both of the conditioned reinforcers identified through the MSWO were delivered immediately following the completion of four PR response requirements for Jack and Michael, and two PR response requirements for Cheeto. The participants were given 120 s to interact with the items. The two conditioned reinforcers were action figures and car track for Jack and Michael, and play dough and wooden dress-up doll for Cheeto.

**Token reinforcers.** During the token reinforcer sessions, a token was delivered immediately following the completion of the PR response requirements. These sessions
were designed to be an analog of a real token economy, in which a variety of back-up reinforcers were available (Ayllon & Azrin, 1968). Therefore, once Jack and Michael accumulated four tokens or Cheeto accumulated two tokens, they were exchanged for both of the primary and conditioned reinforcers. In this regard, the token was a conditioned generalized reinforcer (Skinner, 1953), a stimulus exchangeable for a number of other reinforcers. The reinforcers available during token sessions were equal to the reinforcer available in the primary and conditioned sessions combined. The participants were given 120 s to consume and interact with the items.

**Dependent Variables and Response Measurement**

**Preference Assessments.** Stimulus selection served as the dependent variable for the preference assessments. Stimulus selection was defined as physical contact with one of the items presented in the array. The stimulus array was arranged in such a way that accidental contact with the stimuli was unlikely. If the participant made contact, or attempted to make contact, with more than one stimulus only the first contact was recorded. After a selection was made and the participant was given the opportunity to consume or contact the selected item, the trial ended. If any stimuli remained in the array, a new trial was presented. The first selection of each trial was recorded. Trials continued until all of the stimuli in the array were selected or 30 s elapsed without a selection. The experimenter recorded the sequence of the array from left to right and the item selected for each trial on the data sheet.

**Motivating operations analysis.** The dependent variables for the motivating operations analysis were determined through a two-stage functional skills assessment
conducted by the experimenter. The dependent variables for Jack and Michael were correct responses to math problems. The math problems for Jack were single digit addition, with numerals 0 to 10, and the math problems for Michael were single digit multiplication, with numerals 0 to 6. Math problems were presented on worksheets. Each sheet contained 20 problems horizontally arranged. A correct response was scored when the participant’s response matched the actual value of the mathematical equation. The experimenter recorded the number of correct math problems on the data sheet.

The dependent variable for Cheeto was correctly transcribing four-letter words. Cheeto was given a worksheet that contained two columns. In the left column, there were 16 four-letter words. Each word was in size 22 font and started with a capital letter, followed by three lowercase letters (e.g., Fame, Maze, and Vest). In the right column, besides each word, there was an empty box. A correct response was scored when Cheeto wrote the word as it appeared in the left column in the empty box.

Finally, if the participant made an error, the experimenter informed the participant of the error. The participant was then prompted to make the appropriate corrections. In this regard, each terminal response was correct.

**Experimental Design and Data Analysis**

A superordinate multielement design (Hains & Baer, 1989) with an initial baseline was used to examine the effects of primary, conditioned, and token reinforcers across establishing and abolishing operation conditions. “By embedding a multielement design within a reversal design, treatment interactions and operative contextual controls can be examined relatively efficiently” (Neef, 2008, p. 60). An initial baseline condition
was included to determine the level and pattern of the dependent variable prior to the introduction of the independent variables. The interactions examined between reinforcer class and MO condition are depicted in Figure 3.1. The EO and AO conditions were counterbalanced across participants. Although counterbalancing does not eliminate sequence effects, it allows them to be observed (Hains & Baer, 1989). The classes of reinforcers were alternated in a quasi-random order, such that each combination of non-successive conditions (e.g., token following primary and token following conditioned) occurred within each phase and no more than two sessions with the same reinforcer class occurred in succession. Examining each combination of non-successive conditions could reveal possible sequence effects. For instance, if a low rate of the target behavior was observed in the conditioned reinforcer sessions that occurred after token reinforcer sessions, but not after primary reinforcer sessions, it could be possible that the sequence of conditions was exerting some control over the dependent variable.

Figure 3.1. The interactions examined between reinforcer class and motivating operation condition.
This design made it possible to analyze the effects of MOs across and within each class of reinforcer. Decisions to change experimental conditions were made using the steady-state strategy (Johnston & Pennypacker, 2009). The steady-state strategy is an “approach to making experimental comparisons that involves measuring responding … to assess and manage extraneous influences and thereby obtain a stable pattern” (Johnston & Pennypacker, 2009, p. 195). For the purposes of this research study, a steady state or trend of at least three data points during each initial condition (i.e., the first pre-session access condition and the first pre-session restriction condition) was required before changing conditions. Therefore, each of the initial motivating operation conditions contained at least nine sessions (i.e., three primary, conditioned, and token reinforcement sessions). The total number of MO condition comparisons was determined by the time remaining in the school year, stability of the data, and the extent to which a functional relationship had been demonstrated.

Three data analysis procedures, similar to those described by Roane, Call, and Falcomata (2005), were used to examine the interactions between reinforcer class and MO condition on the dependent variable. First, the frequency of the dependent variable under each interaction condition was examined. Because sessions contained multiple trials in which the number of possible responses per trial was held constant, or in the case of baseline the session duration was held constant, frequency was the preferred unit of measurement (Cooper et al., 1987). For the purposes of this study, frequency refers to
count per observation time (Cooper et al., 2007). Frequency was calculated by counting the number of times the dependent variable occurred during each session.

Second, a work-demand function was used to examine changes in the dependent variable under each interaction condition as the result of increased response requirements. A work-demand function “describes changes in the rate of responding (or work emitted) as the schedule requirement increases” (Tustin, 1994, p. 598). The work-demand function was formed by calculating the mean frequency of the dependent variable at each PR response requirement. A work-demand function with a slope of one (i.e., a straight diagonal line) means the dependent variable occurred the maximum number of times despite increasing response requirements. This pattern of performance would be associated with a very powerful reinforcer, all things being equal. The point at which the slope falls below one, also known as the break point, shows the pattern of response degradation as a result of increased response requirements.

Third, a reinforcer-demand function was used to examine changes in the frequency of reinforcement under each interaction condition as the result of increased response requirements. A reinforcer-demand function describes changes in the frequency of reinforcement as the schedule requirement increases (Hursh, 1984). The reinforcer-demand function was formed by calculating the mean frequency of reinforcement delivery at each PR response requirement. A reinforcer-demand function at the highest value on the y-axis with a slope of zero (i.e., a straight horizontal line) means that the maximum number of reinforcers were obtained despite increasing response requirements. This pattern of performance would be associated with a very powerful reinforcer, all
things being equal. The break point of a reinforcer-demand function shows the degradation of reinforcers obtained as a result of increased response requirements.

The demand curves depict the mean frequency of the dependent variable at each reinforcer response requirement. However, according to the procedures described above, a session ended once the participant met the termination criteria. Therefore, it was possible for a participant to never experience certain PR requirements. When examining the demand curves, it is important to note that a participant did not experience the PR requirements that exceeded the level in which the termination criteria were met.

**Procedural Integrity and Interobserver Agreement**

Procedural integrity of the MO across reinforcer class analysis procedures was assessed by the research assistant. Sessions were videotaped because it was not feasible to have the research assistant on site to assess procedural integrity. At minimum, 75% of all sessions were videotaped (79% for Jack, 75% for Michael, and 81% for Cheeto). The sessions were selected in a quasi-random fashion to be recorded, such that each condition was sampled multiple times throughout the experiment. The research assistant used a task analysis developed by the experimenter to mark the presence or absence of the procedural component (e.g., providing the proper instruction at the start of the session). A separate task analysis was developed for each of the conditions (See Appendix C). Procedural integrity was assessed for at least 34% of the sessions (35% for Jack, 43% for Michael, and 34% for Cheeto).

Procedural integrity coefficients were calculated by dividing the number of steps completed by the total number of steps in the task analysis and then multiplying by 100.
Finally, the mean of the procedural integrity coefficients was calculated for each participant. The mean procedural integrity was 100% for Jack, Michael, and Cheeto.

Interobserver agreement (IOA) was assessed by comparing the records of the experimenter and the research assistant who independently measured the occurrence or non-occurrence of the dependent variable within each trial as well as the frequency of the dependent variable. The research assistant was given videotaped sessions and copies of the permanent product (e.g., completed math sheet) to score. IOA was assessed for at least 33% of the sessions (33% for Jack, 43% for Michael, and 35% for Cheeto).

IOA coefficients were calculated using the trial-by-trial and total count methods (Cooper et al., 2007). In combination, these two methods provide a conservative measure of IOA. The trial-by-trial method was used to measure occurrence and non-occurrence IOA of the dependent variable within each discrete trial. Trial-by-trial IOA was calculated by dividing the number of trials with agreements by the total number of trials and then multiplying by 100. The mean IOA using the trial-by-trial method was 100% for Jack, Michael, and Cheeto. Because it was not possible for the research assistant to determine the exact amount of work completed per trial or the distribution of work through examination of the permanent product, total count IOA was also calculated. Total count IOA was calculated by dividing the smaller count by the larger count and then multiplying by 100. The mean IOA using the total count method was 100% for Jack, Michael, and Cheeto.
Chapter 4

RESULTS

Jack

Preference assessments. The results of the MSWO preference assessments for Jack are presented in Figure 4.1. String cheese was the most frequently selected putative primary reinforcer (ranked score: 23), followed by Jello (ranked score: 17). The car track was the most frequently selected putative conditioned reinforcer (ranked score: 21), followed by action figures (ranked score: 19). The top two primary and conditioned reinforcers were used in the MO analysis.
The total ranked score (maximum = 25) for each putative primary and conditioned reinforcer for Jack.

Motivating operations across reinforcer class analysis. The frequency of the dependent variable under each interaction condition is depicted in Figure 4.2. During baseline in which there was no programmed consequence, Jack completed zero math problems. In the subsequent conditions, reinforcement was made contingent upon the completion of math problems according to a PR schedule.

In the first condition following baseline, Jack was given pre-session access to the reinforcers until the items were rejected. The mean duration of pre-session access was about 51 min (primary reinforcer $M = 23$ min, range: 16.75–22.25 min; conditioned reinforcer $M = 66$ min, range: 42.25–88.5 min; token reinforcer $M = 67$ min, range: 43.3–89.25 min). Initially the levels of responding were highly variable; between sessions 5 and 14 an increase and subsequent decrease was observed in the number of math problem completed in association with each reinforcer (primary reinforcer $M = 12.6$, range: 0–39;...
conditioned reinforcer $M = 15.2$, range: 0–76; token reinforcer $M = 4$; range: 0–12). The last two data points of the condition for each class of reinforcer were stable at zero.

Figure 4.2. The number of math problem completed under each interaction condition for Jack.

In the second condition following baseline, access to the reinforcer was restricted prior to the start of the session. The longest pre-session restriction period was about 96 hr, which occurred as a result of Jack being absent on a Monday following the weekend. The frequency of completed math problems associated with each reinforcer class was relatively stable across the condition. A sharp increase in the level of responding was observed in the primary ($M = 93.3$, range: 84–112) and token ($M = 84$, range: 84) reinforcer sessions relative to the pre-session access condition. During the conditioned
reinforcer sessions ($M = 9.3$, range: 4–12), there was a slight increase in the number of math problems completed. The frequency of completed math problems was low when compared to the other classes of reinforcers.

Following a reversal to the pre-session access condition, the frequency of completed math problems immediately decreased to zero. The mean duration of pre-session access was about 27 min (primary reinforcer $M = 13$ min, range: 0.75–23.3 min; conditioned reinforcer $M = 48$ min, range: 23.3–79.25 min; token reinforcer $M = 19.3$ min, range: 0.25–35.5 min).

During the next condition, access to the reinforcer was again restricted. The longest pre-session restriction period was about 72 hr, which occurred as a result of the weekend. The frequency of completed math problems, associated with each class of reinforcer, increased to levels similar to those observed during the first pre-session restriction condition (primary reinforcer $M = 98$, range: 84–112; conditioned reinforcer $M = 2.6$, range: 0–4; token reinforcer $M = 86$, range: 60–112).

In the final phase of the experiment, the pre-session access condition was reinstated. The mean duration of pre-session access was about 12 min (primary reinforcer $M = 18.25$ min, range: 16.5–20 min; conditioned reinforcer $M = 0.07$ min, range: 0.07 min; token reinforcer $M = 17.2$ min, range: 0.07–34.3 min). Jack completed zero math problems during this condition.

**Demand functions analysis.** Figures 4.3 and 4.4 show the demand functions during the pre-session access and pre-session restriction conditions, respectively. The work-demand and reinforcer-demand functions for the first pre-session access condition
(leftmost panels of Figure 4.3) reflects the variability observed during the start of the phase. Differences in the amount of work completed and number of reinforcers contacted across reinforcer class were minimal. However, Jack most consistently completed the largest amount of work and contacted the highest percent of reinforcers during the primary reinforcer sessions. These results suggest that primary reinforcers were slightly more effective during pre-session access than tokens or conditioned reinforcers, which was evident by the higher break point. The single highest reinforcer response requirement completed occurred during a conditioned reinforcer session. However, with the exception of this one session, Jack completed zero math problems in all other conditioned reinforcer sessions.

The work-demand and reinforcer-demand function for the second and third pre-session access conditioned (middle and rightmost panels of Figure 4.3) show that Jack did not complete any math problems or contact any of the available reinforcers contingent upon work completion. These results suggest that pre-session access until rejection was equally effective at abolishing the reinforcing value of each reinforcer class. The results of the first pre-session condition, as it relates specifically to the level of responding observed during the primary reinforcer sessions, were not replicated.
Figure 4.3. Work-demand (top panels) and reinforcer-demand (bottom panels) functions for each pre-session access phase of the motivating operations across reinforcer analysis for Jack. Reinforcer response requirements are plotted along the x-axis.

The top left panel of Figure 4.4 shows the work-demand function during the first pre-session restriction condition for Jack. Jack completed similar amounts of work during the primary and token reinforcer sessions. However, as the response requirements increased to 28, a greater degradation was observed in the amount of work completed in the token sessions. This difference was slight and was only observed during one session. Overall, the primary and token reinforcer maintained a high level of responding despite the increases in reinforcer response requirements. These patterns of responding are typically associated with powerful reinforcers. During the conditioned reinforcer sessions, the amount of work completed fell sharply as the reinforcer response requirements increased beyond the initial requirement of four responses. Relative to primary and token reinforcers, the break point observed during the conditioned reinforcer
sessions suggests that conditioned reinforcers had significantly less reinforcing value.

The bottom left panel of Figure 4.4 shows the reinforcer-demand function. Jack contacted the most reinforcers during the primary reinforcer sessions, followed by the token reinforcer sessions. Again, the difference between the primary and token reinforcer sessions was slight in terms of number of reinforcers contacted. During the conditioned reinforcer sessions, Jack consistently the conditioned reinforcer under the initial response requirements. However, as the response requirements increased an immediate degradation in responding was observed.

Figure 4.4. Work-demand (top panels) and reinforcer-demand (bottom panels) functions for each pre-session restriction phase of the motivating operations across reinforcer analysis for Jack. Reinforcer response requirements are plotted along the x-axis.
The work-demand and reinforcer-demand functions for the second pre-session restriction condition are presented in the rightmost panels of Figure 4.4. Responding during the primary reinforcer sessions was similar to the pattern observed in the first pre-session restriction condition. The break point for the primary reinforcer sessions was higher than the other two classes of reinforcers. This finding replicates the results of the first pre-session restriction condition, suggesting that primary reinforcers were the most effective reinforcer for Jack. Overall, the token and conditioned reinforcers appeared to be slightly less effective in the second pre-session restriction condition than in the first. During the token reinforcer sessions, the break point occurred at 24 responses. However, at the highest reinforcer response requirement Jack completed more work and contacted more reinforcers than the first pre-session restriction condition. Taken together, the reinforcing effectiveness of the primary and token reinforcer appear to be similar, with the primary reinforce being slightly more effective. As with the first pre-session restriction condition, the conditioned reinforcer was associated with the lowest break point. Jack completed less work and contacted less reinforcement during the second conditioned reinforcer phase when compared to the first.

**Michael**

**Preference assessments.** The results of the MSWO preference assessments for Michael are presented in Figure 4.5. Fruit snacks were the most frequently selected putative primary reinforcer (ranked score: 23), followed by Reece’s Cereal (ranked score: 22). The action figures were the most frequently selected putative conditioned reinforcer (ranked score: 25), followed by the car track (ranked score: 15). The top two primary and
conditioned reinforcers were used in the MO analysis. The car track and microscope had the same ranked score. The car track was used in the MO analysis because preference for the microscope decreased over the course of the assessment period.

Figure 4.5. The total ranked score (maximum = 25) for each putative primary and conditioned reinforcer for Michael.

Motivating operations across reinforcer class analysis. Figure 4.5 presents the frequency of completed math problems under each interaction condition. During the baseline condition, Michael completed zero math problems for all three sessions.

In the first MO manipulation condition, access to the reinforcer was restricted prior to the start of the session. The longest pre-session restriction period was about 72 hr, which occurred as a result of time that elapsed between Friday and Monday. Following the introduction of the reinforcement contingency, an immediate increase in the number of math problems completed was observed for each reinforcer class. During
the primary reinforcer sessions ($M = 30$, range: 24–40), the number of math problems completed was relatively stable. The increase in frequency observed in session eight reflects the completion of one additional trial relative to the two other primary reinforcer sessions. During the conditioned reinforcer sessions, the frequency of completed math problems was low and stable. Michael completed 12 math problems for each of the three sessions, which was the lowest frequency observed during the first pre-session restriction condition. Finally, during the token sessions, Michael completed 60 math problems for each of the three sessions. The highest frequency of completed math problems during the first pre-session restriction condition occurred in the token reinforcer sessions.

In the next condition, Michael was given pre-session access to the reinforcers until the items were rejected. The mean duration of pre-session access was about 10 min (primary reinforcer $M = 3$ min, range: 2.2–6.6 min; conditioned reinforcer $M = 16$ min, range: 13.6–18.3 min; token reinforcer $M = 9$ min, range: 3–14.7 min). The number of completed math problems fell sharply with the change of conditions. During the primary and token reinforcer sessions ($M = 2.6$, range: 0–4), the frequency of completed math problems was low and stable at near zero levels for all three sessions. The frequency of math problems completed decreased from four in the first sessions to zero the second sessions. In the final session for both classes, Michael completed four problems. During the conditioned reinforcer sessions, Michael completed zero math problems for all three sessions.
A reversal to the pre-session restriction condition was initiated during the third phase of the experiment. The longest pre-session restriction period was about 72 hr, which occurred as a result of the weekend. An immediate increase in the number of math problems completed was evident for each reinforcer class. However, this initial increase represents the completion of only one additional trial for primary and conditioned reinforcers relative to the number of trials completed during the pre-session access condition. Therefore, the change in level is best described as modest. The initial increase associated with the token session was markedly higher than the other reinforcer classes. However, this increase was lower than the level of responding observed in the first token reinforcer pre-session restriction sessions. During the primary reinforcer sessions ($M = 18$, range: 12–24), the number of math problems completed increased from 12 the first
two session to 24 for the last two sessions. The last two data points overlap the level observed in the first pre-session restriction condition. During the conditioned reinforcer sessions, Michael completed 12 math problems for all three sessions. This was the same number of math problems completed in the first pre-session restriction condition. During the token reinforcer sessions \((M = 20.8, \text{ range: } 4–40)\), the frequency of the dependent variable was highly variable. The data path osculated between high and low points. The highest point was session 24, in which Michael completed 40 problems. The lowest point was session 30, in which Michael completed four problems. All of the data points were well below the level observed in the first pre-session restriction condition. However, with the exception of session 30, the frequency of the dependent variable for all of the token sessions was relatively higher than the prior pre-session access sessions.

A reversal to the pre-session access condition was initiated during the fourth phase of the experiment. The mean duration of pre-session access was about 4 min (primary reinforcer \(M = 2.4\) min, range: 1.3–5.5 min; conditioned reinforcer \(M = 4\) min, range: 0.5–6 min; token reinforcer \(M = 5.5\) min, range: 1.75–10 min). The reintroduction of pre-session access corresponded with an immediate decrease in the level of responding associated with the primary \((M = 2; \text{ range } 0–4)\) and conditioned \((M = 0.8; \text{ range } 0–4)\) reinforcer. The number of math problems completed during these sessions was nearly identical to the levels observed during the first pre-session access condition. During the token sessions \((M = 9.3; \text{ range } 4–12)\), responding was relatively stable. There was a small decrease in the number of math problems completed with the re-introduction of pre-
session access. However, compared to the previous pre-session access condition, Michael completed more math problems.

In the final two conditions of the experiment, the conditioned reinforcer sessions were discontinued to allow for additional examinations of the primary and token reinforcers with the time remaining in Michael’s school year. The decision to discontinue the conditioned reinforcer sessions was based on the stability observed in both the pre-session access and pre-session restriction conditions. First, access to the reinforcers was restricted prior to the start of the session. The longest pre-session restriction period was about 72 hr. The level of responding associated with primary and token reinforcers immediately increased following the start of the condition. The increase represents the completion of one to two additional trials relative to the pattern of responding that occurred in the previous condition. During the primary reinforcer sessions ($M = 24$), the number of math problems completed was stable at a level that matched all of the previous pre-session restriction conditions. During the token reinforcer sessions ($M = 32$; range 24–40), an increasing trend was observed in the number of math problems completed. The level of responding fell within the range of the previous pre-session restriction condition.

Second, Michael was given pre-session access to the items. The mean duration of pre-session access was about 7 min (primary reinforcer $M = 4.5$ min, range: 1.3–7.75 min; token reinforcer $M = 9.2$ min, range: 4.25–12.6 min). After reinstating the pre-session access condition, the number of math problems completed (primary reinforcer $M = 4$; token reinforcer $M = 6.6$, range 4–12) decreased to levels similar to those observed in the previous pre-session access condition.
**Demand functions analysis.** The demand curves for the pre-session restriction and pre-session access conditions are presented in Figures 4.7 and 4.8, respectively. The leftmost panels of Figure 4.7 shows the work-demand and reinforcer-demand functions for the first pre-session restriction condition. The amount of work completed in association with each class of reinforcer was clearly differentiated. Michael completed the largest amount of work during the token sessions. The break point for the token sessions was well above the break points of the other reinforcer classes. Similarly, the token was the most frequently contacted class of reinforcer. As the response requirements increased beyond 16 during the primary reinforcer sessions and 12 during the conditioned reinforcer sessions, the amount of work completed and reinforcers consumed fell sharply. These results suggest that tokens were the most effective class of reinforcer used during the first pre-session restriction condition.

In the second pre-session restriction condition (middle panels of Figure 4.7), responding was much less differentiated when compared to the first pre-session restriction condition. Michael completed about the same amount of work during the primary and token sessions. Although there was some variation, it was slight. Overall, the primary and token reinforcers were much less effective in the second pre-session restriction condition than the first. At a response requirement of 20, Michael did not complete any work. The pattern of responding observed during the conditioned reinforcer sessions was identical to the first pre-session restriction condition. Once the response requirement reached eight, an immediate degradation was observed. The reinforcer-demand function shows that token reinforcers were contacted more than the other classes.
at response requirement 12 and 16. However, actual difference in the amount contacted was relatively small.

Figure 4.7. Work-demand (top panels) and reinforcer-demand (bottom panels) functions for each pre-session restriction phase of the motivating operations across reinforcer analysis for Michael. Reinforcer response requirements are plotted along the x-axis.

The rightmost panels of Figure 4.7 depict the work-demand and reinforcer-demand functions for the third pre-session restriction condition. Conditioned reinforcers were discontinued during this phase of the experiment. Michael completed similar amounts of work during the primary and token reinforcer sessions. However, as the response requirements increased to 16, a greater degradation was observed in the amount of work completed during the primary reinforcer sessions. The reinforcer-demand function shows that Michael consumed an equal number of reinforcers during the first
three response requirements. When the response requirements increased to 16, Michael contacted the reinforcer in the token reinforcer session but not in the primary reinforcer session. Although the difference in break point and reinforcers consumed was minimal, the results suggest that tokens were slightly more effective reinforcers.

Figure 4.8. Work-demand (top panels) and reinforcer-demand (bottom panels) functions for each pre-session access phase of the motivating operations across reinforcer analysis for Michael. Reinforcer response requirements are plotted along the x-axis.

The work-demand and reinforcer-demand functions for the first pre-session access condition are shown in the leftmost panels of Figure 4.8. Differences in the amount of work completed and number of reinforcers contacted across reinforcer class were minimal. Primary and token reinforcers produced an identical pattern of responding and appeared to be slightly more effective than conditioned reinforcers.
The work-demand and reinforcer-demand function for the second pre-session access conditioned (middle panels of Figure 4.8) shows that the reinforcer classes were differentially effective. Again, the differences in the amount of work completed and the number of reinforcers contacted across reinforcer class were small. The token reinforcer maintained the highest level of responding. During the primary and conditioned reinforcer sessions, the initial reinforcer response requirements produced considerable degradation in responding. The differential break points for each class of reinforcer are clearly visible in the reinforcer-demand function. The results obtained during the primary and conditioned reinforcer sessions replicate the findings of the first pre-session access condition. Lastly, compared to the first pre-session access condition, tokens appear to function as more effective reinforcers.

The rightmost panels of Figure 4.8 depict the work-demand and reinforcer-demand functions for the third pre-session access condition. Conditioned reinforcers were discontinued for this phase of the experiment. The amount of work completed and number of reinforcers consumed was similar to the results obtained in the previous pre-session assess condition. The break point for token reinforcers was slightly higher than the break point for primary reinforcers. These results, along with the results of the previous pre-session access conditions, suggest that token reinforcers were the most effective class for Michael.

**Cheeto**

**Preference assessments.** The results of the MSWO preference assessments for Cheeto are shown in Figure 4.9. Popcorn was the most frequently selected putative
primary reinforcer (ranked score: 19), followed by Cheetos (ranked score: 16). The ocean play dough set was the most frequently selected putative conditioned reinforcer (ranked score: 24), followed by the wooden dress-up doll (ranked score: 21). The top two primary and conditioned reinforcers were used in the MO analysis.

Following session 14, a second MSWO was conducted in order to reassess putative conditioned reinforcer preference. The top three stimuli from the first MSWO (i.e., play dough, wooden dress-up doll, and Barbie doll) and two new items (i.e., Nick Jr website and Strawberry Shortcake DVDs) were included in the analysis. Two MSWO preference assessments were conducted over the course of one day (total rank score maximum = 10). Strawberry Shortcake DVDs were the most frequently selected conditioned reinforcer (ranked score: 10), followed by the Nick Jr website (ranked score: 8). Cheeto did not select any of the other items.
Motivating operations across reinforcer class analysis. Figure 4.10 shows the frequency of transcribed words for each interaction condition. During baseline ($M = 0.16$), Cheeto transcribed zero words for all but one session, in which she transcribed one word. Overall, the frequency of the dependent variable was stable at zero or near zero levels for all six baseline sessions.

The top panel of Figure 4.10 depicts the number of words transcribed when primary reinforcers were available. During the pre-session restriction condition, a decreasing trend was observed in the number of words transcribed following the second session. The frequency of the dependent variable was low and stable for most of the condition ($M = 5.7$, range 2–12). The longest pre-session restriction duration (for each reinforcer class) was about 144 hr, which occurred as the result of spring break. During the pre-session access condition, Cheeto did not transcribe any words. The mean duration of pre-session access was 15.6 min (range: 0.05–28.25 min). Following session 19, a 45
The time limit, which was never reached when primary reinforcers were available, did not appear to have any effect on the number of words transcribed. The response effort of the dependent variable was decreased after session 33. Cheeto was given worksheets that contained two-letter words instead of four-letter words. Reducing the response effort did not have an observable effect on the number of words transcribed during the primary reinforcer sessions.

The middle panel of Figure 4.10 shows the frequency of the dependent variable for the conditioned reinforcer sessions. During the pre-session restriction condition, Cheeto did not write any words when the conditioned reinforcers identified in the first MSWO were available. After preference for the putative reinforcers was reassessed (see above) and two new items were identified, an immediate increase in the number of words transcribed was observed. With the exception of the first session, in which Cheeto wrote many words, the frequency of the dependent variable was low and variable (\(M = 7.3\), range 0–28). During the pre-session access condition, Cheeto transcribed zero words when the conditioned reinforcers identified in the first MSWO were available. The duration of pre-session access was less than 3 sec. A similar pattern of responding, with respect to the dependent variable, was observed following identification of the two new conditioned reinforcers. Cheeto transcribed zero words for all but one session, in which she transcribed two words (\(M = 0.4\)). The mean duration of pre-session access was 30.6 min (range: 0.05–127+ min). The experimenter imposed an upper limit to the duration of pre-session access following a session (i.e., session 19) that had to be terminated due to
the excessive length. The time limit was never reached in any subsequent pre-session access conditioned reinforcer sessions. Reducing the response effort did not have an observable effect on the number of words transcribed during the conditioned reinforcer sessions.

The frequency of the dependent variable for the token reinforcer sessions is presented in the bottom panel of Figure 4.10. During the first pre-session restriction condition, Cheeto wrote 20 words. Anecdotally, Cheeto consumed the edible items but never interacted with the putative conditioned reinforcers during the token exchange periods. Following the second MSWO, responding was low and stable when Cheeto was given worksheets that contained four-letter words ($M = 3.75$, range 0–6). Anecdotally, Cheeto interacted with the putative conditioned reinforcers during each token exchange period after the second MSWO. Reducing the response effort coincided with an immediate increase in the number of words transcribed. Cheeto wrote the maximum number of words for both sessions ($M = 42$). During the first pre-session access condition, Cheeto wrote six words. The duration of pre-session access was 9.4 min. Anecdotally, Cheeto did not interact with the putative conditioned reinforcer during the pre-session access period as well as the token exchange period. Following the second MSWO, a decreasing trend was observed in the level of responding. Cheeto wrote zero words for the final three sessions ($M = 1.8$, range 0–7). The mean duration of pre-session access was 35.25 min (range 0.75–75.5). After the experimenter imposed a limit to the duration of pre-session access, two pre-session access periods were terminated. Terminating the pre-session access period did not appear to have any effect on the
number of words Cheeto wrote. Lastly, there was no noticeable change that occurred as a result of the reduced response effort during the pre-session access condition.

**Demand functions analysis.** Due to the procedural changes that were made throughout the MO analysis condition and response variability, demand curves were not constructed for Cheeto. Calculating the mean frequency of the dependent variable at each PR value would have yielded misleading information. During the pre-session restriction condition, when Cheeto was given four-letter words, she completed a similar amount of work across each reinforcer class. The differences in the amount completed were slight. However, when Cheeto was given two-letter words, she completed significantly more work during the token sessions relative to the primary and conditioned reinforcer sessions. These results suggest that the token functioned as the most effective reinforcer, once the response effort was reduced.

During the pre-session access condition, zero to near zero levels were observed in all of the sessions associated with the primary and conditioned reinforcers. In this respect, the AO was equally effective across these reinforcer classes. During the token reinforcer sessions, Cheeto completed the initial reinforcer response requirement for the first two sessions and part of the initial reinforcer response requirement on the third session. At least initially, it appears that the token functioned as an effective reinforcer after pre-session access. However, in light the procedural changes that occurred, this finding should be viewed with caution. Cheeto did not complete any work for the final three token sessions.
Figure 4.10. The number of words transcribed under each interaction condition for Cheeto. Note: “1” = use of different conditioned reinforcers; “2” = start of 45 min time limit for pre-session access; “3” = start of reduced response effort.
Chapter 5

DISCUSSION

The purpose of this study was to examine the evocative- and abative-effects of a functionally defined MO (i.e., pre-session access and restriction) on the frequency of a target behavior maintained by primary, conditioned, and token reinforcers. Additionally, this study sought to determine if a functionally defined MO differentially influenced the effectiveness of each reinforcer class.

With respect to the evocative- and abative-effects of an MO, the results showed that pre-session access and restriction could reliably alter the effectiveness of primary, conditioned, and token reinforcers. The level of responding varied according to the MO condition for all three participants. The frequency of the target response was lower during the pre-session access conditions than the pre-session restriction conditions. This finding supports previous research that used a functionally defined MO (e.g., Lang et al., 2009; O’Reilly et al., 2009). Although there were across subject differences in the level of responding during the pre-session access and restriction conditions, the independent behavior altering-effects of the EO and AO were clearly evident. This finding is particularly important as it relates to the conceptualization of token reinforcers.

The effectiveness of a token reinforcer has been assumed to be relatively free from momentary motivational conditions because it is associated with a variety of back-
up reinforcers (Catania, 1998; Cooper et al., 2007; Skinner, 1953). Money, exchangeable for a number of primary and conditioned reinforcers, exemplifies this characteristic of token reinforcers (Hackenberg, 2009). However, in applied practice, most token economies contain only a limited number of back-up reinforcers (e.g., Moher et al., 2008; Montarello & Martens, 2005; Sran & Borrero, 2010). The results of this study show conclusively that pre-session access to a limited number of back-up reinforcers had an abative-effect on behavior maintained by token reinforcement. For all three participants, the level of responding associated with the token was lowest during the AO condition relative to the EO condition. This finding supports the idea that the reinforcing value of a token is related in large part to the value of the back-up reinforcers. Although it would be atypical to give an individual free access to all of the back-up reinforcers, it is important for researchers and practitioners to acknowledge the variables that influence token reinforcer effectiveness as well as the limits of token reinforcer effectiveness.

From a conceptual standpoint, there is reason to believe the reinforcer classes are differentially influenced by MOs. This is due in part to the difference in biology and/or history that accounts for the reinforcing characteristic of the stimuli. For example, a primary reinforcer requires no previous history to function as a reinforcer but has biological value, whereas a conditioned reinforcer acquires reinforcing properties through pairing with other, already established, reinforcers. It stands to reason that the behavior- and value-altering effects of an MO would affect each reinforcer class differently.

There are at least two ways in which the differential effects of an MO can be observed. The first way is to look for differences in the level of responding during a
functionally defined AO condition. If extraneous variables are controlled, differences can be attributed to the effectiveness of the AO. In this regard, a reinforcer class that was less affected by an AO would be associated with higher levels of responding when compared to a reinforcer class that is more affected by the AO. The second way is to look for patterns that reliably alternate across MO conditions. For example, suppose that during a pre-session restriction condition a student completes a lot of work when primary reinforcers are available and a midrange amount of work when token reinforcers are available. During the pre-session access condition, if the student then completes less work when primary reinforcers are available and about the same amount as the previous condition when token reinforcers are available, the difference can be attributed to the effectiveness of the MO.

With respect to differential effects of the MO, the results of the current study show clearly differential effects for Michael and potential differential effects for Cheeto. These effects for both participants were observed in the level of responding associated with the AO condition. There was no clear differential pattern of responding across MO conditions. During the pre-session access condition, Michael completed more work when primary and token reinforcers were available relative to conditioned reinforcers. Despite being given access to these items until rejection, they still functioned as effective reinforcers, albeit less effectively than when access was restricted. Furthermore, during the second pre-session access condition, Michael completed markedly more math problems when token reinforcers were available relative to the two other classes. For Cheeto, tokens initially functioned as more effective reinforcers during the pre-session
access condition relative to the other reinforcer classes. The results show no differential effects for Jack; the MO was equally effective across EO and AO conditions. Although the level of responding varied according to the reinforcer class (e.g., the first restriction condition of Figure 4.2), the effect of the MO was consistent across each phase of the analysis. Taken together, these results suggest that MOs can have differential effects across the classes of reinforcers. However, these effects appear to be idiosyncratic across participants. For two participants, token reinforcers were less affected by MO changes than primary and conditioned reinforcers. Although this effect was clear, the actual differences in the level of responding were modest. It is not clear what reinforcer class was most affected by MO changes. During the AO conditioned reinforcer sessions, the level of responding was near zero for all of the participants. In comparison, a similar level of responding was observed for only two of the participants during the AO primary reinforcer sessions.

The results of this study provide evidence that the reinforcer class influences the effectiveness of an MO. However, these findings should be viewed with appropriate caution. The differential effects, as described above, were modest and were clearly evident for only one of the participants. It is possible that more pronounced differential effects could have been observed had the intensity of the AO been reduced. It is reasonable to assume that the differential effects of an MO vary on a spectrum related to the magnitude of the MO. At some point, all behavior related to a given reinforcer will abate when an AO of sufficient magnitude is in effect. Alternatively, the negative results for Jack could indicate that MOs are not differentially effective. However, given the
evidence provided by this study as well as the conceptual foundation for differential effects, this conclusion seems erroneous.

The current study extends previous research by explicitly examining the effects of an MO on a target behavior maintained by each of the reinforcer classes. According to the framework established by Michael (1982; 1993; 2000) and Laraway et al. (2003), the current effectiveness of a stimulus to function as a reinforcer is determined by MOs. In this regard, understanding the effect of MOs is important for both practice and theory. Although the results of this analysis should be viewed as preliminary, these findings advance reinforcement and MO theory. MOs describe a functional relation between an antecedent event and some change to the reinforcing value of a stimulus and frequency of behavior related to the stimulus. The findings of this study suggest that the effectiveness of an MO is determined, at least in part, by the class of reinforcer that maintains the target response. Although it was not stated as such, the relation between MO and reinforcer was conceptualized as being one way. That is, the MO establishes or abolishes the value of the reinforcer and produces an increase or decrease in the frequency of behavior related to that outcome. It appears that the reinforcing stimulus is an important variable with respect to the effectiveness of the MO. These effects are likely to be even more pronounced when the MO is not determined through functional means (e.g., arbitrary selection of pre-session duration).

In order to examine the effects of MOs across each reinforcer class, stimuli representative of each class had to be selected. The results should be interpreted as it relates to the reinforcers selected. It is important to note that the reinforcing effectiveness
of each stimulus was not equal. This is evident by the varied levels of responding associated with each reinforcer class. It is only in the context of a functionally determined MO that the effectiveness of each reinforcer class can be meaningfully compared. For example, had the participants been given 15 min pre-session access to each of the reinforcers, the effectiveness of the AO could have varied significantly. Fifteen min may have been sufficient to produce a noticeable abolishing effect for one of the reinforcers but not for the others.

The completion of work following pre-session access until rejection seems paradoxical. However, Michael regularly completed work when primary and token reinforcers were available, and Cheeto initially completed work when token reinforcers were available. There are three possible explanations as to why participants completed work during this condition. First, the participant could have experienced some naturally occurring reinforcer following work completion. In this regard, natural reinforcers could have maintained the target response. However, the zero to near zero level of responding during baseline and subsequent conditioned reinforcer sessions for both participants suggests this was not the case.

Second, the experimenter-delivered consequence functioned as a reinforcer. In this regard, the stimulus change that followed work completion (e.g., delivery of an edible item) increased the likelihood of the target behavior occurring again within similar conditions (e.g., the given PR value). The relation between the stimulus and the reinforcing value of the stimulus is clear for primary and conditioned reinforcers. For example, the reinforcing value of Jello is determined by the momentary MO state related
to that item. However, as described in the introduction, the reinforcing value of a token reinforcer is determined by multiple factors (i.e., the value of the token, the value of the back-up reinforcers, and the number of back-up reinforcers). As a result, it is difficult to identify the factor that was responsible for the change in token reinforcer effectiveness. In the current study, the number and type of back-up reinforcers available were held constant. Therefore, this factor could be ruled out. Pre-session access to the back-up reinforcer was designed to decrease the reinforcing value of these items. However, responding during token sessions could have been due to the value of the token, the value of the back-up reinforcers, or both. It is not clear how these two factors influenced responding. Anecdotally, Cheeto described the token in a manner that was often associated with putative reinforcers (e.g., “I don’t want X, I want to do the tokens” and “Yeah, tokens”) during the pre-session access condition. However, these verbalizations occurred only during the initial pre-session access condition.

Third, the AO was terminated before the value of the reinforcer was fully abolished. Participants were given pre-session access until they rejected the items. In this regard, the participant controlled the duration of pre-session access. Terminating pre-session access before the value of the reinforcer was fully abolished could account for responding that occurred when reinforcers were made contingent upon the completion of work. However, examination of the MO analysis data for Michael and Cheeto shows that responding was at or near zero when conditioned reinforcers were available. In some respects, the conditioned reinforcer sessions served as a control, demonstrating the ongoing effectiveness of pre-session access. For responding to be a function of premature
termination, participants would have had to reject the items inconsistently across reinforcer classes. Based on the relative stability of responding during the AO condition, this interpretation of the results seems unlikely.

Over the course of the study, a decrease in the mean duration of pre-session access was observed for Jack and Michael. Moreover, the frequency of responding during the pre-session restriction conditions for Michael showed a decrease in the level of responding relative to the first condition. These findings point to a possible AO that was in effect across conditions. From a conceptual standpoint, contact with the reinforcers has an abolishing effect regardless of condition. Although the effects of an MO are temporary, there is reason to believe that the effect can span days (or even weeks and months). For Cheeto, there was no clear trend in the duration of pre-session access. However, an examination of responding during the initial pre-session restriction sessions for each reinforcer class shows that Cheeto completed less work as the study progressed (not counting the session in which the response effort was reduced). In this regard, the AO appeared to have a fairly immediate effect. Changing the reinforcers or allowing the participants to select different reinforcers could have reduced this putative AO. However, introducing new stimuli would represent a confounding variable. An across condition AO is likely in any study that uses a finite number of reinforcers. It is possible that the schedules of reinforcement used in this study (i.e., PR schedule of reinforcement and FR second-order schedule) made the AO effects easily observable relative to schedules that use constant reinforcer response requirements.
This study incorporated behavioral economic principles and techniques, such as demand curves and PR schedules of reinforcement. The inclusion of these behavioral economic tools increased the depth of analysis relative to standard single-subject design data analysis procedures. For example, the demand curves clearly illustrate the break point of each reinforcer class across the MO conditions. Based on the author’s review of the research literature, this study is among the first to use behavioral economic principles in the analysis of MOs.

**Applied Implications**

The findings of the current investigation have a number of important implications for practice. First, contact with the back-up reinforcers can abolish the value of the token. Because most token economies in applied setting have a finite number of back-up reinforcers, it is important to understand that the effectiveness of the token is not completely free from MO changes. To maximize the effectiveness of the token, researchers and practitioners should create a closed economy (Roane et al., 2005) in which access to the back-up reinforcer is possible only through token exchange. When back-up reinforcers are substitutable for naturally occurring reinforcers, it is likely that tokens will be ineffective in producing desired behavior change.

Second, the time necessary to abolish the value of the reinforcer through pre-session access until rejection is likely to be prohibitive in many applied settings. For example, many of Jack’s pre-session access durations were well over 60 min. In most situations, it would be hard to justify 60 min of pre-session access to abolish the value of a reinforcer, even if that reinforcer maintained challenging behavior. Furthermore,
providing unlimited access to the items was very resource intensive. For example, Jack consumed one to two packages of Jello almost every pre-session access period it was available. Pre-session access until rejection should be used with caution in applied settings. The benefits of using pre-session access until rejection should be evaluated along with the costs.

Third, this study made use of naturally occurring AOs in addition to pre-session access. For example, AO sessions were conducted after the participants ate lunch or dinner. This compound MO likely reduced the duration of pre-session access. In a number of instances, the participant rejected the putative reinforcer without ever contacting it. In this regard, the naturally occurring AO was sufficient to abolish the reinforcing value of the stimulus. In applied settings, there are a number of natural MOs in effect each day, such as the time before lunch when food reinforcers are more likely to be effective and the time after lunch when food reinforcers may be less effective. Not only should practitioners be aware of these MOs, they should alter programming to take advantage of them. For example, a teacher could alter the reinforcer class available during a given period of time.

Fourth, tokens were the only class to function as effective reinforcers for all three participants (for Cheeto this was observed after response effort was reduced). This particular finding is not surprising as the token reinforcers were exchangeable for both primary and conditioned reinforcers, which is often the case in applied settings. These results add to the large body of research that demonstrates the effectiveness of token reinforcers (Simonsen, Fairbanks, Briesch, Myers, & Sugai; 2008). Furthermore, during
the pre-session access condition, tokens produced the highest levels of responding for two participants, relative to the other reinforcers. This reinforcer class is a good choice for practitioners given these findings coupled with the additional benefits of tokens (see Ayllon & Azrin, 1968),

Fifth, one of the unexpected implications of this research relates to the practice of using duration of engagement as a measure of preference. Hagopian, Rush, Lewin, and Long (2001) evaluated the predictive validity of a single stimulus engagement preference assessment. The results showed that duration of engagement reliably predicted relative reinforcer effectiveness for all the participants in a subsequent reinforcer assessment. However, duration of engagement does not necessarily translate into a measure of reinforcer effectiveness, especially when there is not a comparable response alternative (e.g., the student can play a game or do nothing). The results of the current study illustrate a significant limitation with this preference assessment methodology. Jack, for example, engaged with the conditioned reinforcers for extended periods of time during the pre-session access condition. However, when the effectiveness of conditioned reinforcers was assessed during the pre-session restriction condition, Jack completed very little work. Furthermore, relative to the duration of engagement with primary reinforcers, which produced much higher levels of responding, Jack engaged with the conditioned reinforcers for much longer periods of time.

**Considerations and Limitations**

During the functional skills assessment, Cheeto’s parents reported that preference for edible and tangible items shifted frequently. For example, Cheeto’s parents stated that
she would play with one toy exclusively for a day or two, then never play with that toy again. Anecdotally, a similar pattern of preference was observed for the initial putative reinforcers identified through the MSWO preference assessment. Throughout the preference assessment, Cheeto engaged in behaviors that are often associated with an item that functions as a reinforcer, such as saying “Can I play with the play dough today?” when the experimenter walked in the room, or crying when the items were removed from the stimulus array. However, during the MO analysis, Cheeto did not complete any work when play dough or the wooden dress-up doll were available. Further evidence of this preference shift is evident in the pattern of responding during the EO conditioned reinforcer sessions after the second MSWO. Cheeto completed a relatively large amount of work for one session when the newly identified conditioned reinforcers were available. During subsequent sessions, the level of responding was much lower.

Following session 19 for Cheeto, it was necessary to establish a time limit on the duration of pre-session access. For two consecutive AO sessions, the duration of pre-session access was in excess of 60 min and interfered with Cheeto’s nap time. A 45 min time limit was imposed on the duration of pre-session access. This time limit was met on two occasions; the level of responding did not appear to be affected by the termination of pre-session access. Had the 45 min time limit not been sufficient to abolish the value of the reinforcer, it would have been necessary to incrementally increase the duration of pre-session access. Although changes were made to this MO, it was still functionally defined. The majority of AO sessions continued until rejection and on the occasion that pre-
session access was terminated, the pattern of responding was similar to the pattern observed during the AO sessions.

When evaluating the results of this study, a number of limitations should be taken into account. First, the pattern of responding observed during the first pre-session restriction condition for Michael was not replicated. As described above, it is likely that there was an AO in effect across conditions. Relatively stable patterns of responding occurred in the second and third pre-session restriction condition. However, failure to replicate the level and pattern of responding that occurred in the first pre-session restriction condition made the results difficult to interpret.

Second, the initial variability in the level of responding for Jack during the first pre-session access condition suggest that there was some uncontrolled variable that exerted influence over the target behavior. Anecdotally, Jack’s teacher started measuring fluency of math facts around this time. The procedures used by Jack’s teacher had a number of similarities to the procedures used in this study. However, it is unclear if this experience had any effect on Jack’s performance during the study.

Third, procedural alterations that were made for Cheeto throughout the study make it difficult to directly compare the results across participants. Due to Cheeto’s age and developmental level, a number of alterations were made to the procedures (e.g., a termination response) prior to the start of the MO analysis. However, during the MO analysis, additional changes were made in response to Cheeto’s performance. For example, it was necessary to re-assess preference following two sessions in which Cheeto completed no work when the conditioned reinforcers were available. Although the basic
mechanics of the procedures remained the same for all participants, the differences warrant caution when interpreting the results.

Fourth, it is possible that the superordinate multielement design arrangement used for Cheeto introduced a confounding variable. On most days, two sessions were conducted. The first session occurred prior to dinner whereas the second session occurred after dinner. Roane et al. (2005) showed that post-session access to the reinforcer can reduce within-session response rates. In this respect, Cheeto may have engaged in lower levels of responding during the pre-session restriction condition than would have been observed had pre-session access occurred at some other time. During the sessions, Cheeto made statements that suggested she did not recognize when pre-session access occurred in relation to pre-session restriction (e.g., “Can I get the X for free next time?”). However, it is possible that this variable was responsible, at least in part, for the general low levels of responding that were observed during most pre-session restriction sessions. This particular design arrangement is best avoided when examining a variable in which post-session access could act as a confound.

Fifth, multiple treatment interference is an inherent concern when using a multielement design (Barlow & Hayes, 1979). Multiple treatment interference refers to the “effects of one treatment on a subject’s behavior being influenced by the effects of another treatment administered in the same study” (Cooper et al., 2007, p. 196). It is important to note that sequence, carryover, and alterations effects refer to the same type of problem (Hains & Baer, 1989). It is unclear if the level of responding in association to
one of the independent variables would remain the same if that variable had been examined in isolation.

**Future Research**

A logical extension of the current study would be to deliver primary and conditioned reinforcers following the completion of each PR requirement. This would allow for a comparison of reinforcer effectiveness at the reinforcer level, whereas the current study compared reinforcers at the system level. However, the back-up reinforcers available during the token sessions represent a potential magnitude confound. To counteract this effect, it may be necessary to provide NCR inter-trial access during the primary and conditioned reinforcer sessions.

In the current study, participants were given pre-session access to all of the back-up reinforcers during the AO token sessions. Furthermore, token exchange resulted in access to the entire class of back-up reinforcers. This arrangement represents one of many possible parametric arrangements as it relates to these variables. For example, the participant could be given pre-session access to a portion of the back-up reinforcer class. To fully understand the interaction between MO and token reinforcer it would be important to experimentally examine these other arrangements. Such research could reveal information about the situations in which a token reinforcer is most and least affected by MOs.

Although an effective AO, giving participants pre-session access until they rejected the item required significant amounts of time. The time limit imposed on the duration of pre-session access for Cheeto suggests that value of the reinforcer may be
abolished prior to rejection of the item. Conducting within-session probes of reinforcer effectiveness, on a fixed time schedule, may provide more accurate and timely results regarding the effectiveness of the AO. For example, during a pre-session access condition, the experimenter could present the participant with some nominal work task on a fixed time schedule. Following completion of the work task, the pre-session access period would resume. However, if the individual did not complete the work task, the pre-session access period would be terminated. Future research should compare the effectiveness of within-session probes and pre-session access until rejection to functionally identify an AO.

Finally, attempting to isolate the variables that determine token reinforcer effectiveness under EO and AO conditions might provide useful information. In the current study it was not clear if responding during the AO token condition for Michael was a result of the value of token, the value of the back-up reinforcer, or both. The interaction effects between MO and token reinforcer could be evaluated using a superordinate multielement design. Such a study would have two MO conditions and three token conditions. The two MO conditions would be pre-session access and restriction. The three token conditions would be token exchangeable for back-up reinforcers, token not exchangeable for back-up reinforcers, and no token just back-up reinforcers. Comparing the level of responding across each of these interaction effects could reveal the variables that determine token reinforcer effectiveness.
Conclusion

Hains and Baer (1989) state that “the meaning of reinforcement is such that it cannot be examined except at some point on its deprivation-satiation interaction” (p. 63). Reinforcers derive their effectiveness through MOs. However, it appears that the effectiveness of an MO may be influenced by the reinforcer class. Although the results of this investigation are preliminary, these findings shed light on the interactions between reinforcer class and MO. The analysis of MOs has become increasingly sophisticated and the effects more widely understood. However, there are many essential questions regarding the relationship between reinforcer and MO that require further research. The contemporary analysis of MOs holds much promise as it relates to developing technologies that bring the power of this variable to bear on socially important behaviors.
References


O'Reilly, M., Lang, R., Davis, T., Rispoli, M., Machalicek, W., Sigafoos, J., ... Didden, R. (2009). A systematic examination of different parameters of presession


Appendix A: Parent Permission and Participant Assent
Dear Parent/Guardian,

My name is Jonathan Ivy and I am a doctoral candidate conducting a research study in your child’s school. I am interested in studying the effects of different kinds of reward systems on the work habits of students. The goal of this study is to find out which reward system is best. Three different types of reward systems will be examined: The first system will use edible rewards (e.g., Goldfish cracker), the second system will use tangible rewards (e.g., time to play with a toy), and the third system will use token rewards (e.g., tokens).

I would like to work with your child 2-4 times per week for approximately 10-45 minutes per session. The estimated total time commitment is 16 hours (20 min sessions * 3 times a week * 4 months). The total duration of this project will be less than 6 months, it is estimated that your child will be involved for 4 months. During our sessions your child would be asked to complete a work task. The work will be very similar to the work that your child is already doing at the school. After a specific amount of work is complete your child will earn a reward. The amount of work your child must complete will gradually increase over the course of a session. The way your child responds to this arrangement will give us information about the effectiveness of each reward system.

Throughout this project your child’s identity will be kept safe by using an alias. I will not record your child’s name or any other materials that will identify your child. Only information regarding your child’s performance will be collected, for example the amount of work completed per session.

This research may benefit your child in a number of ways. First, they will receive extra practice of an important skill in a highly reinforcing setting. Second, these procedures could teach your child to be more tolerant of delays. Additional benefits can be found on the Parent Permission Document included in this packet.

Lastly, the risks associated with this research are minimal. It is possible that your child may become frustrated, but this frustration should be no different than the frustration they may experience throughout the typical school day. Additionally, your child will be able to end the session at any time.

If you agree to allow your child to participate in this project please:
- Sign and complete the attached permission form (white copy)
- Keep the second copy of the permission form for your own records (green copy)
- Put the signed white copy in the envelope marked “Return Envelope”
- Have your child take the “Return Envelope” to school and deposit it in the lock box in the office

Thank you for your time and consideration. If you have any questions or concerns about the study, or if you would like to withdraw your child from the study, please contact me at:

Email: ivy.17@buckeyemail.osu.edu
Phone: (614) 573-0223

Sincerely,

Jonathan Ivy
The Ohio State University Parental Permission
For Child’s Participation in Research

Study Title: Motivating Operations Across Classes of Reinforcers: Are there Differential Effects?

Researcher: Nancy Neef and Jonathan Ivy

This is a parental permission form for research participation. It contains important information about this study and what to expect if you permit your child to participate.

Your child’s participation is voluntary.

Please consider the information carefully. Feel free to discuss the study with your friends and family and to ask questions before making your decision whether or not to permit your child to participate. If you permit your child to participate, you will be asked to sign this form and will receive a copy of the form.

Purpose:
This study is designed to examine the effects of three different commonly used rewards systems. The first system will use edible rewards (e.g., Goldfish crackers), the second system will use tangible rewards (e.g., time to play with a toy), and the third system will use token rewards (e.g., tokens). The goal of this research is to determine which reward system is most effective with your child.

Procedures/Task:
In this study your child will earn rewards by engaging in functional skills, such as reading words or completing daily living skills. The specific skill will be identified as part of the study procedures. Initially rewards can be earned by completing only small amounts of work. However, as the session progresses the amount of work will gradually increase. During some of the sessions your child will be able to access the rewards before the start of the session. The procedures used in this study closely resemble the day-to-day programming at the Haugland Learning Center.

Duration:
The estimated total time commitment is 16 hours (20 min sessions * 3 times a week * 4 months). The total duration of this study will be less than 6 months. It is estimated that your child will be actively involved for approximately 4 months. Individual interactions, or experimental sessions, will occur 2-4 times per week, with each interaction being approximately 10-45 minutes. Your child may leave the study at any time. If you or your child decides to stop participation in the study, there will be no penalty and neither you nor your child will lose any benefits to which you are otherwise entitled. Your decision will not affect your future relationship with The Ohio State University.
Risks and Benefits:
The risks associated with this research include minimal. Your child may experience some frustration when asked to do work. However, this frustration is similar to the frustration your child may experience with their day-to-day work. Lastly, your child will have the ability to stop the session at any time.

The benefits associated with this research are numerous. First and foremost, your child will have the opportunity for additional practice of an important skill/behavior. Second, the format of each trial could help improve your child's on-task behavior. Third, since rewards can be earned frequently your may find the work sessions enjoyable. This may carry over to work sessions that occur outside of this study. Lastly, these procedures may teach your child that by completing their work they will gain access to preferred items.

Confidentiality:
Efforts will be made to keep your child's study-related information confidential. However, there may be circumstances where this information must be released. For example, personal information regarding your child's participation in this study may be disclosed if required by state law. Also, your child's records may be reviewed by the following groups (as applicable to the research):
- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices;
- The sponsor, if any, or agency (including the Food and Drug Administration for FDA-regulated research) supporting the study.

Incentives:
Beyond the benefits stated above there will be no incentives to participate in this study.

Participant Rights:
You or your child may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you or your child is a student or employee at Ohio State, your decision will not affect your grades or employment status.

If you and your child choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights your child may have as a participant in this study.

An Institutional Review Board responsible for human subjects research at The Ohio State University reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.
Contacts and Questions:
For questions, concerns, complaints, or if you feel that your child has been harmed as a result of this study please contact:

Jonathan Ivy (email: ivy.17@buckeyemail.osu.edu)
Nancy Neef (email: neef.2@osu.edu)

For questions about your child’s rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-6251.

Signing the parental permission form
I have read (or someone has read to me) this form and I am aware that I am being asked to provide permission for my child to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to permit my child to participate in this study.

I am not giving up any legal rights by signing this form. I will be given a copy of this form.

Printed name of subject

Printed name of person authorized to provide permission for subject

Signature of person authorized to provide permission for subject

Relationship to the subject

Date and time

AM/PM

Investigator/Research Staff
I have explained the research to the participant or his/her representative before requesting the signature(s) above. There are no blanks in this document. A copy of this form has been given to the participant or his/her representative.

Printed name of person obtaining consent

Signature of person obtaining consent

Date and time

AM/PM
The Ohio State University Assent to Participate in Research

Study Title: Motivating Operations Across Classes of Reinforcers: Are there Differential Effects?

Researcher: Nancy Neef and Jonathan Ivy

- You are being asked to be in a research study. Studies are done to find better ways to treat people or to understand things better.
- This form will tell you about the study to help you decide whether or not you want to participate.
- You should ask any questions you have before making up your mind. You can think about it and discuss it with your family or friends before you decide.
- It is okay to say “No” if you don’t want to be in the study. If you say “Yes” you can change your mind and quit being in the study at any time without getting in trouble.
- If you decide you want to be in the study, an adult (usually a parent) will also need to give permission for you to be in the study.

1. What is this study about?
   
   Answer: This study is about how much work you are willing to do to earn things like tokens, toys, and small snacks.

2. What will I need to do if I am in this study?
   
   Answer: If you are in this study you will be asked to complete some work. When you complete work you will earn rewards, for example a time to play with a toy.

3. How long will I be in the study?
   
   Answer: If you want to participate, you will meet with me 2-4 times a week for about 10-45 minutes. We will meet for less than 6 months, probably closer to about 4 months. That being said, I think on average we will meet 3 times a week for about 20 minutes, over a 4 month period. The estimated total time commitment is 16 hours.

4. Can I stop being in the study?
   
   Answer: Yes, you may stop being in the study at any time.
5. What bad things might happen to me if I am in the study?

   Answer: During this study you will be asked to do some work. If you don’t like doing work you may get a bit frustrated. But remember, you can stop at anytime.

6. What good things might happen to me if I am in the study?

   Answer: If you decide to participate in this study you will get to practice an important skill. Additionally, you will have a number of chances to earn rewards.

7. Will I be given anything for being in this study?

   Answer: During the study you will be able to play with and eat some things that you like. However, you will not be given anything that you can take with you after the session.

8. Who can I talk to about the study?

   For questions about the study you may contact:
   Jonathan Ivy (email: ivy.17@buckeyemail.osu.edu)
   Nancy Neef (email: neef.2@osu.edu)

   To discuss other study-related questions with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-0251.
Signing the assent form

I have read (or someone has read to me) this form. I have had a chance to ask questions before making up my mind. I want to be in this research study.

_________________________________________  ________________________________  AM/PM
Signature or printed name of subject                  Date and time

Investigator/Research Staff

I have explained the research to the participant before requesting the signature above. There are no blanks in this document. A copy of this form has been given to the participant or his/her representative.

_________________________________________  ________________________________  AM/PM
Printed name of person obtaining assent                      Signature of person obtaining assent

______________________________  ________________________________
Date and time                                                      Date and time

This form must be accompanied by an IRB approved parental permission form signed by a parent/guardian.
Verbal Script for Obtaining Assent

“Hello, my name is Jonathan Ivy. I am a doctoral candidate at The Ohio State University in the Special Education Department, and I am conducting a research project that will be used in my doctoral work.

The purpose of this study is to figure out how much work you are willing to do to earn different kinds of rewards. For example, time to play with a toy or a Goldfish cracker. To earn these rewards you need complete some work, for example reading words.

When we meet, I will ask you to complete some work. After you do a specific amount of work you will get a reward. Each time you work with me you will have many chances to earn rewards. Sometimes you will get rewards without having to do any work.

If you want to participate, you will meet with me 2-4 times a week for about 10-45 minutes. We will meet for less than 6 months, probably closer to about 4 months. That being said, I think on average we will meet 3 times a week for about 20 minutes, over a 4 month period. The estimated total time commitment is 16 hours.

If you decide to participate, a good thing that will happen is that you will become better at the skill we are practicing. Also you may find yourself enjoying school work more than you already do.

The risks associated with this research are minimal. Also I will not use your real name but an alias or made up name. This is done to protect your identity.

Participation is voluntary. You get to choose if you want to work with me or if you don’t want to work with me. If you decide not to participate, nothing bad will happen to you, no one will think less of you, and you will not lose anything to which you are otherwise entitled to. If you do start working with me, you are free to stop at any time. Again, nothing bad will happen to you, no one will think less of you, and you will not lose anything to which you are otherwise entitled.

If you have any question about this study or your participation in it, please feel free to contact me, my faculty supervisor or our university research office at any time.”

- The individual will be given an information card, containing name, institutional affiliation, and contact information

“Do you have any questions about this research? Do you agree to participate?”
Appendix B: Data Sheets
Baseline Data Sheet

Researcher: ________________  Session #: ________  Date: __________

Participant Code: ____________  Start Time: ________  End Time: ________

**Instructions:** “You can do as much work as you like. You don’t have to do any work if you don’t want to. There are no rewards to earn this session.”

**Directions:** Following the instruction, the participant was given the appropriate task materials. There was no programmed consequence for engaging in the dependent variable. Baseline sessions lasted 10 min or until 30 sec elapsed without an occurrence of the dependent variable.

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**MO Analysis Data Sheet**

Participant Alias: ________________  Session #: ______  Date: ______

Condition: ________________  Start Time: ______  Finish Time: ______

Pre-Session Access: Yes or No  Duration of Engagement: ____________

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</table>

TOTAL
Participant Alias: ____________________ Session #: ________ Date: ________

Condition: ____________________ Start Time: ________ Finish Time: ________

Pre-Session Access: Yes or No Duration of Engagement: ________________

<table>
<thead>
<tr>
<th>Sr+ Sched.</th>
<th>Dependent Variable</th>
<th>Sr+ Access</th>
<th>Trial Time</th>
<th>Total</th>
</tr>
</thead>
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</tbody>
</table>

TOTAL
Appendix C: Treatment Integrity and Interobserver Agreement Forms
Baseline Treatment Integrity and IOA

Research Assistant: ___________________________  Participant Alias: ________________
Session #: __________  Condition: Baseline

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Yes or No</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did the experimenter provide the proper instruction?</td>
<td></td>
<td>“You can do as much work as you like. You don’t have to do any work if you don’t want to. There are no rewards to earn this session.”</td>
</tr>
<tr>
<td>Did the experimenter provide the student with the appropriate instructional materials?</td>
<td></td>
<td>Writing implement and worksheet</td>
</tr>
<tr>
<td>The experimenter provided no consequence following occurrences of the dependent variable.</td>
<td></td>
<td>No programmed consequence. Interaction kept to a minimum.</td>
</tr>
<tr>
<td>Did the experimenter terminate the session after 10 min or 30 sec without an occurrence of the dependent variable?</td>
<td></td>
<td>30 sec with no response, session terminates or until 10 min elapse, whatever comes first.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>According to the permanent product, what is the total number of correct work completed?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Yes or No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once you have completed the sections above, look at the experimenter’s data sheet. Does the total number of correct responses match the number you have?</td>
<td></td>
</tr>
</tbody>
</table>
### MO Analysis Treatment Integrity and IOA

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Yes or No or NA</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>If pre-session access condition, did the experimenter give the proper instruction?</td>
<td>Yes or No or NA</td>
<td>&quot;Here are some things for you to eat (and/or play with) you can have as much as you want, when you are day say I am done or wait a few seconds&quot;</td>
</tr>
<tr>
<td>If pre-session access condition, was the participant given NCR access to the appropriate materials?</td>
<td>Yes or No or NA</td>
<td>Primary Sr = Jello, conditions Sr = Car track, and token Sr = Jello and Car track.</td>
</tr>
<tr>
<td>If pre-session access condition, was the participant given NCR access until 30 sec (+3 sec) elapsed or indicated &quot;done&quot;?</td>
<td>Yes or No or NA</td>
<td>The participant is longer contacting the item or the participant is holding the item, but not manipulating it as designed or says &quot;done&quot;.</td>
</tr>
<tr>
<td>Did the experimenter provide the proper instruction?</td>
<td>Yes or No or NA</td>
<td>“You can do as much work as you like. You don’t have to do any work if you don’t want to. You can earn X this session if you do your work”</td>
</tr>
<tr>
<td>Was the appropriate reinforcer-specific discriminative stimulus present on the table?</td>
<td>Yes or No or NA</td>
<td>Primary Sr = green, conditions Sr = white, and token Sr = orange.</td>
</tr>
<tr>
<td>Did the experimenter provide the student with the appropriate instructional materials?</td>
<td>Yes or No</td>
<td>Writing implement and worksheet</td>
</tr>
<tr>
<td>Did the experimenter give the participant the appropriate reinforcer following the completion of the reinforcement schedule?</td>
<td>Yes or No</td>
<td>Primary Sr = Jello, conditions Sr = Car track, and token Sr = Jello and Car track.</td>
</tr>
<tr>
<td>Did the experimenter terminate the session after 30 sec elapsed without an occurrence of the dependent variable or completion of the final PR requirement?</td>
<td>Yes or No</td>
<td>30 sec with no response, PR 6 for Subject 305, PR 7 for the Emperor, and PR 5 for Cheeto.</td>
</tr>
</tbody>
</table>

### Measurement

<table>
<thead>
<tr>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>According to the permanent product, what is the total number of correct work completed?</td>
</tr>
</tbody>
</table>

### Procedure

<table>
<thead>
<tr>
<th>Yes or No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once you have completed the sections above, look at the experimenter’s data sheet. Does the total number of correct responses match the number you have?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial Number</th>
<th>Work Completed Y or N</th>
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</thead>
<tbody>
<tr>
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<tr>
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<tr>
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</tbody>
</table>