2004-07-16

Melioration and the Behavioral Addiction Process: An Experimental Analysis

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MELIORATION AND THE BEHAVIORAL ADDICTION PROCESS: AN EXPERIMENTAL ANALYSIS

by

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A Dissertation Presented to the Faculty of

Brigham Young University

in partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

Department of Counseling Psychology and Special Education

Brigham Young University

August 2004

BRIGHAM YOUNG UNIVERSITY

GRADUATE COMMITTEE APPROVAL

of a dissertation submitted by

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As chair of the candidate's graduate committee, I have read the dissertation of Jared M. Dinehart in its final form and have found that (1) its format, citations, and bibliographical style are consistent and acceptable and fulfill university and department style requirements, (2) its illustrative materials including figures, tables, and charts are in place and (3) the final manuscript is satisfactory to the graduate committee and is ready for submission to the university library.

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ABSTRACT

MELIORATION AND THE BEHAVIORAL ADDICTION PROCESS: AN EXPERIMENTAL ANALYSIS

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Doctor of Philosophy

Melioration can be a factor contributing to behavioral addiction. In this study, 76 university undergraduates operated a "money machine" by selecting between choices that corresponded to maximization and melioration. Participants initially made choices consistent with a strategy of melioration and demonstrated significantly greater variability in choice behavior when visual cues were presented aimed at exposing the internality (or consequence) of the choice situation. Removal of the visual cues resulted in a return to lower responding. Visual cues may aid in interrupting the behavioral addiction pattern by limiting exclusive use of a melioration choice strategy. Methods of restructuring and experimentation with choice allocations are suggested as possible alternatives to melioration.

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Chapter 1: Introduction

Suboptimal behavior, including addiction, can be conceptualized as the consequence of a decision strategy called melioration (Herrnstein & Vaughan, 1980; Loewenstein & Elster, 1992) that is utilized in choice situations in which the value of an alternative is affected by the rate of its availability. It is a function of the economic principle of supply and demand (Bickel & Marsch, 2000). The higher the rate of availability of an alternative (usually associated with lower cost), the lower the overall value. Melioration can result in negative consequences that are not recognized by the individual until their cumulative negative effect becomes unavoidable (Bickel & Marsch, 2000; Elster and Skog, 1999; Rachlin, 2000). This negative effect may go unrecognized because individual decisions in the series of repeated choices are not perceived as adding much weight to the overall consequences of the series. This failure to perceive the overall outcome has been referred to as the "primrose path to addiction" (Rachlin, 2000, p. 74).

This dissertation will describe melioration as a possible contributing factor involved in a behavioral addictive process. It will attempt to demonstrate the prevalence of melioration in an experimental setting and then demonstrate that melioration and subsequent addictive processes may be interrupted. With this information, better understanding and potential interventions may be used to address the ever-increasing prevalence of behavioral addictions.

This chapter is intended to establish melioration as a contributing factor to the behavioral addictive process by framing the addictive process in general terms first. Areas of specific concern will then be addressed as they represent instances of an underlying factor. I will argue that a behavioral process based on melioration is common in normal populations and at extreme levels is indicated in clinical concerns. Drug and alcohol addictions, depressive disorders, anxiety disorders, eating disorders, gambling, and sexual compulsivity disorders will be

presented as possible examples of melioration and the behavioral addictive process.

I will then contrast melioration with maximization, a concept that suggests that humans prefer decisions that tend to maximize overall reinforcement for their choices. In order to maximize behavior effectively, people are often required to demonstrate self-control in their decision making. Oppositely, melioration limits one's ability to employ self-control strategies.

Two strategies of self-control will be introduced as possible ways to avoid melioration: precommitment and restructuring. Restructuring will be presented as a potentially effective component of interventions aimed at increasing self-control and decreasing melioration, and thereby promoting maximizing behavior. I will conclude by introducing an experimental design that has been demonstrated to be an effective way to measure melioration; then I will present my hypotheses.

Melioration as Part of the Addictive Process

The economic principle of melioration depends on the individual's ability to detect the rate (or value) of each of the competing alternatives (sources of reward) that are available in a choice situation. If the rate is undetectable, behavior is likely to be a random switching between alternatives. If detectable, then as long as the value of one alternative is higher than that of the others that are available, the probability that a person will continue to select that alternative will remain high (Herrnstein, Loewenstein, Prelec, & Vaughan, 1993; Herrnstein, 1997; Rachlin, 2000). In other words, the same behavior is likely to continue as long as the current value of the rewards it produces is higher than that of any of the alternatives. The individual is likely to switch to an alternative when the rate of the current reward is no longer higher than the reward of the alternatives.

To explain this process, it may be useful to employ the example of writing a dissertation.

Engaging in writing the dissertation competes with all other alternative behaviors. As long as the value of writing the dissertation is higher than that of the alternatives (eating, sleeping, watching movies, completing other coursework, etc.), the writing is likely to continue. In this example, the reinforcement for writing the dissertation (completion of the work, accolades from peers, removal of sanctions from the department) will be constantly compared with the other reinforcements. To maintain an overall maximization of dissertation writing, the individual would have to ration the selection of alternative choices competing with the choice to work on the dissertation. In this way, the long-term value of the dissertation will remain high and the competing choices will not interrupt the writing process constantly.

A melioration strategy, in contrast, would ignore the future impact of either choice when comparing the value of the dissertation. The selection of an alternative would depend only on the perceived value of each option at the moment of the choice. If the person writing were invited to go to a movie with friends, distraction might be seen as the higher immediate value selection and be chosen over writing. Some behaviors produce negative overall effects when they are selected. As smaller, less valuable overall choices are repeatedly selected, the overall value of all the alternatives diminishes because the subjective value of the larger reward is repeatedly devalued when compared in individual decisions. In the long run, the overall value of both the larger and the smaller alternatives equalize (e.g., writing the dissertation is not valued more than going to the movies generally). In this way, the value of completing the dissertation might be reduced and the writer is often hard pressed to find motivation to select the alternative that had previously maintained high value. This pattern of choosing represents the addictive process at work. Small choices are repeatedly made that eventually strip away long-term value of all the alternatives (Heyman, 1996). In the end, little reinforcement is enjoyed (Herrnstein &

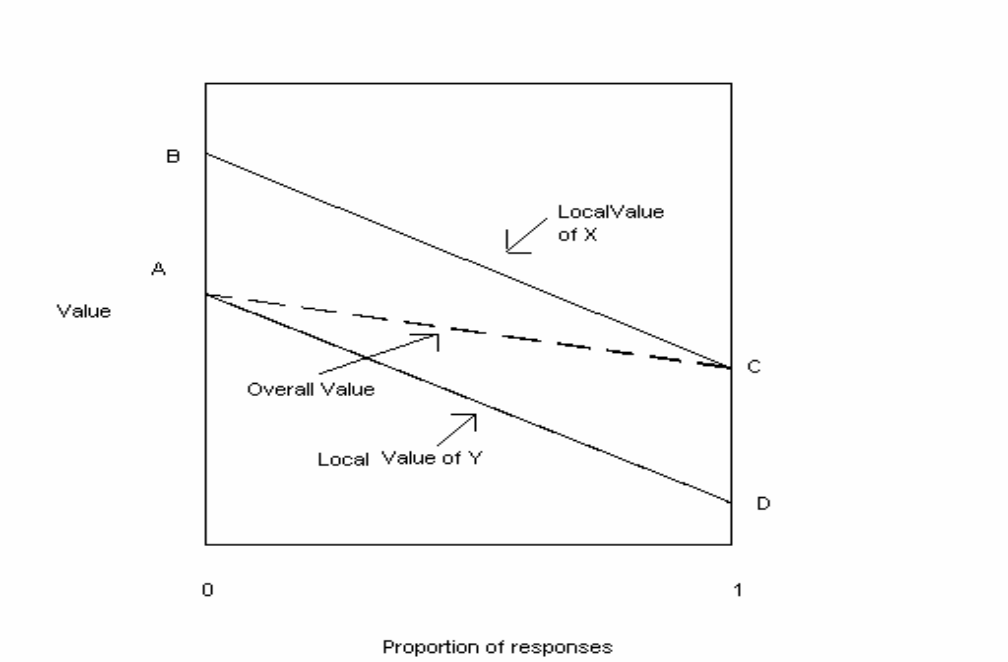
Prelec, 1991; Rachlin, 1997; Rachlin, 2000). This phenomenon is also described as the cycle of bad habits or vices (Carnes, 1999) that ultimately leads to suboptimal behavior and, in the extreme, to addiction. It is a paradox because as one spends more time with the bad habit, negative effects from the habit not only lower its value but also lower the value of alternative choices, reducing the likelihood that the individual will switch behaviors (Herrnstein, 1993; Rachlin, 1997; Rachlin, 2000). The end result is stabilization of behavior that is of overall low value. Figure 1 is similar to diagrams representing melioration and the primrose path to addiction as reported in Herrnstein and Prelec (1992) as well as Rachlin (1997).

The process of addiction is represented by movement from A through B and ending at C in the diagram. Position A represents a behavior choice that is of overall high value and does not decrease in value with repeated selection. Position B represents an alternative to A that has higher current (immediate) value. Rachlin (1997) suggests that in the case of alcoholism, for example, A would represent not drinking and B represents drinking. Drinking has higher immediate value compared to not drinking. The immediate benefits of drinking consistently exceed those of not drinking. This is the "temptation" of drinking.

The addictive path from A to C requires an individual to select an alternative to A. By selecting alternative B (one with consequences that are negative on the overall value), the local value of both A and B decrease (with movement from left to right on the diagram). With repeated selections of alternative B, more and more value is lost until the individual reaches point C in which the person typically selects the alternative with short-term value.

Once choice selection reaches point C, an addiction has been established and movement away from point C is difficult. In the case of drinking or not drinking, point C represents alcoholism. An individual who has consistently selected a melioration strategy and is now at

Figure 1



Representation of the addictive model as described by Herrnstein and Prelec (1992) as well as Rachlin (1997).

point C would maintain a stable state of choosing because, by definition, he or she would not select an alternative that might have overall higher value but appeared to have low current value. Rachlin (1997) suggested that the alcoholic may begin to drink and is initially positively reinforced with the immediate benefits of alcohol consumption (movement from A to B). Later, the negative effects of repeatedly choosing to drink (tolerance, health deterioration, social consequences) accumulate and the value of both drinking and not drinking reduce (movement from B to C). The individual might have initially been reinforced, but later is avoiding punishment (negative consequences). In this situation, a change in behavior to reverse the process is difficult, requiring a change to point D, which appears to have less value than the addiction (according to a meliorator's perspective).

Reversal of this process is difficult at best for the individual in recovery from this type of behavioral addiction without a method of changing the process of valuing decisions. It requires the repeated selection of an alternative that has long-term reinforcement value that is typically delayed. Additionally, the value of this type of reinforcer is often perceived to be low compared to immediately available alternatives (comparing the value of choices C and D in Figure 1).

Clinical Implications of a Melioration Strategy of Decision Making

Melioration appears to be a decision strategy experienced by most people in normal functioning. Engaging in the melioration process to an extreme level, however, suggests that the pattern of an addictive process may be involved. In this way, addiction may be conceptualized as a difference in degree of melioration rather than different kinds of problems (Lewis, 1994).

Behavioral addictions have been increasing for the past several decades (Bickel & Marsch, 2000; Stevens-Smith, 1994). Bickel and Marsch (2000) suggest that North American society promotes short-term thinking and by extension, choice strategies that are shortsighted

(melioration). A societal value of immediate gratification on various levels has been suggested as a contributing factor in the increase in the number and type of presentations of addictive behaviors. Additionally, a decline in traditional resources such as families, religion, and social networks used to modify and counterbalance extreme melioration has been reported (Bickel & Marsch, 2000; Lewis, 1994; Stevens-Smith, 1994). This combination of the increased visibility and acceptance of a "buy now, pay later" (Stevens-Smith, 1994, p. 15) worldview, as well as a decline of mediating forces promoting awareness of long-term consequences, continues today.

Rather than addressing clinical concerns separately, clusters of disorders that have a "behavioral repertoire" (Bickel & Marsch, 2000, p. 357) based on shortsighted behavior is recommended (Schneider & Irons, 1997). High comorbidity rates among addictive disorders have been noted in many clinical categories (APA, 2000; Schneider & Irons, 1997); these high rates may be the result of common features of melioration. By implementing a melioration choice strategy based on shortsighted information, several behaviors that are clinical concerns may be initiated or maintained, often contributing to addictive processes that are unrecognized. In suggesting that there may be a common component of many types of concerns that are increasingly prevalent, it is important for clinicians and researchers to become aware of the nature of this underlying factor (Lewis, 1994; Vuchinich, 1999). Melioration and the addictive process may be involved in a variety of concerns receiving more attention in both public and clinical settings. Substance addictions, depressive symptoms, anxiety disorders, and harmful eating behaviors, as well as sexual compulsivity, may have components linked to melioration.

Substance Addictions

Behavioral economists have long analyzed substance-related behavior in terms of economic principles (Madden, 2000). Bickel and Marsch (2000) suggest that drug and alcohol

use and abuse are prime examples of the process of behavioral addiction. Because many chemical substances are low-cost as well as highly reinforcing and immediately available, the tendency for many individuals is to choose to engage in substance use as quick way to gratification (O'Connor, Esherick, & Vieten, 2002; Tucker & King, 1999). In most cases, the deleterious longer-term effects of the substance use are not considered (APA, 2000; Rachlin, 1997, 2000) and result in addiction (Bickel & Marsch, 2000; Carroll & Campbell, 2000; Rachlin, 2000).

Depressive Disorders

One of the hallmarks of the primrose path to addiction and melioration is the loss of subjective value of both the short-term alternative that is repeatedly chosen as well as the competing alternatives (Herrnstein, Loewenstein, Prelec, & Vaughan, 1993; Rachlin, 1997; 2000). Some of the symptoms felt by individuals experiencing depression may in fact be the value-reducing effect of melioration and the addictive process. The effects may be reported as loss of interest in activities that were previously pleasurable, decreased motivation, and ambivalence toward changing behavior (Lewis, 1994).

Bickel and Marsch (2000) suggest that individuals already exhibiting depressive symptoms may be reflecting a shortsighted choice strategy that prevents them from moving to a more positively reinforcing situation. They suggest that a pattern of isolation from social support and of reduced use of social skills, as well as a passive nature, prevents individuals from engaging in behavior based on longer-term reinforcement.

Anxiety Disorders

The broad category of anxiety disorders consists of experiences of panic or intense fear that may be caused by either an internal or external perception (APA, 2000). Though the source

of the fear response may be varied, most of these clinical disorders are characterized by efforts to reduce anxiety that are selected by an individual. These anxiety-reducing activities are often immediately available (typically, such an activity is a removal of self from the anxiety-provoking situation, or taking part in a compulsive activity or ritual that soothes fears) and result in reinforcement for their selection. Unfortunately, many of these activities also lead to a pattern of behavior that resembles the behavioral addictive process described previously (Ciaroochi, 1995). In this way, short-term reinforcers are repeatedly selected at the expense of long-term benefits resulting in a pattern of behavior that is difficult to change.

Eating-related disorders

Eating-related disorders may be seen as an extreme level of melioration and the addictive process. The prevalence and presentation of a variety of eating-related disorders also coincides with the societal environment that favors immediate reinforcement regardless of future consequences (Stevens-Smith, 1994).

The continuum of eating-related disorders ranges from complete restriction to complete indulgence (Schneider & Irons, 1997). The primrose path to eating-related addiction does not suggest an addiction to food itself (Epstein & Saelens, 2000; Raeburn, 2002; Schneider & Irons, 1997) but to behaviors related to eating. Individuals may have an overall, longer-term goal with positive consequences related to eating (dealing with social, physical, or emotional well-being). Individual choices as to how to obtain that goal, however, often involve behaviors that are immediately gratifying but have negative long-term consequences making melioration and the addictive process likely. Behaviors that are selected as immediate reinforcers (binging, purging, exercise, etc.) compromise the overall value of the original goal (Stevens-Smith, 1994). As these behaviors are repeatedly selected based on melioration, the negative effects become more salient.

The extreme of this process is a devaluation of the choice alternatives available and a pattern of behavior that is highly resistant to change (Schneider & Irons, 1997).

Gambling

A national survey on gambling suggested that 60% of the adult population of the United States gamble for money occasionally (National Gambling Impact Study Commission, 1999). Lightsey and Hulsey (2002) suggest that increased availability of Internet gambling will likely increase prevalence rates. One of the reasons that gambling is such a common practice is associated with the anticipation of the result, which may produce a euphoric state described as a 'rush' similar to drug use (Schneider & Irons, 1997). In both women and men, the use of gambling as a means of immediate reinforcement as well as an escape from emotional, financial, and social problems is increasing (Davis, 2002; Schneider & Irons, 1997). Several highly negative consequences have been reported as typical results of gambling in moderate or extreme amounts. Serious financial, social (both societal and individual), job, and relationship problems are associated with gambling behavior (Davis, 2002; Ghezzi, Lyons, & Dixon, 2000; National Impact Study Commission, 1999; Schneider & Irons, 1997).

Sexual compulsivity

Schneider and Irons (1997) report that sexual disorders are an extreme manifestation of sexual urges and behaviors that when kept in balance, provide a form of comfort, status, and personal worth. Taken to an extreme, however, they are part of a group of disorders described as process addictions that involve mood alterations that serve as reinforcement (Braun-Harvey, 1997). Sexual disorders have a physiological reinforcement that may be similar to substance use (Carnes, 1999). Goodman (1998) suggests that the sexual addict is engaged in a process of repeatedly selecting short-term reinforcement which overrides longer-term consequences. The

behavioral process underlying a sexual addiction, therefore, may be another type of presentation resulting from melioration. An individual repeatedly chooses to act on urges in anticipation of an available reinforcer, not recognizing the increasing negative consequences (related to health, relationships, professional situations, financial situations, etc.) that are common (Braun-Harvey, 1997; Carnes, 1999; Rubin, 2002; Schneider and Irons, 1997).

Melioration vs. Maximization

Melioration seems to be inconsistent with traditional economic theory, which suggests that humans tend to maximize overall utility, that is, to prefer behaviors that optimize or produce the highest rate of overall reinforcement (Ainslie, 1999; Elster & Skog, 1999; Herrnstein et al., 1993; Herrnstein, 1997; Rachlin, 2000). One reason people might engage in a melioration choice strategy is a limitation on the amount of information available to them when they assign value to the options that are present. A person with a limited perspective (that is, with a myopic or shortsighted view of the situation) may weigh the options more heavily in favor of the option that currently yields higher utility (Herrnstein, 1997; Rachlin, 2000), regardless of any consequences that selecting that option may have on future returns from the entire set of options (as with the dissertation example cited previously). Current subjective value could be assigned by perception of supply and demand, availability that is present or delayed (Logue, 1995), magnitude of reward (Herrnstein, et al., 1993), or the context of choice (Rachlin, 2000). If the person has a broader perspective of the situation (that is, takes into account future as well as present rewards), value may be assigned to each option on the basis of both positive and negative consequences for future valuation. The ability to evaluate the overall outcomes of the options in context (that is, over time) may allow their present values to be differentiated more accurately (Elster & Skog, 1999; Rachlin, 2000). This evaluation could include the effects of recent decisions on the present

situation, leading to a decision that will yield the greatest value overall (maximization). Maximization may require one to forego a currently available option for a delayed option.

Self-Control and Precommitment

Self-control is defined by Logue (1995) as the choice of a larger, delayed outcome over a smaller but immediately available alternative. Impulsiveness refers to the choice of the latter. According to Logue, to be able to choose a larger, delayed outcome, one is required to be sensitive to the rates of return both now and in the future. With such sensitivity intact, it is possible to engage in a precommitment strategy that can be implemented while both the smaller, less valuable alternatives and the larger, deferred alternatives are still in the future. That is, one can make a binding decision before one arrives at the point where the poorer alternative is immediately available, while the larger richer alternative remains distant. This process essentially commits the individual to a valuation of the alternatives taken in advance that maintains the valuation in spite of an immediately available option (Logue, 2000). For example, I may commit myself to write for 2 hours on this chapter. To commit myself to this choice, I may unplug the telephone and isolate myself temporarily from friends who would invite me to go to the movies, making myself unavailable to shorter-term decisions that would compete with my prior commitment.

Time Discounting and Restructuring

Herrnstein et al. (1993) hypothesized that people might be impulsive because they (1) cannot retain and process enough information about the rates of response and the rates of return, (2) are unaware of the relationship between the two categories of rates, or (3) follow a principle called . The principle of time discounting suggests that the individual discounts the value of the larger reward in favor of the smaller reward because of the greater proximity (in time) of the

latter. As the delay to the choice point becomes smaller, the value of the more immediate reward will increase to the point that it has a greater current value than that of the larger, more delayed reward. The ability to abstain from choosing the currently better option and instead to wait in order to get the larger one has been demonstrated experimentally with humans and animals in various situations (Rachlin, 1997). There is evidence, however, that in other situations, both humans and animals will fail to demonstrate self-control. They make choices that result in a smaller overall reward (Ainslie, 1992; Forzano & Logue, 1992, 1994; Logue, 1995; Herrnstein, 1997; Rachlin, 2000).

Restructuring is the act of incorporating more information (or context) into the current utility-yield prediction (Herrnstein, 1997; Rachlin, 2000). It may be used to counter the effects of time discounting that lead to impulsivity. Considering more information before choosing among alternatives allows the person to see the current choice as part of a broader set of choices (Ainslie, & Halsam, 1992; Hayes, Stroshal, & Wilson, 1999) and base her or his decision on the overall outcome rather than on the immediate choice outcome. This form of valuation allows the overall outcome to approach overall maximization, which is consistent with traditional economic theory.

Rather than completely isolating myself from friends and family while I write this chapter (as with precommitment), I may attempt to assess the value of taking time to write compared with competing alternatives. When compared with 2 hours of writing, a movie may appear to have higher current value. However, compared with the long-term value of completing this dissertation, the movie holds little value. In fact, the small amount of distraction today may actually be more of a hindrance in receiving the satisfaction (and accolades, diploma, and job placement) that would come with the completion of the dissertation. One of my professors

suggested that every year graduation is delayed (by becoming ABD) costs the person approximately $30,000 in wages that are not earned. In this context, the value of the movie significantly decreases and the probability of selecting the writing option is greater as competing alternatives are presented. This process of recognizing and keeping the context of choices within a series salient is one way to help avoid melioration and promote maximizing behavior.

Experimental Design Validating Melioration and Restructuring

Experiments attempting to describe and explain melioration are a part of a broader area of research addressing behavioral economics. This field focuses on explaining, describing, and predicting principles and interventions that govern and influence behavior choice. Prominent in behavioral economics is the principle of matching. Herrnstein (1970) stated that when several contingencies of reinforcement are in operation concurrently, subjects will match the relative rates of reinforcement from those contingencies. In other words, subjects' behavior will "match" the reinforcement contingencies provided in the situation, maximizing their overall reinforcement. As described earlier, melioration is a choice strategy that stands in contrast to the traditional economic principle of maximization and leads to suboptimal behavior.

Numerous experiments with animal subjects have been published in support of melioration as an explanation of suboptimal choice (see, for example, Ainslie, 1974; Bron, Sumpter, Foster, & Temple, (2003); Herrnstein & Vaughan, 1980; Heyman, 1996; Landon, Davidson, & Elliffe, 2003; Logue, 1995; and Vaughan, 1981). Different methods were used in these experiments, but generally the designs provided a choice between two schedules of reinforcement that were presented to the subject simultaneously (concurrent schedules).

Reports of melioration with human subjects appear less often in the literature. One of the major difficulties in these designs has been establishing one that provides an immediately

available reinforcement that, when chosen, increases the negative consequences of the available options as melioration predicts. Herrnstein et al.'s 1993 study, which involved human subjects, asked whether humans meliorate or maximize and sought to identify the conditions in which each type of decision making is likely to occur. The study provided a method that demonstrated the process of melioration with humans in a context that may be used to experimentally document the addictive process described earlier. Additionally, the process may be generalized to a variety of presentations of the addictive process.

Definitions

As an introduction to Herrinstein et al.'s experimental design, a few definitions may be helpful. The term *internality* is defined by Herrnstein et al. (1993) as the effect of a person's recent allocation of behavior on future returns. In other words, it is the consequence assigned to a particular choice or series of choices. This allocation of choices (e.g., my choice to write part of the dissertation in the past) may impact the value the participant assigns to the alternatives in a given situation (e.g., my present choice to write or go to a movie). In the dissertation example mentioned above, the internality includes the rate of return from movies. It is assumed that the value of choosing to go to a movie decreases with consumption (the more movies watched, the less valuable movie watching becomes overall). If the internality of decreasing returns from continued consumption is ignored, the overall returns will likely decrease. If I were instead to allocate optimally, individual decisions would be made not only considering the current yield possibilities (immediate rewards and punishments) but also taking into consideration the effects the current choice would have on future returns (the internality). Decision outcomes aggregated over a longer period of time would result in an overall higher yield. When decision making produces the highest yield, it is considered maximizing. Maximization is a strategy that

considers the internalities currently in place with respect to future yields and selects the alternative that results in the most favorable outcome. To maximize efficiently, movie watching should be rationed, allowing the value of writing to remain high.

In the context of the experimental design presented below, the averaging window is closely related to internality. The averaging window is simply the number of past decisions that are included in the calculation of the consequences of the current decision. The averaging window sets the recent past to a precise length. If the size of the window is large, more past responses are considered in calculating the consequence of the current choice. For example, the averaging window could be set at 20 choices. For the present choice, the consequence would be estimated on the basis of the results of the last 20 responses. If the consequence was negative (for example, movies' losing their value due to repeated watching), the size of the negative effect could be determined by multiplying some negative constant by the proportion of times a particular decision had been made in the last 20 trials. Consider the following example: if A was the option of interest and A had been selected 15 times out of the last 20 choices, then the proportion would be 3/4 (.75). This value would then be multiplied by a negative constant, say, -2. The result would be a penalty of -1.5 units. This penalty could be expressed as waiting an additional 1.5 seconds, losing 1.5 dollars, losing 1.5 units of movie value, or a similar reduction of other variables the particular experiment was controlling. Thus, with each individual selection to watch a movie within my last 20 choices, the overall proportion of movie selection to writing increases. The negative consequence is then a reflection of how much I have chosen according to a melioration strategy in the recent past. Continuing to meliorate will increase the negative consequences and reduce overall value. By selecting the other alternative, each successive choice then reassigns the proportion of my last 20 choices accordingly, reducing the negative

consequences and increasing the value of maximization.

Increasing the size of the window (that is, using a greater number of past responses in the calculation of the current choice consequence) decreases the detection of the internality. If too many past choices are considered, the impact of each individual response on the overall payoff is likely to be negligible and not recognized by the participant. If the averaging window is small (only a few past choices are involved in the calculation), the internality is high, and each choice dramatically changes the consequence for each subsequent choice.

Review of Herrnstein et al. (1993)

In most of the conditions reported in the 1993 article, the reward was an animated coin that appeared on a computer monitor and was later exchanged for money. The amount of money represented by the coin varied from trial to trial. In Herrnstein et al.'s third experiment, however, reward delay rather than amount was varied. The monetary value of the coin was held constant. Two mutually exclusive alternatives were presented to the subject. Each produced an equal amount (one cent). The delay in delivering the coin (and thus the delay to the next trial) was a function of the proportion of past responses for the shorter delay. However, as the proportion of choices for the shorter delay increased over the previous 10 trials (the averaging window), the length of the delay for both coins also grew on each trial. Melioration would predict that the longer-term effects (the increasing delay for both alternatives) would be ignored in favor of local preference, that is, the coin providing the shorter delay would always be chosen. But by continually choosing the shorter delay, future reward (the number of trials the subject could complete within the fixed-duration session) would be consistently reduced. Thus the subject would earn significantly less money during the session than might have been earned.

Given the payoff functions that Herrnstein et al. (1993) utilized, maximization would

predict exclusive selection of the choice with the larger delay. This would have caused the overall delay to be minimized (never increasing the delay). More trials would have been completed within the session and more money earned as a result. In this way, the time delay became an immediately consumable reinforcer that the participant was able to experience. In most types of choice experiments, reinforcements (money, points, etc.) are received after the experiment has concluded. This reduces the likelihood that humans will respond to experimental procedures in a manner consistent with melioration because all reinforcements are delayed until the conclusion of the experimental session. By making this factor immediately available, this design better approximates the immediate payoff (and consequences) made in the human decision process. Time delay (availability) becomes immediately consumable and likely to influence a choice strategy used. It is this consumable component or availability that makes some behaviors more likely to become addictive than others (e.g., gambling versus dissertation writing).

In the 1993 study, subjects were placed in an experimental session in which they could choose one of two mutually exclusive alternatives. Specifically, they could choose to press the right or the left arrow key on a computer keyboard that was placed in front of a monitor on a table at which they sat. Prior to the session, participants saw the following instructions on the computer monitor:

> In this experiment you operate a "money machine." The amount you earn depends on your skills in controlling the machine. When you have finished reading these instructions, the money machine will appear on the screen.
>
> The machine has left and right coin dispensers. Each coin that drops

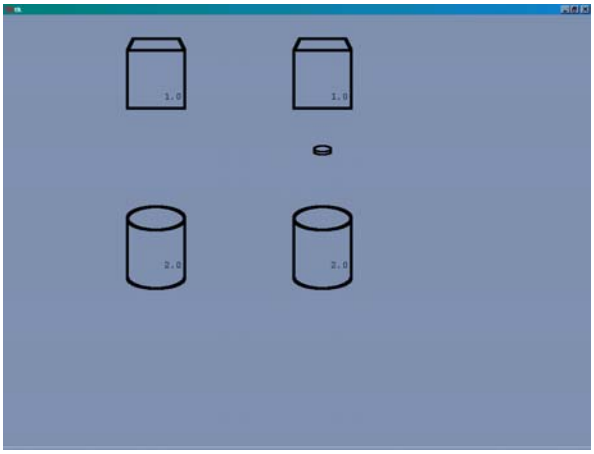
> from a hopper pays the amount in cents designated on the dispenser, which is one cent for all trials. You do best by trying to make the trials come as rapidly as possible.
>
> To run the machine press either the left or right arrow. After you do so, a coin will drop from either the right or left dispenser, depending on which arrow you struck. When the coin finishes dropping, you can earn another coin by operating either the left or right arrow. Each coin that drops belongs to you.
>
> You will be given 300 seconds of practice. The coins you earn during these trials will not count toward your earnings. After practice, you can run the machine for anther 900 seconds. Your payment equals the amount earned from both the dispensers during these 900 seconds, plus $2.50 for finishing the entire session (Herrnstein et al., 1993, p155).

After a key was pressed, an animated display similar to Figure 2 was presented in which a coin fell from a dispenser on the right or left side of the monitor into a coin holder below.

While the coin was falling from the dispenser into a collector, no further choices could be made. The left coin would always take 2 seconds longer to fall than the right coin. The time required for the coin to reach the collector constituted the delay before the next trial could begin. The length of the delay was an increasing linear function of the number of right-key choices during the most recent 10 trials (the averaging window). The cumulative number of coins appeared on each of the coin holders.

In this experiment, for half of the participants the right key provided the shorter delay while, for the other half, the left key did so. This arrangement was designed to counterbalance position preferences. The averaging window was set at 10 responses for all trials. In other

Figure 2



Display from the Money Machine Program.

words, after each response was made (that is, after an arrow key was struck), the computer recalculated the delays for the next response by using the proportion of right (or left) key responses made within the last 10 trials. The equations used to calculate the delay for the right and left keys were $D_R = 4r + 2$ and $D_L = 4r + 4$, respectively, for those participants where the right key had the shorter delay. For the remainder of the participants, the equations were just the opposite; $D_R = 4r + 4$ and $D_L = 4r + 2$. The value of r in these equations was the proportion of responses in the averaging window. For example, when the right key had the shorter delay, if, during the last 10 trials the right key was pressed 3 times, the proportion of right-key choices would be .3.

In their original experiment, Herrnstein et al. (1993) sought to compare the effects of payoff functions with different mathematical forms (linear and curvilinear) and also to compare reward dimensions (coin value versus coin delay). Using the linear functions described in a previous experiment (Herrnstein et al., 1986), they sought to replicate the earlier results in which subjects produced melioration. Their results were confirmatory: humans tend not to maximize when the reward dimension is coin-delay. The authors suggested that one possible reason for this outcome is that the calculation of overall reward based on a sequence of past choices places excessive cognitive demands on the individual who is trying to maximize. The individual is required to remember both the current rates of return for the two options as well as the internality in making each decision. Individuals who meliorate need only take into account the current rates of return.

Review of Dinehart's 2001 Master's Thesis

Building upon the procedure used by Herrnstein et al. (1993), and to establish the saliency of cues that would aid in reducing the cognitive demands required for the maximization,

the author's master's thesis (Dinehart, 2001) was a modification of the Herrnstein et al's 1993 design. I was interested in finding out whether external cues would aid individuals in their ability to maximize behavior. This was accomplished by increasing the amount of information that was available to the participants, specifically, information about the internality that was in operation. It was expected that participants who had access to such information would be more likely to make decisions consistent with maximization rather than melioration.

The type and saliency of the information presented to the subject was the focus of the study. As suggested by Logue (1995) and Herrnstein et al. (1993), information that revealed more of the overall context of an individual decision was likely to aid the subject in decision making. In effect, it would make the relationship between choices and overall outcomes more salient (that is, it would vivify the internality) and would be conducive to maximization.

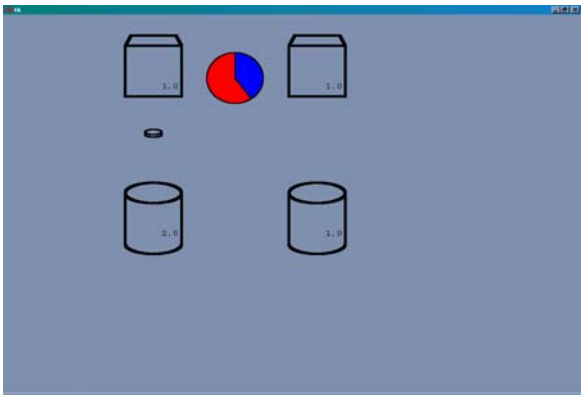
For the author's master's thesis, a different group of 24 participants was involved in each of five experiments. The first experiment was a direct replication of the conditions reported in Herrnstein et al.'s Experiment 3a, serving as a control condition for group comparisons. I was interested in replicating melioration in the study. Once this was done, I intended to find out what type of information would be helpful in exposing the internality in operation as a way of establishing an aid to maximization. The remaining experiments included two types of modifications to the original design. These were intended to aid participants in their ability to allocate their choices in a manner closer to maximization than melioration. The first type of procedural change was the substitution of the geometric mean for the proportion of responses in the delay calculation described above. This modification did not produce results suggesting an aid to maximization. The second type of modification was the addition of visual cues related to the delay assigned to each response. I hypothesized that a visual cue might aid maximization in

the experimental setting by cuing the participant to attend to more information than simply the immediate utility function. The results of the experiments were confirmatory: responding between groups where a visual cue was introduced into the session was significantly different from the responses of the controls.

Choice history cue. This was the first of three experiments intended to assist participants in allocating their decisions in a manner closer to maximization by providing a visual cue as to the internality operating in the experiment. As suggested by Herrnstein et al. (1993), one possible reason why participants tended to meliorate was the difficulty of retaining information about the payoff functions in order to successfully maximize the return. Specifically, in order to calculate a higher yield, "the decision maker must, in some cases, (1) know the current return to each alternative; (2) be aware of the existence and magnitude of the internality affecting future current returns; and (3) use the information in (1) and (2) to find the allocation yielding the long-run maximum" (p.177). In contrast, melioration is less complicated, requiring only that the current returns be estimated. Providing external cues of the internality might reduce the tendency to meliorate and produce results closer to maximization. To test this hypothesis, a modification was made to the original design mentioned above. The addition was a graph that was displayed between the coin hoppers (see Figure 3). When one of the arrow keys was pressed, the graph displayed the proportion of right-key responses (or left-key responses, depending on the group) made during the previous 10 trials (the averaging window).

The graph served as a visual representation of the internality in the current situation. It was hypothesized that visually representing the past 10 responses would allow the participant to move closer to maximization by simplifying the cognitive requirements for its achievement. Statistical results confirmed the hypothesis demonstrating that participants in this experiment

Figure 3



Choice History display from Money Machine Program. The graph cue is visible between the coin hoppers.

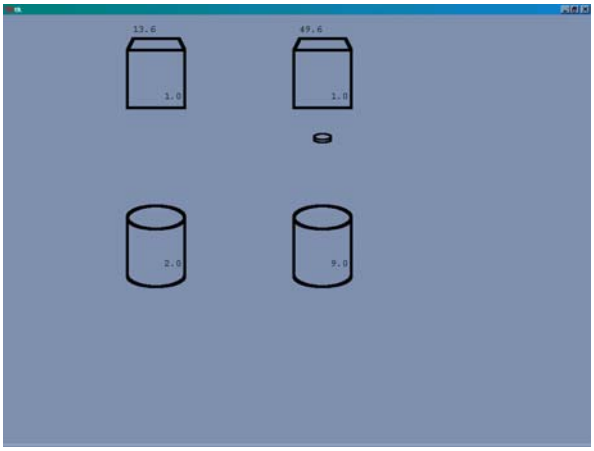
were significantly more likely to select the longer delay arrow, thus potentially earning more money than the control group (see Appendix A for comparison graphs).

Time-measure cue. In this experiment, a second type of external cue was introduced. Again, the design was identical to that used in Experiment 1, except for the addition of a numerical counter that appeared over each of the hoppers on the screen (see Figure 4). The counter displayed the summed drop time (in seconds) of the coins from each hopper beginning with the first experimental trial.

This change in procedure addressed the discrepancy in the results using the coin-delay and coin-value variables reported in Herrnstein et al's Experiment 3. The advantage of the coin-value procedure was that the value was visible in a numerical display on the screen. This reduced the need for the participant to combine a pair of subjective estimates: duration of the delay and amount of money earned over the entire session. Similarly, if the participants had access to a numerical display of the amount of delay, this might also ease the perception of the internality. It would effectively increase the amount of information available for estimating future returns. If the participant became more sensitive to the internality by means of the information provided by the counter, she or he might alter her or his subsequent response allocation between the right and left key alternatives. This alteration might well lead to an overall allocation of responses closer to maximization than melioration. Indeed, this was the hypothesis of the experiment. Again, the results demonstrated that participants in this experiment selected the longer delay arrow significantly more often than the control group, increasing their overall earning potential.

Combination cue. The visual cues introduced in the previous two experiments were selected to reduce the requirements for maximizing monetary returns in situations where rewards

Figure 4



Time Measure cue display from Money Machine Program. The timer cues are visible above the coin hoppers.

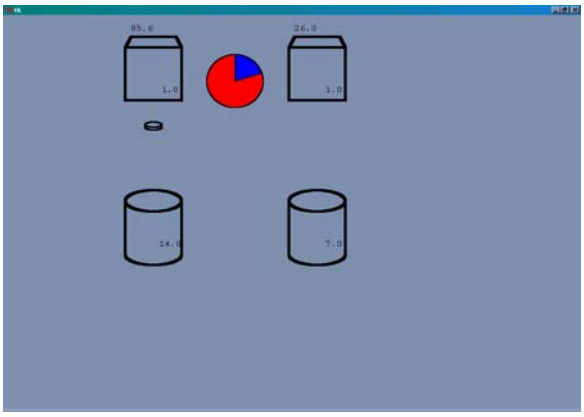
were delayed. However, the simple existence of a timer or a pie chart on the screen did not mean the participants would attend to it. If the participants did attend to the visual cues, it is possible that they would not know how the cues were to be interpreted, since this information was not included in the instructions. Thus, the cues would be of little use during the session. This experiment was intended to clarify the role of the two types of cues. Both were available to the participants during the session (see Figure 5). The procedure was the same as in Experiment 1, except that additional instructions were provided on how to activate one or the other or both of cues. The additional instructions read as follows:

> You will be able to activate counters at any time during the session. They will indicate, in seconds, the total time it has taken each coin to fall. They will appear on the screen above the two dispensers. You can activate this feature by pressing the SPACE BAR. To remove this feature, press the SPACE BAR a second time.
>
> You will also be able to activate a graph that shows the total number of times you have pressed the right [or left] key. The graph will be updated each time a key is struck to represent the proportion of times the key has been struck. You can activate this feature by pressing the ENTER key. To remove this feature, press the ENTER key a second time (Dinehart, 2001, p.25)

These instructions were included with the general instructions (see above) following the sentence, "Each coin that drops belongs to you." The computer recorded whether each of the cues was turned on or off on each trial.

Similar to the two experiments mentioned previously, results demonstrated that participants all accessed both the visual cues during the session and also, even more so

Figure 5



Combination cue display from Money Machine Program. The graph and timer cues are both visible on the screen.

than in the previously mentioned experiment, allocated more of their choices to the longer delay arrow key. Participants in this group earned more money than any other group and significantly more than the control group.

After completion of the money-earning portion of the session of all experiments, participants were asked to complete an exit survey prompting them to verbalize what they thought was happening during the session and to describe any strategies they used to earn the money (see Appendix B for survey questions and Appendix C for group comparisons). They were then paid $2.50 plus value of the coins collected during the session.

Results and Rationale for Methodological Changes

Visual cues aimed at exposing the internality to the participant resulted in behavior that more closely approximated maximization. The differences between the results from the control group and all three experimental groups showed that increasing participants' access to information about the internality had a positive effect on their ability to maximize in situations that were otherwise conducive to melioration. The results from Experiments 3 (choice history cue) and 5 (combined cue), specifically, suggested that a graphical representation of the participant's recent allocation of choices may have been beneficial in providing a broader context for decision making. The use of cues may have allowed the recent allocation of responses between the two alternatives to become more salient, thereby allowing the participant an effective access to useful information by which to make the next response.

The combined cue experiment also demonstrated that the combination of a graphical representation of previous response allocation and information about cumulative delay improved subjects' tendency to maximize. The internality may have become even more salient because of the combination. Not only did the greatest percentage of participants allocate their responses in a

pattern consistent with maximization, but they were also more accurate in verbalizing the relationship between behavior and outcome. Table 1 summarizes the percentages of participants whose performance favored maximization and the percentage of participants who reported a relationship between the two choices in their post session survey responses.

Table 1

Master's Thesis Group Comparisons.

Experiment	Participants Showing Maximization	Participants Reporting a Relationship
1 (Control)	20%	16%
2 (Choice history cue)	44%	44%
3 (Time measure cue)	41%	25%
4 (Combined cues)	56%	83%

These results suggest that providing information about the internalities of payoff leads to behavior that is more consistent with maximization (see Rachlin, 2000). Finding a way to expose the internalities in a controlled situation was the first step to identifying cues for real-world decision making.

The results presented from my master's thesis reflect differences in scores between group means. The overall differences between groups receiving cues as to the internalities suggested that the visual cues were salient. What the results did not suggest, however, was that behavior change was the result of exposure to the visual cues. When an individual is experiencing the effects of a melioration strategy because the demands to maximize may be high, exposure of the internality may be particularly useful as an intervention. The design of most experimental procedures (including Herrnstein et al., 1993, and the author's master's thesis) use group

comparisons based on mean scores. By separating groups into control and exposure conditions, experimental control is achieved but vital information is lost as to the utility of the cue in real-time behavior change. Experimental studies of treatment effectiveness also suffer from this type of information loss (Gall, et al., 2003). They are not suited to individual behavior change over time as are single subject, repeated measures, and longitudinal designs.

Having established a method of delivering a cue to participants in the author's master's thesis, the present research aimed at demonstrating that participants will engage in behavior change more consistent with maximization as a result of exposure to cues presented. Analogous to single subject study and longitudinal designs (Gall, et al., 2003), this information may be used to evaluate the utility and efficacy of exposing internalities with visual cues.

Summary and Hypotheses

Melioration is a decision strategy based on short-term decision making that may be part of the behavioral addiction process. Melioration suggests that when selecting from among alternatives, failure to account for consequences and reinforcements both now and in the future may lead to a pattern of choices that results in low overall value. This pattern is called the primrose path to addiction because its effects are often unrecognized and may be a behavioral pattern that is manifest in a variety of both normal and clinical presentations. Substance use and abuse, depressive symptoms, anxiety related behavior, gambling, and sexual compulsivity may all be conceptualized as having a common feature of melioration. Maximization, or the ability to evaluate the reinforcement and consequences of choices both now and in the future stands in contrast to melioration. Self-control, which is the act of foregoing an immediate smaller reinforcement for a larger, delayed reinforcer is required to maximize behavior. Precommitment and restructuring are two strategies of employing self-control in decision making.

Basic research aimed at establishing the conditions for exposing internality may well lead to better understanding of melioration and the addictive process. Herrnestein et al's 1993 experiment, as well as the author's master's thesis, represents a valuable method to examine the process of melioration in a human population and provides a format in which to introduce ways in which the process of melioration may be avoided, as well as the associated addictive process. The present research was an attempt to correct limitations to previous research and to provide validation of the ability to interrupt melioration and encourage self-control and maximization in an experimental setting.

Hypothesis 1

I hypothesized that participants who were exposed to an experimental situation that was a modification of the conditions reported in Herrnstein et al. (1993) and the author's master's study (Dinehart, 2001) would initially respond use a choice strategy resembling melioration. Later, within the same experimental session, a cue would be introduced intended to expose the internality active in the experiment. I hypothesized that, once exposed to this cue, participants would alter their behavior choice allocations in a way that more closely resembled maximization.

This hypothesis was based on the assumption that participants were likely to employ a strategy of melioration in a situation providing little information as to the internality in place. Once established, this pattern of behavior would be a reliable reference from which to compare interventions aimed at interrupting a pattern of melioration and promoting maximization.

The essential idea was that the information provided by a visual cue would allow the participants in the experiment to become aware of the internality (the overall consequences of their choices) and allocate their patterns of behavior based on overall reward rather than on present value. These new patterns of behavior, then, would interrupt the cycle of decreasing

returns experienced through the melioration as well as the addictive process. These patterns could only be observed across a series of choices in which the internality was hidden and then exposed.

Hypothesis 2

Several participants who responded to the treatment condition by altering their allocation of choices more consistently with maximization returned to a lower level of responding when the visual cue was removed. The purpose of exposing the internality was to promote maximization by encouraging choice allocation based on overall returns rather than present reinforcement value only. Participants who returned to a lower level of responding (or more similar to melioration) during the third period of Experiment 1 were screened to participate in an additional experiment in which the visual cue was gradually removed during the second time period. This second experiment was intended to provide participants with an alternative presentation of the visual cues that would help them maximize their behavior once the cues were removed. A fading procedure was used to gradually decrease the exposure of the cues over several trials.

I hypothesized that participants who returned to baseline responding following exposure to a visual cue in Experiment 1 would benefit from a fading procedure in the follow-up session and that their responses in the final time period of the second experiment would be closer to maximization than in the initial baseline period.

Question 1

The averaging window of the experiments proposed had been set at 10 choices in previous studies. Participants demonstrating maximizing behavior in Experiment 1 might be able to provide additional information about the limits of exposure to the internality that could be of use in treatment planning by providing additional information about the amount of

information from each choice necessary for the internality to continue to be exposed. Typically, 10 choices in the averaging window allow for an adequate representation of the internality. Fewer choices used in the calculation of the consequences can make the internality highly variable (each choice represents large proportions of the total, meaning larger effects per choice). More choices included in the allocation of consequences (more choices included in the averaging window) may obscure the internality because each choice contributes much less to the proportion of the total. Participants, however, may demonstrate some level of variability in the amount of information necessary for them to achieve maximization in their decision making. To increase understanding of the variability involved, in addition to the experimental design presented thus far, a follow-up condition was made available to participants who demonstrated consistent maximization in the second baseline (third time period) condition of Experiment 1.

Chapter 2 : Method

General Method

It was my intent to demonstrate that human participants in an experimental choice situation would initially respond in a manner consistent with melioration and then change their behavior to resemble maximization following the introduction of an external cue exposing the internality (payoff functions) involved. Demonstrating that the introduction of a cue exposing the internality would elicit behavior more consistent with maximization would also suggest that melioration and the addictive process may be interrupted and individuals may better evaluate their choice options over time. Gall, Gall, & Borg (2003) suggest that basic research of this nature may be influential in providing support for theory and applied research in clinical fields.

A within-subjects design was used to determine whether an individual's behavior would shift toward maximization and away from melioration within the experimental session. A traditional ABA design recorded initial melioration in the first portion (baseline) followed by exposure to a visual cues exposing the internality (treatment). A final period resembled the first in which no cue was provided.

Participants and Recruitment

Participants consisted of 76 students attending Brigham Young University, Provo Campus, during winter semester 2004. Participants were recruited by Psychology 111 class instructors who were asked to advertise participation in the study during their classes. Potential participants were instructed to contact the principle researcher via e-mail to schedule a session.

When participants arrived at their scheduled time, they were required to read and sign a consent form stating the risks and benefits for participation in the study. Participation was voluntary and participants were informed they could leave the experimental session at any time

they wished. Participants were instructed that in leaving, they would receive the amount of money earned to that point in the session but would not receive a $2.50 session completion fee. Participants were also informed that upon completion of Experiment 1, some participants might be invited to participate in a follow-up session. Participation for the follow-up session was also to be voluntary, and no penalty would be imposed should they choose not to return.

Only students 18 years of age and older were included in the study. The mean age of all participants was 20 years old, with ages ranging from 18 to 32 years old. Participants consisted of 38 females and 38 males. Thirty participants (40%) were freshman, twenty (26%) were sophomore, twenty (26%) were juniors, five (7%) were seniors, and one (1%) identified as "other."

Apparatus

The "money machine" program used in this experiment was originally written in the spring of 2000 for use in the author's (Dinehart, 2001) master's thesis. The current version was written in the fall of 2003 and consisted of a separate program for each of the 3 experiments used. All of the programs were written in Python programming language and used Microsoft Excel to record all data.

All programs were run on IBM compatible computer systems using the Windows XP operating system. Each computer console operated as an independent experiment station and was in a private room. In each of the rooms, there was only a desk (upon which sat the computer, monitor, keyboard and mouse) and a seat for the person. No clock or other timing device was available in the experimental session.

Procedure

Research assistants were kept blind as to the experimental condition that each of the

participants would receive. A master participant tracking sheet (see Appendix D) was used to schedule and assign participants in equal numbers to all three cue conditions based on gender. Assignment was based on numbers and letters representing the experiment, cue, and laterality variables. For example, the first female participant's information was entered into the first female line of the tracking sheet and was assigned to the 1AX experiment combination. This information was entered into the computer program indicating that, for this participant, Experiment 1 would provide the timer cue (A) and the left key (X) would represent maximization. The next female participant's information was entered on the tracking sheet and was assigned to the 1BX experimental condition. This process continued, assigning participants to all 3 cue conditions (timer, graph, and combination) and an equal number of participants in each condition received the right and left keys representing maximization.

Once the participant had signed the consent form, a research assistant would escort the participant to an experimental room and enter information from the tracking sheet into the computer and thereby select the appropriate program to run. Once the program had begun, the research assistant would remain in the room while the participant entered her or his demographic information into the computer. Each participant was asked to enter her or his age, class status and gender and the last four digits of her or his social security number into the program. Once this information was entered, an instruction screen was displayed. The research assistant would then move the mouse away from the participant so that only the keyboard was accessible and then exit the room until the participant had completed the experiment.

Experiment 1

All 76 participants completed Experiment 1. Participants were assigned using a sequence of variable combinations (See Appendix D column 4) to one of three groups of equal gender

composition. Twenty-six individuals completed the experiment with the graph (13 males and 13 females), 26 with the timer (13 males and 13 females), and 24 with both cues present (12 males and 12 females).

In this experiment, each participant completed a 20-minute session. The session began with an instruction screen identical to that presented in the author's master's thesis, as described above. For the combination cue, no additional instructions were given as in the procedure method described earlier; all participants received the same instructions. Next, each participant was given a practice period of 1 minute in which to become familiar with the experimental procedure. A 5-min baseline condition then began in which the participant earned money in the absence of visual cues. At the conclusion of that time, a 1-min break was taken, followed by a 5-min period in which the participant continued earning money and in which one of the three visual cue options was presented (the graph, timer, or a combination). Following that interval, another 1-min break occurred. The final 5-min period was a return to the baseline condition in which money was earned but no visual cues were present. A "thank you" screen indicating that the experiment was concluded appeared when the final 5-min period expired.

Once a participant completed the experimental session, a research assistant gave the participant a post session survey with her or his corresponding identification number. During the time that the participant filled out the survey, a research assistant would access the Microsoft Excel file for that session and identify the total number of coins collected within the session by the participant. The program recorded the number of coins from each time period as well as the total number of coins collected over the entire session (see Appendix E). After the participant had completely filled out the post session survey, the research assistant would pay her or him 1 cent for each coin collected during the experiment plus $2.50 as an experiment completion fee.

Additionally, the software program recorded the ratios of choices corresponding to maximization for each time period as well as for the entire session. The program also recorded an indicator informing the research assistant that she or he was to invite the participant to complete a follow-up session. The indicator represented whether or not the participant had satisfied the selection criteria to be included in Experiment 2. If this indicator appeared on the participant's Excel file, the research assistant would invite the participant to complete the second experiment.

Experiment 2

Participants in Experiment 1 who responded in the second time period with at least 55% of their choice selections representing maximization were candidates for Experiment 2. Using a slightly higher criterion than chance responding (50%) was intended to include those participants who at least partially responded in a pattern representing maximization. The second criterion for inclusion in Experiment 2 was a return to a lower level of responding during the final time period by those who initially responded with more than 55% maximization in the second time period. A return to a lower level of responding was defined as an overall drop of 25% or more maximization responses in the final time period compared with responses in the second time period. In this way, participants were selected on a relative decrease in performance based on their own responding pattern.

Based on these criteria, 37 participants in Experiment 1 qualified to complete Experiment 2, and all consented to participate. Fifteen were male (40.5%) and 22 (59.5%) were female. Participants ranged in age from 18 to 23 years old, with a mean age of 20. Participants consisted of 38% freshman, 38% sophomores, 19% juniors, and 5% seniors. Nine participants received the timer cue (6 females, 3 males), 13 received the graph cue (6 female, 7 male), and 15 received the

combination cue (9 female, 6 male).

The second experiment assessed whether a fading procedure would aid individuals in maintaining maximizing choice allocation following. The procedure was almost identical to that described in Experiment 1 and each participant was matched to the cue she or he had previously received. The only variation occurred in the second time period. After the second money earning portion of the experiment began, the visual cue was present for the first 10 trials made. Once those 10 trials were made, only the first 8 of the next 10 trials had the visual cue present. After 8 subsequent choices were made, the cue was removed for 2 choices. The next 10 trials consisted of the first 6 with the cue present and the remaining 4 without the cue present. Ten trial blocks with the visual cue present for 4 and 2 choices respectively concluded the time period. A 1-min break followed and a final 5-min money-earning time period concluded the session, as with Experiment 1.

Behavior choice allocation that more closely approximated maximization in the second time period compared with the first would represent exposure to the internality and resultant behavior modification. Choices more similar to maximization in the third time period compared with the first would suggest that the fading procedure was a more successful way of removing the cue and allowing the participant to maintain awareness of the internality in the absence of the visual cue.

Experiment 3

Participants who responded with .75 or more of their choice allocation to the key representing maximization during the final time period of Experiment 1 qualified to be invited to participate in Experiment 3. This criterion was selected to identify those individuals who established and maintained a strategy more consistent with maximization following the treatment

condition. With a cutoff of .75, participants who used a strategy of balancing their choices equally between the choices would not be included, nor would those who selected the key representing maximization for a short time then returning to a melioration strategy overall.

Following Experiment 1, the researcher was to open the Excel file as explained previously. If the participant did not qualify to participate in Experiment 2, the research assistant was to record the ratio score from the third time period to determine whether or not the participant qualified to participate in Experiment 3. Appendix E represents the Excel file for a participant who did not qualify to participate in Experiment 2 but was qualified to participate in Experiment 3. Cell B17 in appendix E represents the ratio of responses representing maximization from the third time period. If the participant allocated more than .75 of her or his choices to maximization, the research assistant would invite her or him to participate in Experiment 3.

Based on the selection criteria, eight participants qualified to complete Experiment 3. However, only one participant was actually invited to complete the experiment. The participant was an 18-year-old female freshman who received the graph cue.

Experiment 3 was similar in procedure to Experiments 1 and 2, but there were several notable differences. The experiment provided 900 seconds in which to earn money, with no breaks available during the session. The session began with a 1-minute warm-up period in which no money was earned and in which the averaging window was set at 10 choices, meaning only the most recent 10 choices were used to calculate the delay for the next choice made. Following the warm-up, the averaging window for the session was resized based on responding within the window. The resizing of the averaging window would initially occur following completion of the first 10 choices. If 75% or more of the participants' responses had been allocated to the key

representing maximization for the 10 choices, the window size would be increased to 12 choices. The previous 12 choices would then be used in calculating the delay for the next choice made. However, if responding did not reach at least 75% maximization, the window would remain at 10 choices. If the participant received an averaging window of 12 choices, choice allocation within the next 12 choices (the new size of the averaging window) of 75% maximization the result would be an increase in the size of the averaging window to 14 choices following the completion of the 12 trials. If participants who received an averaging window of 12 choices failed to allocate 75% of their choices to maximization, the averaging window would be decreased to 10 following the completion of the 12 trials.

This pattern of reducing the window by 2 each time the participant failed to allocate 75% of their choices to maximization or increasing the size of the window by 2 when responding exceeded 75% maximization continued until the conclusion of the session. The minimum possible size of the window was 10 choices and the maximum possible size was 20 choices.

Again, the criterion of 75% of the choices allocated to maximization was intended to increase the size of the averaging window only if an overall pattern of maximization occurred. Participants who balanced their choices between the two keys or who allocated their choices consistent with a melioration strategy would not receive a larger averaging window.

Chapter 3: Results

Experiment 1

In each of the time periods (baseline, treatment, baseline) the total number of responses made by each participant as well as the ratio of responses consistent with maximization within the time period was recorded. The ratio scores were used in all statistical analyses. Preliminary analyses were conducted to determine if differences in scores were evident across participant gender or across the laterality of the presentation key (left or right). An alpha level of .05 was used for all statistical tests.

Gender

A one-way between subjects analysis of covariance (ANCOVA) was calculated to examine the effects of gender on scoring in the second period, controlling for the score in the initial time period. Scores in the first and second time periods were related ($F(1,73) = 16.14$, $p < .001$). The main effect for gender was not significant ($F(1,73) = .866$, $p = .36$), with females ($m = .46$, $sd = .23$) not demonstrating behavior more consistent with maximization than males ($m = .39$, $sd = .23$) in the second time period after controlling for the initial ratio score in the first baseline period.

Laterality

A one-way between subjects ANCOVA was calculated to examine the effects of laterality (left or right presentation of the criterion key) on scoring in the second period, controlling for the score in the initial time period. The main effect for laterality was not significant ($F(1,73) = .223$, $p = .638$), with participants receiving the criterion as the left key ($m = .43$, $sd = .26$) not demonstrating behavior more consistent with maximization that those receiving the criterion as the right key ($m = .41$, $sd = .22$) after controlling for the initial ratio

score in the first baseline period.

Group differences based on gender or laterality were not significant. Therefore, all subsequent statistical analyses were based on the full group of participants.

Treatment Effect

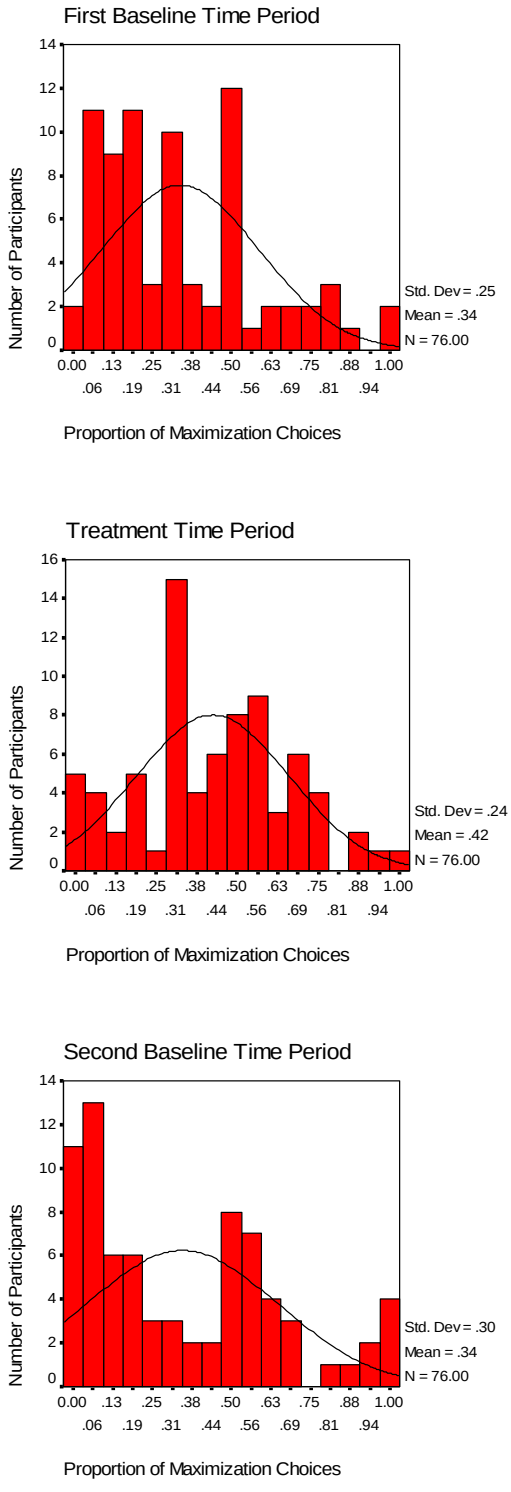
A one-way repeated measures ANCOVA was calculated comparing participants' ratio responses from the three time periods. A significant effect was found ($F(2,150) = 4.947$, $p < .05$). Follow-up protected *t* tests revealed that ratios representing maximization increased significantly from the first baseline period ($m = .34$, $sd = .25$) to the treatment period ($m = .42$, $sd = .24$). Ratio scores decreased significantly from the treatment period ($m = .42$, $sd = .24$) to the second baseline period ($m = .34$, $sd = .30$). No significant difference existed between the two baseline condition ratio scores (see Figure 6).

Table 2 indicates the percentage of choices allocated to the key representing maximization (MAX) as well as the proportion of choices allocated to the key representing melioration (MEL) for all participants across the three time periods. Also included is the percentage of increase or decrease in each of the time periods from the previous time period. The final columns indicate the number of participants (#>50%) who allocated at least 50% of their choices to the key representing maximization during the time period and the percentage (%>50%) of all the participants who allocated at least 50% of their choices to the key representing maximization.

Cue Presented

A one-way between subjects ANCOVA was calculated to examine the effect of cue presented (graph, timer, and combination) on ratio score during the treatment period, controlling for the effect of initial ratio score in the first baseline condition. First baseline scores

Figure 6.



Experiment 1 Time Period Comparison Graphs.

were significantly related to treatment period scores ($F(1,72) = 16.432$, $p < .01$). The main effect of cue type was not significant ($F(2,72) = .58$, $p = .563$), with scores from groups receiving the graph ($m = .45$, sd .30), the timer ($m = .37$, $sd = .20$), and the combination ($m = .45$, $sd = .18$) cue not significantly different from each other after controlling for the initial ratio score in the first baseline period (see Appendix F).

Table 2

Experiment 1 participant performance across time periods.

	Percent MAX	Percent MEL	Number Increase	Number Decrease	Number >50%	Percent >50%
Baseline 1	34	66	___	___	25	33
Treatment	42	58	8	___	34	44
Baseline 2	34	66	___	8	30	39

As a way of comparing individual participant's overall scores within each group, participants were identified as high scorers if their overall score was at or above the 75th percentile for all participants. Low scorers were identified by overall scores at or below the 25th percentile for all participants. This process was used to validate the responses from participants on the post session surveys as well as provide another descriptive way to compare groups receiving different cue presentation.

Table 3 indicates the number of participants scoring in the high range (scoring at or above the 75th) and low range (scoring at or below the 25th percentile). Also indicated are the percentages of participants indicating on their post session survey that there was a relationship between the two choices that would influence the consequence they received. The final column

indicates the number of participants accurately stating what the internality (consequences) was.

Table 3

Participant performance across cue presentations in Experiment 1.

	Number Hi Score (>75%)	Number Lo Score (<25%)	Percent Stating Relationship	Number Stating Internality
Timer	12	5	40	5
Graph	7	6	36	___
Combination	10	9	38	3

Experiment 2

As above, in each of the time periods (baseline, treatment, baseline) the total number of responses made by each participant as well as the ratio of responses consistent with maximization was recorded. The ratio score was used in all statistical analyses. An alpha level of .05 was used for all statistical tests.

Gender

A one-way between subjects ANCOVA was calculated to examine the effects of gender on scoring in the second period, controlling for the score in the initial time period. Scores in the first and second time periods were related ($F(1,34) = 22.55$, $p < .001$). The main effect for gender was not significant ($F(1,34) = .064$, $p = .802$), with females ($m = .25$, $sd = .23$) not demonstrating behavior more consistent with maximization than males ($m = .29$, $sd = .23$) in the second time period after controlling for the initial ratio score in the first baseline period.

Laterality

A one-way between subjects ANCOVA was calculated to examine the effects of laterality (left or right presentation of the criterion key) on scoring in the second period, controlling for the effects of score in the initial time period. The main effect for laterality was not significant ($F(1,34) = 1.82$, $p = .186$), with participants receiving the criterion as the left key ($m = .30$, $sd = .24$) not demonstrating behavior more consistent with maximization that those receiving the criterion as the right key ($m = .23$, $sd = .23$) after controlling for the initial ratio score in the first baseline period.

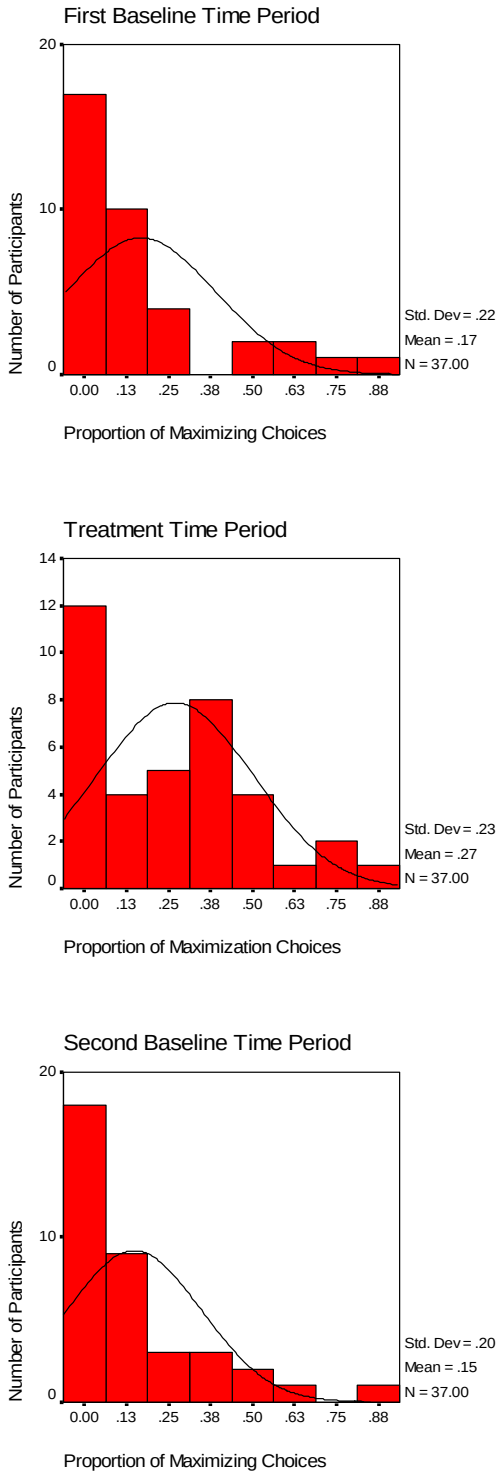
Group differences based on gender or laterality were not significant. Therefore, all subsequent statistical analyses were based on the total group and will not be reported for the separate group factors.

Treatment Effect

A one-way repeated measures ANCOVA was calculated comparing participants' ratio responses from the three time periods. A significant effect was found ($F(2,72) = 9.67$, $p < .01$). Follow-up protected *t* tests revealed that ratios representing maximization increased significantly from the first baseline period ($m = .17$, $sd = .22$) to the treatment period ($m = .27$, $sd = .23$). Ratio scores decreased significantly from the treatment period ($m = .27$, $sd = .23$) to the second baseline period ($m = .15$, $sd = .20$). No significant difference existed between the ratio scores of the two baseline conditions (see Figure 7).

Table 4 indicates the proportion of choices allocated to the key representing maximization (MAX) as well as the proportion of choices allocated to the key representing melioration (MEL) for all participants across the three time periods. Also included is the percentage of increase or decrease in each of the time periods from the previous time period.

Figure 7.



Experiment 2 Time Period Comparison Graphs.

The final columns indicate the number of participants (#>50%) who allocated at least 50% of their choices to the key representing maximization during the time period and the percentage (%>50%) of all the participants who allocated at least 50% of their choices to the key representing maximization.

Table 4

Experiment 2 participant performance across time periods.

	Percent MAX	Percent MEL	Number Increase	Number Decrease	Number >50%	Percent >50%
Baseline 1	17	83	___	___	6	16
Treatment	24	76	7	___	16	43
Baseline 2	15	85	___	9	4	11

Cue Presented

A one-way between subjects ANCOVA was calculated to examine the effect of cue presented (graph, timer, and combination) on ratio score during the treatment period, covarying out the effect of initial ratio score in the first baseline condition. The score for the first baseline period was significantly related to treatment period score ($F(1,72) = 16.26$, $p < .01$). The main effect of cue type was not significant ($F(2,33) = 3.06$, $p = .06$). Scores from groups receiving the graph $m = .07$, $sd = .10$), the timer ($m = .31$, $sd = .27$) and the combination cue ($m = .35$, $sd = .23$) were not significantly different from each other after controlling for the initial ratio score in the first baseline period (see Appendix G).

Table 5 indicates the number of participants completing Experiment 2 from each of the cue presentation conditions. It also indicates the number of those participants who scored in the high

range (scoring at or above the 75th percentile across groups) and low range (scoring at or below the 25th percentile across groups). Also indicated are the percentages of participants indicating on their post session survey that there was a relationship between the two choices that would influence the consequence they received. The final column indicates the number of participants accurately stating what the internality (consequence) was.

Table 5

Participant performance across cue presentations in Experiment 2.

	Number of Participants	Number Hi Score (>75%)	Number Lo Score (<25%)	Percent Stating Relationship	Number Stating Internality
Timer	9	0	2	___	___
Graph	13	4	3	14	1
Combination	15	5	2	11	1

Experiment 3

Only one participant completed Experiment 3. No statistical analyses were performed. The participant was an 18-year-old female freshman who received the graph cue. During the warm-up period, the participant allocated 93% of her choices to the key representing maximization. Following the warm-up time period, the participant's overall ratio of choices allocated to the key representing maximization was .87 for the main session. The participant selected the key representing melioration in 3 discrete episodes occurring at the beginning of the main session, approximately half way through the main session, and the last 4 choices made.

Chapter 4: Discussion and Conclusion

Experiment 1

Experiment 1 was intended to test the hypothesis that an experimental situation could be presented in which participants would demonstrate melioration and represent the behavioral addiction process (see Rachlin, 2000). This experiment attempted to represent the addiction process described in chapter 1 of this dissertation.

The Addictive Process Represented

In Experiment 1, a choice value decrease was represented by an increase of delay time resulting in decreased availability. The delay function equations discussed in chapter 1 set the minimum delay time for the key representing maximization to 4 seconds. Participants exclusively selecting this key (choice A in Figure 1) would be able to earn a coin by pressing the key every 4 seconds, never increasing the delay. The minimum delay time for the key representing melioration (choice B) was set at 2 seconds. This delay time would increase with each additional selection of the key until it would reach its maximum delay of 6 seconds (position C). Once a participant reached this delay time, selection of the maximizing key (position D) would produce a delay of 8 seconds that would decrease with each additional selection of the maximizing key. In this way, Experiment 1 provided an experimental representation of the addictive process described earlier.

During the initial period of Experiment 1, participants responded in a manner consistent with melioration. This result helps support the validity of the present research model in replicating previously cited methods. Strong preference for a melioration strategy of choice selection seems to be quickly established and maintained. The mean ratio of choices allocated to maximization across all participants was .34. This suggests that as a group, approximately 66%

of all choice selections made by participants contributed to a decrease in the overall value of both choices available.

Paralleling a pattern indicative of a melioration strategy suggested by the statistical data is the finding that 30 of the 76 participants (29%) indicated on their post session surveys that they would recommend a strategy of determining which key resulted in the shortest initial delay and then to select only that key. One participant wrote, “I compared the time it took for each dispenser to drop a coin and get the coin in the cup. Once I figured out which dispenser went faster, I weighed down the arrow key to the corresponding dispenser and just watched the money come.” This participant earned much less money than those not using a choice strategy exclusively based on melioration.

Other participants indicated they had used a similar strategy of selecting the fastest key extensively with rare selections of the "slow" key. One of the participants wrote, “Don’t worry about the other side because it will be slower throughout the whole game.” During the first baseline period of the experiment, many of the participant’s choice selections and verbal reports appear to agree that a strategy of melioration was quickly set up and maintained, paralleling the primrose path to addiction.

Treatment Effect

Having established a baseline condition from which comparisons could be made, the second period of the experiment was intended to aid participants in recovery from the addictive nature of the choice situation. It was hypothesized that participants would initially respond to repeated choice opportunities in a manner more consistent with melioration and then after receiving a visual cue exposing the internality of the experiment, participants would allocate their choices more consistently with a maximizing choice strategy. For some participants, this

change in choice strategy was recorded experimentally as well as verbally. Other participants demonstrated more choice variability but did not describe a strategy of maximization.

The statistical results presented in the previous chapter indicated that the treatment effect was observed. Participants in Experiment 1 demonstrated choice allocation significantly less consistent with melioration during the second time period of the session (in which the visual cue was present) than they did during the initial phase (baseline). The mean ratio of choices allocated to maximization was .42. This change of responding is notable, particularly when considering that a majority of the participants had already experienced a decrease in the overall value of their choices as a consequence of their previous selection of the key representing melioration. Participants were much more likely to go through a process of selecting the key representing maximization and waiting longer than they had previously.

In the post session written responses, more than 50% of the participants indicated that during the treatment periods, they experimented with their choice allocation based on the cues presented. Interestingly, when this overall result was broken down by the type of cue received, it was found that only 5% of those receiving the timer cue reported a strategy of experimenting with their choice selection. Of those participants receiving the graph and combination cues, post session survey responses indicated experimentation with choice selection was a strategy used by 80% and 53% respectively. Participants receiving the two cue presentations including the graph appear to have been more likely to experiment with choosing the longer delay key (maximization) than were the participants receiving the timer cue only.

Fourteen of the participants (18%) indicated that they experimented with their choices and eventually decided to strike a balance between the two choices. One participant who received the timer cue stated, “I struck a balance between the left [maximization] and right

[melioration] side machines. I took a conservative approach and hoped for equals." Another participant receiving the graph wrote, "When the pie chart came up, I found that the right side slowed the more I clicked it, so I experimented with the left and saw it sped up. Then I tried the right and saw it dropped faster than before, but slowed again, so out of curiosity I clicked the left till the whole chart was red and saw the rate stayed at a constant 5 seconds." That same participant also indicated that the graph was helpful in finding the trends of the coins that influenced her strategy for choosing.

The third time period of the experiment represented a return to the baseline condition. With the removal of the cues presented, the mean ratio of responses representing maximization dropped significantly to .34, the same ratio as in the first baseline condition. Further examination of the trends from these time periods revealed that although the mean ratio was identical, the distribution of scores was very different across the two baseline conditions (see Figure 6). In the first baseline condition, 25 of the participants (33%) allocated approximately half or more of their responses to the key representing maximization. That number increased to 34 (44%) in the treatment condition with the cue present. During the second baseline condition, 30 participants (39%) allocated approximately 50% or more of their responses to the maximization key. That is a change of only 5% fewer than the treatment condition, and a notable increase from the first baseline period, in which only 7 participants (9%) had this type of score.

Overall, the results indicated that, for this group, a treatment effect occurred and there was a significant decrease in meliorating behavior when the cues were presented. There was also a significant increase in meliorating behavior when the cues were removed, although the total number of people maximizing after the cue was removed was higher than the baseline period.

Differences Between Cue Presentations

There were no statistically significant differences in maximization ratios across the three types of cues presented. Participants receiving the graph and combination cues consistently allocated more of their choices to the key representing maximization than did those receiving the timer cue; however, the differences were nominal.

Another indication of the compatibility of cues comes from the responses on the post session surveys. Across the three groups, 10 participants (40%) receiving the timer cue specifically stated that there was a relationship between the keys. Nine participants (36%) receiving the graph cue indicated a relationship between the keys. Ten participants (38%) stated they noticed a relationship between the keys and the delay. These responses suggest that a similar number of participants across all three cue presentations indicated awareness of part of the internality, or delay function. Identification of a relationship between choice values was one of the factors described in the restructuring process, leading to maximizing behavior (Ainslie, & Halsam, 1992; Hayes, Stroshal, & Wilson, 1999; Herrnstein, 1997; Rachlin, 2000).

When a cut-point analysis was used, some group differences became apparent between participants receiving different cues. Participants whose scores exceeded the 75^{th} percentile of all participant scores were classified as high scorers, and participants whose scores fell below the 25^{th} percentile were classified as low scorers. Participants receiving the graph and combination cues seemed to be equally split in the amount of individuals that fell in the high and low categories. Of the participants receiving the timer cue, 12 scored in the high scorer category and 5 fell in low scorer category. Compared with the overall percentages of participants scoring in the high (38%) and low (26%) categories, participants receiving the timer cue did not typically balance their choices but favored either melioration or a maximization strategy. They were also

less likely to experiment with their choice allocation than participants receiving the graph or combination cues.

Identification of the Internality

Another interesting indicator of cue presentation efficacy is a tally of participants who were able to clearly describe the internality. Correct identification of the internality in place would suggest choice selection could be based on the overall value of the choice and the process of melioration would be less likely to be used. A total of 8 participants (approximately 10%) specifically identified the internality on their post session surveys. Five of these participants had received the timer cue and 3 of them had received the combination cue. One participant who received the timer cue wrote, "Left [maximization]-wait a few trials, it will speed up and be constant. Right [melioration]-the first few are fast, then it slows down." Another participant receiving the combination cue wrote, "The speed of the left [melioration] coin falling was proportional to the # of times the right [maximization] coin fell, increasing as the # of right coins did. The speed of the right coins also increased the more times you pressed it. Even though it's slower at first, press the right coin 10 or so times." These participants explained that they had indeed noticed that the value of individual choices had to be weighed against the overall pattern of change resulting from choice allocation. Several participants, not just those able to verbalize the internality in place described Restructuring and self-control strategies such as these.

Restructuring and Self-Control

As mentioned in chapter 1, melioration may be the result of limited information as to the overall context of the choice itself. Thirty participants (39%) reported that the only strategy they used was to judge which of the coins fell fastest initially and to then select that key most often throughout the experiment. This strategy represents a myopic, or shortsighted view, that resulted

in those participants receiving less compensation from their efforts and actually waiting longer for each coin to drop. Herrnstein (1997) and Logue (1995) proposed two strategies aimed at assisting an individual in the choice process. Post session surveys confirm the usefulness of these strategies.

Participants utilizing the timer and the graph cues reported less decision making based on the local value of each choice and more willingness to experiment with their choices in an effort to asses the impact of their choices on the overall result of the experiment. In other words, 29 participants (37%) wrote statements defining a relationship between the consequence of selecting one choice over another. Thirty-nine participants (51%) stated that information was found out through experimentation based on cues that were presented (restructuring), and suggested that at least some tolerance for a delay (self-control) was necessary to achieve overall benefit. The overall result was an overall decrease in the number of participants using an exclusive melioration strategy.

Experiment 2

The Addictive Process Established

Experiment 2 was intended to provide an alternate means of fading a cue in an attempt to promote learning. Thirty-seven participants (48%) in Experiment 1 qualified to participate in Experiment 2. As with Experiment 1, a statistically significant treatment effect was observed across the 3 time periods. During the initial baseline condition in which no cue was present, the mean ratio of choices corresponding to maximization was .17. This suggests that among a portion of the original sample, participants allocated more than 80% of their choices to the key representing melioration during the first time period. This group of participants likely responded this way because there was little learning effect demonstrated within the previous session.

Additionally, there may have been a tendency to choose exclusively according to a melioration strategy because of their exposure to the previous experiment (exposure effect/test-wise bias). Only 6 of the 37 participants (16%) allocated half or more of their choices to the key representing maximization. Overall, this group was clearly following a melioration strategy from the beginning. Several participants indicated on their post session surveys that they followed a pattern similar to that used in the previous experiment. Wrote one participant in response to a question asking about strategies used, "The same as last time, only almost no left [maximization] arrow."

Treatment Effect

During the treatment period in which the cue was intermittently presented, the mean ratio of choices allocated to maximization rose to .24. Sixteen participants (43%) allocated half or more of their choices to the key representing maximization. This was a significant increase from the first baseline time period. Participants from the graph and combination groups seemed to experiment much more than those receiving the timer cue. The overall result was that participants made many more attempts to change their patterns of responding when the visual cues were present compared to the baseline time periods.

All eleven participants who indicated that they recognized a relationship between the choices received the graph or the timer cue. Nine of them specifically indicated that they made their choice selections in an attempt to maximize overall reward. These participants seemed to gain a greater perspective of the value of patterns of choices rather than focusing on any particular choice. Six participants indicated that they actively experimented with both choices because they noticed the cues and used them to try to increase their reward. Three participants indicated that they used a strategy of keeping a balance between their choices.

Three participants correctly stated the internality in operation. One participant who received the graph explained, “The right [maximization] continues to reward people the more you stick with it. The left [melioration] has instant gratification but slows down quickly and ruins your prospects for the investment of time with the right key.” Another participant receiving the combination cue stated, “It’s as if the left [maximization] gives ‘gas’ to the right [melioration].” This latter participant also indicated that much of his choosing was based upon using the graph. As with Experiment 1, these participants described strategies of incorporating more information into their decision making process and employed some strategies of self-control to maximize their responses.

The original hypothesis was that participants receiving a fading procedure would maintain a higher level of responding following the treatment period of the experiment. The mean ratio of choice allocation to the key representing maximization during the second baseline phase was .15. This indicates that as a group, participants did not maintain their level of responding and returned to a lower level of choice allocation to maximization. In fact, whereas 6 participants allocated half or more of their choices to maximization in the first baseline time period, only 4 participants did so in the second baseline time period.

Many of the participants indicated on their surveys that they did notice the cues presented but that they only experimented with their choosing while the cues were visible. For example, one participant said, “Use only the left [melioration] arrow unless the pie chart is present. If it is, alternate between the arrows.” Another participant said, “When the graph came up, I chose more right [maximization].” The intermittent presentation of the timer likely drew more attention to them than in previous experiments. Those participants that noticed and attended to the timers were more accurate in describing the internality. Other participants did notice the timers but

chose to ignore them because they did not know what they represented.

Differences Between Cue Presentations

An interesting result of group comparisons also revealed differences between groups receiving the timer, graph, and combination cues. Of the 37 participants completing Experiment 2, all 9 of the participants receiving the timer cue followed a melioration strategy and 7 of them specifically indicated as much on their post session surveys. Only 2 of them reached or exceeded the 50th percentile in overall earnings for Experiment 2. Many participants wrote that they did notice the timers, but that they did not pay much attention to them because they were not sure how to interpret the information the timers were presenting.

Similar to the results from Experiment 1, participants in Experiment 2 who received the timer were less likely to experiment with their choice allocation. In this experiment, the participants did not seem to be using a pattern of choice allocation that balanced their selections between the two options. Participants were more likely to use a melioration choice strategy, resulting in overall lower returns.

More than half of the participants receiving the graph cue indicated there was a relationship between the two choices and indicated the need for consistency when choosing the key with the longer initial delay (one indicated that 10 choices was the criteria for delay changing). Though several participants indicated there was a relationship between the two choices available, many of them reported that they only used that information to influence their decision when the cue was present. One participant said, “When the pie chart was present I alternated arrows, when it wasn’t, I used only the left [melioration] arrow.” It appears that some of the participants receiving the graph cue were also only willing to experiment with alternating their choices if the cue was present.

Fifteen participants receiving the combination cue completed Experiment 2. These participants seemed to represent more equality between maximization, melioration, and balancing strategies for decision making. Four participants stated there was a relationship between the two choices and indicated that they used the graph to determine which key to push, and one participant correctly identified the internality. Only one of them indicated that she used the timer at all. Six participants indicated a strategy of exclusive melioration with one stating, "I wasn't willing to keep using the left [maximizing] dispenser." Three participants stated that they did experiment with their choice allocation, and two said that they kept their choices balanced.

In Experiment 2, the hypothesis that a learning effect would be recorded following the fading procedure was not confirmed. There was support for a treatment effect, though the effect was more modest than expected. Participants tended to choose much more consistently with maximization (through experimentation, balancing of choices, etc.) in the presence of the graph cue than with the timer cue.

Experiment 3

Eight participants allocated over 75% of their choices to the key representing maximization during the final time period of Experiment 1, qualifying them to participate in Experiment 3. Only 1 participant completed the experiment (see Limitations section below for discussion). An overview of the responses recorded indicates that over the full session, only 23 choices were allocated to the key representing melioration. The participant selected the key representing maximization 194 times. At most, she selected the melioration choice 14 times in a row. The final averaging window size was 20, meaning her choices represented more than 75% responding for most of the session. She stated that, "The $ is received quicker when you constantly stay with one side. Also, if you switch to the other side, the $ goes quickly for a few

rounds then slow again." She said she would advise another participant to "Pick a side and stick to it." Little experimentation was used during the session. The averaging window was consistently increased until it reached 20 and fluctuated very little. This participant appears to have established a pattern of maximizing early in the session and demonstrated a type of ceiling effect, demonstrating little variation in her pattern of responding.

General Discussion

Experiments 1, 2 and 3 were all intended to provide evidence that melioration is involved in the behavioral addictive process and can be documented in an experimental setting. Additionally, this research was proposed as a possible way to interrupt the melioration process and allow individuals a way to potentially maximize behavior.

Participants in this research demonstrated a change in their behavior when exposed to visual cues. This change appears to be consistent with a treatment effect from the cues presented, but the treatment effect did not remain when the cues were removed. This absence of a learning effect may be an important limitation of this study and could be the focus of future research in this area. Many of the participants reported on their post session surveys that they were more willing to experiment with their choices only when the cues were present. Participants were highly likely to return to a higher level of meliorating behavior once the cues were removed.

The Within-Subjects Design

One of the main methodological changes used in this study was to provide a within-subjects design. The intent was to be able to compare individuals' response rates over time to measure the treatment effect and possible learning effect of the cue presented. This design maintained the same amount of actual time for the experiment as Herrnstein et al. (1993) and

Dinehart (2001), while decreasing the exposure to the cue during the treatment time period. Participants on the author's master's thesis study were exposed to the visual cue for the entire 15-minute session. Participants in the current study had a maximum exposure time of 5 minutes. Because most participants indicated (in their written reports and with their patterns of responding) that a strategy of melioration was quickly set up within the first baseline condition, a 5-minute period seemed to be an adequate allotment of time for them to establish a pattern of behavior. However, a 5-minute period of time may have not have been sufficient for experimentation with the choice selections to result in exposing the internality. Future experiments may attempt to establish an appropriate level of exposure to the visual cue that would produce an optimal illumination of the internality.

Verbal Identification of a Relationship Between Choice Consequences

Comparing the results of the master's thesis and this study, large differences were recorded when comparing participants' verbal recognition of a relationship between choices. In the master's thesis, 25% of the participants receiving the timer cue stated they recognized a relationship between their choice selections. In the present study, 40% of the participants receiving the timer indicated a relationship. One possible explanation for this change in perception of the relationship may be the saliency of the cue. In the master's project, the timer was present throughout the session. Many of the participants indicated that they did not know what it was to be used for and did not pay attention to it. In the present study, during the treatment time period, the timer was visible. This may have increased the novelty of its presentation and elicited more attention. The differences between reports from participants receiving the graph in both studies are less pronounced. Forty-four percent of the participants receiving the graph cue in the master's study indicated there was a relationship between the

choices. Thirty-six percent of the participants in the present study so indicated. This small difference may also be based on the saliency of the cue. The graph in both situations was large in size relative to the hoppers and changed noticeably with the allocation of choices. In both studies, attention paid to the graph cues may have been more similar than to the timer. Additionally, the small decrease in the percentage of participants indicating a relationship may be due to the decreased exposure time discussed earlier.

The most noticeable difference between the responses from the participants in the master's study and the present study was noted from the groups receiving the combination cue. Thirty-eight percent of those participants indicated they noticed a relationship between the choices they made in the experimental session. This is a substantially lower percentage than the 83% of participants in the master's study. One methodological difference that may have influenced these results may be the instructions themselves. In the master's study, participants were given additional instructions on how they could activate and deactivate the graph, the timer, or both. All participants activated both of them in the master's study. Participants in the present study did not have the additional instructions and no option for activation of the cues was provided. Both the graph and the timer were present during the treatment time period. This change in the involvement of the participant in activating the cues may have significantly influenced the attention to and benefit from the cues. Without this additional information and action, the proportion of participants reporting a relationship between their choices was similar to the other two cue presentations. Requiring participant activation of the cues may be another improvement on the present design that could increase detection of the internality. Future experiments may require participants to activate and deactivate the cues, increasing the possibility of the cue receiving more attention during the experimental session.

Potential Applications of the Findings

Visual cues. In these experiments, visual cues representing aspects of the internality were presented to participants to assist them in allocating their choices based on overall value, not just local value. Participants in this study demonstrated much higher variability of responding when visual cues were present. The presence of the visual cue may have promoted more behavioral experimentation, allowing the participants to notice the effects of their individual choices on the overall outcome of the series of choices. This type of restructuring may benefit people in choice situations representing specific addiction-prone behaviors. Promoting variability in choice may reduce the exclusive use of melioration and may help interrupt the addictive process. For example, to keep myself focused on chapter writing, I might have a timer that would count down the time left until I would unable to finish and defend this dissertation. By keeping the saliency of the need for chapter writing high through more visual exposure, I might allocate a higher amount of time to chapter writing (editing, etc.) than I would if the cue were not present visually.

Another method of restructuring may include keeping a careful account of the activities that are consistent with chapter writing and those that detract from it. Keeping a record that indicates an accurate accounting of the proportion of time (or proportion of activities) dedicated to the overall goal increases the probability that the information might be used in current and future choice situations. For example, I might document how many of the last 10 days I have chosen to work on this dissertation (specifying what constitutes work). The documentation itself might serve as a reminder of the history of my choices and be used to evaluate the benefit of engaging in writing behavior. In addition, consequences could be specified for the proportions of the previous 10 days I have worked on the dissertation. A chart could be produced indicating the consequence (available time to watch movies, amount of writing needed to complete the

project on time, sanctions, etc.).

Visual cues might also be beneficial for individuals in a clinical setting. A cue as to the context of a choice may provide a needed opportunity for an individual to recognize the negative effects of some impulsive choices. An anxious individual, for example, may be given a cue that encourages variability of responding in an anxiety-provoking situation. The individual might typically respond with strategies to reduce anxiety through avoidance. The cue provided may be a reminder of recent choices to avoid anxious situations and the outcome of those choices (internality). This change from typical choice selection may allow the individual to maintain a longer-term perspective of the choice situation and reduce the use of melioration. In this way, the individual may gain a better perspective as to the nature of her or his anxiety responses, decreasing the likelihood of an exclusive use of melioration.

Experimentation. One implication of these findings is that although the internality present in the choice situation might not have been completely exposed, the presence of the visual cues seemed to have fostered more experimentation with choice allocation. Many participants indicated that they did not maintain a choice strategy exclusively based on melioration in the presence of the visual cue. In these cases, the visual cues may have served as a sign to change behavior. Some participants explained that they were willing to experiment with different choice allocations when the graph was present, sometimes allowing them to become aware of the relationship between the keys. Individuals who use a choice strategy exclusively based on melioration may never be exposed to the effects of choices more consistent with maximization. By experimenting with choice selection, individuals are more likely to gain a better perspective of the consequences of their choices.

The cues presented may have promoted more choice variability, allowing the participants

to experience the effects from both choice options and leading to better understanding of the relationship between choices. In a clinical setting, an individual experiencing some symptoms of depression may be consistently choosing their behaviors from a melioration strategy. A cue may be introduced that would promote experimentation in selecting behaviors, such as changing a daily routine, exercising, changing a diet, allowing the individual to experience the results of behaviors that are not based on melioration. In this way, the individual may have a better perspective from which to make further choices and alter a pattern of behavioral addiction.

Obvious exposure to the internality. Several participants recognized there was a relationship between the choices (keys), though only a few verbally described the internality specifically. Participants might benefit from an explanation of the internality either prior to or within the session. With this information, participants might experience the effects of the internality and become more sensitive to the rates of availability of the choices encountered. In the experimental situation, participants might be more sensitive to the key representing maximization. In the dissertation-writing example, a student might be educated as to the nature of the behavioral addictive process early, and the choice to actively work on the dissertation process from the beginning might be related to the model described in chapter 1. An initial estimate of the value of writing the dissertation and completing the requirements to graduate may be made early in the first year of study. Students might also be introduced to the concept of the decreasing value of the dissertation when shorter-term alternatives (movies, dating, internships, jobs, etc.) compete for the student's time (see Precommitment and Time Discounting above). The value of the dissertation and of the alternatives may be compared by using the model in Figure 1 to recognize the decreasing value function of melioration and perhaps aid the student in choosing behaviors consistent with overall goals.

Individuals experiencing some of the effects of drug and alcohol addictions, depressive symptoms, anxiety, eating disorders, gambling addictions, or sexual compulsivity may benefit in a similar way to the dissertation writer. It may be possible for visual cues to be presented allowing such individuals to assess the value of choices in a way that reduces the exclusive use of melioration. The negative effects of drugs and alcohol have been advertised in an attempt to aid individuals in their choices to consume these substances. The goal of these advertisements has been to accentuate the consequences of choosing to use these substances. Visual cues might serve the function of allowing individuals to more accurately compare the value (availability) of their choices. The form of the visual cue might be that of a timer, a behavioral log, or an overt description of the consequences of their behavior (and the magnitude of the consequences). The cues themselves might serve as a reminder that the subjective values of the choices available might not be consistent across time. Caution should also be taken when introducing any intervention aimed at changing behavior within an addictive cycle. As stated earlier, once an addictive pattern of behavior has been established, it is highly resistant to change because the initial change of behavior is often perceived as highly undesirable compared with the addictive choice. Emphasis on restructuring and gaining better perspective of the choice situation when considering an intervention or cue should be the focus.

Limitations of the Study

Sample selection. The participants for this study were recruited exclusively from undergraduate introductory psychology courses. These courses were targeted because they are required for general education requirements within the university. Because this sample of participants was not randomly selected from the population at large, generalizations are limited. In this study, participants represent students between the ages of 18 and 25 attending an

institution of higher education. This sample would not accurately represent a community sample of individuals and is therefore limited in generalizability. Future studies may be helpful in expanding the applicability of these findings to include to populations representing a more broad range of ages, levels of education, cultural backgrounds, socioeconomic statuses, etc.

Task generalizability. The program used for this experiment was designed to replicate a procedure used previously to document melioration in an experimental setting. The task of choosing between two choices (keys) was intended to represent a choice between two mutually exclusive alternatives. Many choices are mutually exclusive (to write or not to write, to drink or not, etc.). Often, these types of choices are much more complex than a two-choice model (to write, to read, to eat, to watch movies, etc.). Outside this experimental setting, the choice of one alternative over another will likely include a variety of other factors in addition to the internality that may contribute to the overall value assigned to that choice (e.g., time available to make the choice, clarity of the choice alternatives, physical and environmental factors, history of selection, etc.). The results of this study must be interpreted with caution because the task performed was not specific to any particular choice to be made outside the experimental setting. A possible next step for research would be to specify a choice that could be isolated and measured to extend the applicability of this research to other choice situations.

Data collection in Experiment 3. All data collection occurred during the fall semester of 2003. The principle author was not present during data collection. A detailed protocol was provided to instruct research assistants and ensure the data collection process was standardized and valid. All data collected from the 76 participants in Experiment 1 was recorded in Excel ® files and analyzed later by the principle researcher. According to the protocol mentioned, each participant who qualified to participate in Experiment 2 was invited to do so, and all 37

participants consented.

Early in the data collection process, the principle researcher communicated with the principle research assistant concerning the procedure for identifying participants to invite to complete Experiment 3. The procedure had been outlined in the data collection protocol mentioned and the issue was assumed to be resolved. The principle researcher indicated that one participant had been invited to complete Experiment 3. One month later, upon inspection of the data, the principle researcher discovered that there were 8 participants whose data files indicated they had qualified to participate in Experiment 3, but 7 of them had not completed the experiment. No method of contacting the participants was possible at that point because participant contact information was not associated with data files. Additionally, the principle research assistant had graduated and was not available for discussion as to the discrepancy.

One main limitation of this research was the lack of direct supervision provided to the research assistants as to the screening of participants for the third experiment. Each Excel file showed a *yes* or *no,* indicating whether or not the participant was to be invited to complete Experiment 2. For participants qualifying to complete Experiment 3, the research assistant was required to open the Excel file and note whether the proportion of choices for the third time period exceeded .75. Research assistants may not have been instructed properly as to the necessity of noting the participant's information. More direct instruction by the principle researcher and also by the principle research assistant might have eliminated this problem. Additionally, a more timely review of initial data collected might have alerted the principle researcher as to the potential problem and more specific instruction could have been provided to the research assistants. Finally, more communication overall between the principle researcher and principle research assistant throughout the data collection process might have prevented this

outcome.

The single participant completing experiment did provide information as to the limits of the averaging window. The information collected from the participant should be interpreted with caution as it may represent idiosyncratic responding for the participant and might not represent others that might have responded very differently.

Conclusion

The present research study was intended to provide experimental support to previously stated theories of melioration and behavioral addictive processes. The involvement of melioration in general and clinical populations has been proposed as one way to conceptualize the addictive process. Basic research attempting to clarify the role of melioration was proposed as a valuable tool to identify common factors in the addictive process as provide possible interventions that would interrupt those processes.

The experimental design first introduced by Herrnstein et. al (1993) and reproduced in the author's master's study and the present research represents a valuable method of exploring melioration and addiction in human populations. It capitalizes on the immediately consumable nature of delay (waiting) to approximate situations in which humans tend to use a strategy of melioration, leading to overall low results.

The results of this research study suggest that melioration and the addictive process can be recorded in an experimental setting. As an improvement on previous methods, this study suggests that once established, melioration may be interrupted temporarily in favor of maximization by providing information about the internality present in a choice situation. Overall, participants receiving more information about the effect of their choice allocations altered their responding from a strategy of melioration. Some participants selected a strategy of

balancing their choices, while others identified the internality present and adopted a strategy consistent with maximization. Experimentation with choice allocation was also used by many of the participants in response to the visual cues presented. In relation to the process of behavioral addiction, these strategies seem to reflect choice behavior that is not exclusively based on melioration, reducing the likelihood of maintaining an addictive process.

This experimental design was intended to document the addictive process as described in chapter 1 and to introduce a possible strategy of interrupting that process. Though these findings are highly specific to this study and sample population and should be interpreted with caution when generalizing to other populations, they do suggest that the underlying factor of melioration may be temporarily interrupted in an experimental setting.

Melioration and the Behavioral Addiction Process: An Experimental Analysis

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Abstract

Melioration and the Behavioral Addiction Process: An Experimental Analysis

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Melioration can be a factor contributing to behavioral addiction. In this study, 76 university undergraduates operated a "money machine" by selecting between choices that corresponded to maximization and melioration. Participants initially made choices consistent with a strategy of melioration and then altered their behavior significantly in favor of maximization when visual cues were presented aimed at exposing the internality (or consequence) of the choice situation. Removal of the visual cues resulted in a return to lower responding, indicating a treatment effect had been achieved but a learning effect was not. Visual cues may aid in interrupting the behavioral addiction pattern. Methods of restructuring and experimentation with choice allocations are suggested as possible alternatives to melioration.

KEY WORDS: Melioration
Addiction
Maximization
Behavioral decision
Behavioral economics
Key press
Humans

Suboptimal behavior, including addiction, can be conceptualized as the consequence of a decision strategy called melioration (Herrnstein & Vaughan, 1980; Loewenstein & Elster, 1992) that is utilized in choice situations in which the value of an alternative is affected by the rate of its availability. It is a function of the economic principle of supply and demand (Bickel & Marsch, 2000). The higher the rate of availability of an alternative (usually associated with lower cost), the lower the overall value. Melioration can result in negative consequences that are not recognized by the individual until their cumulative negative effect becomes unavoidable (Bickel & Marsch, 2000; Elster and Skog, 1999; Rachlin, 2000). This negative effect may go unrecognized because individual decisions in the series of repeated choices are not perceived as adding much weight to the overall consequences of the series. This failure to perceive the overall outcome has been referred to as the "primrose path to addiction" (Rachlin, 2000, p. 74).

Melioration as Part of the Addictive Process

The economic principle of melioration depends on the individual's ability to detect the rate (or value) of each of the competing alternatives (sources of reward) that are available in a choice situation. If the rate is undetectable, behavior is likely to be a random switching between alternatives. If detectable, then as long as the value of one alternative is higher than that of the others that are available, the probability that a person will continue to select that alternative will remain high (Herrnstein, Loewenstein, Prelec, & Vaughan, 1993; Herrnstein, 1997; Rachlin, 2000). In other words, the same behavior is likely to continue as long as the current value of the rewards it produces is higher than that of any of the alternatives. The individual is likely to switch to an alternative when the rate of the current reward is no longer higher than the reward of the alternatives.

Some behaviors produce negative overall effects when they are selected. As smaller, less

valuable overall choices are repeatedly selected, the overall value of all the alternatives diminishes because the subjective value of the larger reward is repeatedly devalued when compared in individual decisions. In the long run, the overall value of both the larger and the smaller alternatives equalize. This pattern of choosing represents the addictive process at work. Small choices are repeatedly made that eventually strip away long-term value of all the alternatives (Heyman, 1996). In the end, little reinforcement is enjoyed (Herrnstein & Prelec, 1991; Rachlin, 1997; Rachlin, 2000).

At any given moment, there will be a set of alternatives from which to choose. In the long run for the meliorator, the alternatives will all have low value. Melioration is, therefore, a value reducing strategy and stands in contrast to the traditional economic principal of maximization. The persistent selection of the alternative that is presently higher in subjective value may well compromise the value of the alternative in the future (Heyman, 1996). Reversal of this process is difficult at best for the individual in recovery from this type of behavioral addiction without a method of changing the process of valuing decisions. It requires the repeated selection of an alternative that has long-term reinforcement value but that is typically delayed. Additionally, the value of this type of reinforcer is often perceived to be low compared to immediately available. The meliorator, by definition, would not select this type of alternative, because only the current value of each alternative is considered in the choice process.

Melioration vs. Maximization

Melioration seems to be inconsistent with traditional economic theory, which suggests that humans tend to maximize overall utility, that is, to prefer behaviors that optimize or produce the highest rate of overall reinforcement (Ainslie, 1999; Elster & Skog, 1999; Herrnstein et al., 1993; Herrnstein, 1997; Rachlin, 2000). One reason people might engage in a melioration choice

strategy is a limitation on the amount of information available to them when they assign value to the options that are present. A person with a limited perspective (that is, with a myopic or shortsighted view of the situation) may weigh the options more heavily in favor of the option that currently yields higher utility (Herrnstein, 1997; Rachlin, 2000), regardless of any consequences that selecting that option may have on future returns from the entire set of options.

Current subjective value could be assigned by perception of supply and demand, availability that is present or delayed (Logue, 1995), magnitude of reward (Herrnstein, et al., 1993), or the context of choice (Rachlin, 2000). If the person has a broader perspective of the situation (that is, takes into account future as well as present rewards), value may be assigned to each option based on both positive and negative consequences for future valuation. The ability to evaluate the overall outcomes of the options in context (that is, over time) may allow their present values to be differentiated more accurately (Elster & Skog, 1999; Rachlin, 2000). This evaluation could include the effects of recent decisions on the present situation, leading to a decision that will yield the greatest value overall (maximization). Maximization may require one to forego a currently available option for a delayed option.

Self-Control and Precommitment

Self-control is defined by Logue (1995) as the choice of a larger, delayed outcome over a smaller but immediately available alternative. Impulsiveness refers to the choice of the latter. According to Logue, to be able to choose a larger, delayed outcome, one is required to be sensitive to the rates of return both now and in the future. With such sensitivity intact, it is possible to engage in a precommitment strategy that can be implemented while both the smaller, less valuable alternatives and the larger, deferred alternatives are still in the future. That is, one can make a binding decision before one arrives at the point where the poorer alternative is

immediately available, while the larger richer alternative remains distant. This process essentially commits the individual to a valuation of the alternatives taken in advance that maintains the valuation in spite of an immediately available option (Logue, 2000).

Time Discounting and Restructuring

Herrnstein et al. (1993) hypothesized that people might be impulsive because they (1) cannot retain and process enough information about the rates of response and the rates of return, (2) are unaware of the relationship between the two categories of rates, or (3) follow a principle called . The principle of time discounting suggests that the individual discounts the value of the larger reward in favor of the smaller reward because of the greater proximity (in time) of the latter. As the delay to the choice point becomes smaller, the value of the immediate reward will increase to the point that it has a greater current value than that of the larger, more delayed reward. The ability to abstain from choosing the currently better option and instead to wait in order to get the larger one has been demonstrated experimentally with humans and animals in various situations (Rachlin, 1997). There is evidence, however, that in other situations, both humans and animals will fail to demonstrate self-control. They make choices that result in a smaller overall reward (Ainslie, 1992; Forzano & Logue, 1992, 1994; Logue, 1995; Herrnstein, 1997; Rachlin, 2000).

In connection with pre-commitment strategies mentioned previously, another key to maximizing overall return over a series of decisions is called restructuring. This is the act of incorporating more information (or context) into the current utility-yield prediction (Herrnstein, 1997; Rachlin, 2000). In other words, considering more information before choosing among alternatives allows the person to see the current choice as part of a broader set of choices (Ainslie, & Halsam, 1992; Hayes, Stroshal, & Wilson, 1999) and base their decision on the

overall outcome rather than on the immediate choice outcome. This form of valuation allows the overall outcome to approach overall maximization, which is consistent with traditional economic theory. This decision strategy accounts for more information, highlights the differences in rates of availability, and aids in reducing the effects of time discounting.

Strategies to increase maximization help preserve the relative values (reinforcement) of each of the alternatives rather than decreasing the overall value as melioration would. Additionally, viewing a present choice as part of a series of decisions with long-term consequences, the value of each individual choice is placed into the context of the series. This process of recognizing and keeping the context of choices within a series salient is one way to help avoid melioration and promote maximizing behavior.

Experimental Design Validating Melioration and Restructuring

Experiments attempting to describe and explain melioration are a part of a broader area of research addressing behavioral economics. This field focuses on explaining, describing, and predicting principles and interventions that govern and influence behavior choice. Prominent in behavioral economics is the principle of matching. Herrnstein (1997) explained that when several contingencies of reinforcement are in operation concurrently, subjects will match the relative rates of reinforcement from those contingencies. In other words, subjects' behavior will "match" the reinforcement contingencies provided in the situation, maximizing their overall reinforcement. As described earlier, melioration is a choice strategy that stands in contrast to the traditional economic principle of maximization and leads to suboptimal behavior.

Numerous experiments with animal subjects have been published in support of melioration as an explanation of suboptimal choice (see, for example, Ainslie, 1974; Bron, Sumpter, Foster, & Temple, (2003); Herrnstein & Vaughan, 1980; Heyman, 1996; Landon,

Davidson, & Elliffe, 2003; Logue, 1995; and Vaughan, 1981). Different methods were used in these experiments, but generally the designs provided a choice between two schedules of reinforcement that were presented to the subject simultaneously (concurrent schedules).

Reports of melioration with human subjects appear less often in the literature. One of the major difficulties in these designs has been establishing one that provides an immediately available reinforcement that, when chosen, increases the negative consequences of the available options as melioration predicts. Herrnstein et al.'s 1993 study, which involved human subjects, asked whether humans meliorate or maximize and sought to identify the conditions in which each type of decision making is likely to occur. The study provided a method that demonstrated the process of melioration with humans in a context that may be used to experimentally document the addictive process described earlier.

Definitions

As an introduction to Herrinstein et al.'s experimental design, a few definitions may be helpful. The term *internality* is defined by Herrnstein et al. (1993) as the effect of a persons' recent allocation of behavior on future returns. In other words, it is the consequence assigned to a particular choice or series of choices. This allocation of choices may impact the value the participant assigns to the alternatives in a given situation.

In the context of the experimental design presented below, the averaging window is closely related to internality. The averaging window is simply the number of past decisions that are included in the calculation of the consequences of the current decision. The averaging window sets the recent past to a precise length. If the size of the window is large, more past responses are considered in calculating the consequence of the current choice. For example, the averaging window could be set at 20 choices. For the present choice, the consequence would be

estimated on the basis of the results of the last 20 responses. If the consequence was negative (for example, movies' losing their value due to repeated watching), the size of the negative effect could be determined by multiplying some negative constant by the proportion of times a particular decision had been made in the last 20 trials. Consider the following example: if A was the option of interest and A had been selected 15 times out of the last 20 choices, then the proportion would be 3/4 (.75). This value would then be multiplied by a negative constant, say, -2. The result would be a penalty of -1.5 units. This penalty could be expressed as waiting an additional 1.5 seconds, losing 1.5 dollars, losing 1.5 units of value, or a similar reduction of other variables the particular experiment was controlling.

Increasing the size of the window (that is, using a greater number of past responses in the calculation of the current choice consequence) decreases the detection of the internality. If too many past choices are considered, the impact of each individual response on the overall payoff is likely to be negligible and not recognized by the participant. If the averaging window is small (only a few past choices are involved in the calculation), the internality is high, and each choice dramatically changes the consequence for each subsequent choice.

Review of Herrnstein et al. (1993)

In most of the conditions reported in the 1993 article, the reward was an animated coin that appeared on a computer monitor and was later exchanged for money. The amount of money represented by the coin varied from trial to trial. In Herrnstein et al.'s third experiment, however, reward delay rather than amount was varied. The monetary value of the coin was held constant. Two mutually exclusive alternatives were presented to the subject. Each produced an equal amount (one cent). The delay in delivering the coin (and thus the delay to the next trial) was a function of the proportion of past responses for the shorter delay. However, as the proportion of

choices for the shorter delay increased over the previous 10 trials (the averaging window), the length of the delay for both coins also grew on each trial. Melioration would predict that the longer-term effects (the increasing delay for both alternatives) would be ignored in favor of local preference, that is, the coin providing the shorter delay would always be chosen. But by continually choosing the shorter delay, future reward (the number of trials the subject could complete within the fixed-duration session) would be consistently reduced. Thus the subject would earn significantly less money during the session than might have been earned.

Given the payoff functions that Herrnstein et al. (1993) utilized, maximization would predict exclusive selection of the choice with the larger delay. This would have caused the overall delay to be minimized (never increasing the delay). More trials would have been completed within the session and more money earned as a result. In this way, the time delay became an immediately consumable reinforcer that the participant was able to experience. In most types of choice experiments, reinforcements (money, points, etc.) are received after the experiment has concluded. This reduces the likelihood that humans will respond to experimental procedures in a manner consistent with melioration because all reinforcements are delayed until the conclusion of the experimental session. By making this factor immediately available, this design better approximates the immediate payoff (and consequences) made in the human decision process. Time delay (availability) becomes immediately consumable and likely to influence a choice strategy used.

In the 1993 study, subjects were placed in an experimental session in which they could choose one of two mutually exclusive alternatives. Specifically, they could choose to press the right or the left arrow key on a computer keyboard that was placed in front of a monitor on a table at which they sat. After a key was pressed, an animated display similar to Figure 2 was

presented in which a coin fell from a dispenser on the right or left side of the monitor into a coin holder below.

While the coin was falling from the dispenser into a collector, no further choices could be made. The left coin would always take 2 seconds longer to fall than the right coin. The time required for the coin to reach the collector constituted the delay before the next trial could begin. The length of the delay was an increasing linear function of the number of right-key choices during the most recent 10 trials (the averaging window). The cumulative number of coins appeared on each of the coin holders.

In their experiment, for half of the participants the right key provided the shorter delay while, for the other half, the left key did so. This arrangement was designed to counterbalance position preferences. The averaging window was set at 10 responses for all trials. In other words, after each response was made (that is, after an arrow key was struck), the computer recalculated the delays for the next response by using the proportion of right (or left) key responses made within the last 10 trials. The equations used to calculate the delay for the right and left keys were $D_R = 4r + 2$ and $D_L = 4r + 4$, respectively, for those participants where the right key had the shorter delay. For the remainder of the participants, the equations were just the opposite; $D_R = 4r + 4$ and $D_L = 4r + 2$. The value of r in these equations was the proportion of responses in the averaging window. For example, when the right key had the shorter delay, if, during the last 10 trials the right key was pressed 3 times, the proportion of right-key choices would be .3. This value would be multiplied by 4 in both equations and then would be added to 2 to produce the delay for the next right-key response and added to 4 for the delay of the next left-key response. This process was repeated after every response. The window progressed with each response but always included only the

just-previous 10 responses. The minimum and maximum delays for the shorter key were 2 and 6 seconds respectively. The minimum and maximum delays for the longer key were 4 and 8 seconds respectively.

Review of the Author's Master's Thesis

Building upon the procedure used by Herrnstein et al. (1993), and to establish the saliency of cues that would aid in reducing the cognitive demands required for the maximization, the author's master's thesis was a modification of the Herrnstein's design. I was interested in finding out whether external cues would aid individuals in their ability to maximize behavior. This was accomplished by increasing the amount of information that was available to the participants, specifically, information about the internality that was in operation. It was expected that participants who had access to such information would be more likely to make decisions consistent with maximization rather than melioration.

The type and saliency of the information presented to the subject was the focus of the study. As suggested by Logue (1995) and Herrnstein et al. (1993), information that revealed more of the overall context of an individual decision was likely to aid the subject in decision making. In effect, it would make the relationship between choices and overall outcomes more salient (that is, it would vivify the internality) and would be conducive to maximization.

Choice history cue. This was the first of three experiments intended to assist participants in allocating their decisions in a manner closer to maximization by providing a visual cue as to the internality operating in the experiment. As suggested by Herrnstein et al. (1993), one possible reason why participants tended to meliorate was the difficulty of retaining information about the payoff functions in order to successfully maximize the return. Specifically, in order to calculate a higher yield, "the decision maker must, in some cases, (1) know the current return to

each alternative; (2) be aware of the existence and magnitude of the internality affecting future current returns; and (3) use the information in (1) and (2) to find the allocation yielding the long-run maximum" (p.177). In contrast, melioration is less complicated, requiring only that the current returns be estimated. Providing external cues of the internality might reduce the tendency to meliorate and produce results closer to maximization. To test this hypothesis, a modification was made to the original design mentioned above. The addition was a graph that was displayed between the coin hoppers (see Figure 3). When one of the arrow keys was pressed, the graph displayed the proportion of right-key responses (or left-key responses, depending on the group) made during the previous 10 trials (the averaging window).

The graph served as a visual representation of the internality in the current situation. It was hypothesized that visually representing the past 10 responses would allow the participant to move closer to maximization by simplifying the cognitive requirements for its achievement. Statistical results confirmed the hypothesis demonstrating that participants in this experiment were significantly more likely to select the longer delay arrow, thus potentially earning more money than the control group

Time-measure cue. In this experiment, a second type of external cue was introduced. Again, the design was identical to that used in Experiment 1, except for the addition of a numerical counter that appeared over each of the hoppers on the screen (see Figure 4). The counter displayed the summed drop time (in seconds) of the coins from each hopper beginning with the first experimental trial.

This change in procedure addressed the discrepancy in the results using the coin-delay and coin-value variables reported in Herrnstein et al's Experiment 3. The advantage of the coin-value procedure was that the value was visible in a numerical display on the screen. This

reduced the need for the participant to combine a pair of subjective estimates: duration of the delay and amount of money earned over the entire session. Similarly, if the participants had access to a numerical display of the amount of delay, this might also ease the perception of the internality. It would effectively increase the amount of information available for estimating future returns. If the participant became

more sensitive to the internality by means of the information provided by the counter, she or he might alter her or his subsequent response allocation between the right and left key alternatives. This alteration might well lead to an overall allocation of responses closer to maximization than melioration. Indeed, this was the hypothesis of the experiment. Again, the results demonstrated that participants in this experiment selected the longer delay arrow significantly more often than the control group, increasing their overall earning potential.

Combination cue. The visual cues introduced in the previous two experiments were selected to reduce the requirements for maximizing monetary returns in situations where rewards are delayed. Both were available to the participants during the session.

Similar to the two experiments mentioned previously, participants allocated more of their choices to the longer delay arrow key. Participants in this group earned more money than any other group, and significantly more than the control group.

These results suggest that providing information about the internalities of payoff leads to behavior that is less consistent with melioration (see Rachlin, 2000). Finding a way to expose the internalities in a controlled situation was the first step to identifying cues for real-world decision-making. The next step was to demonstrate that participants would engage in behavior change more consistent with maximization over time as a result of exposure to cues presented.

Summary and Hypotheses

Melioration is a decision strategy based on short-term decision making that may be part of the behavioral addiction process. Melioration suggests that when selecting from among alternatives, failure to account for consequences and reinforcements both now and in the future may lead to a pattern of choices that results in low overall value. This pattern is called the primrose path to addiction because its effects are often unrecognized and may be a behavioral pattern that is manifest in a variety of both normal and clinical presentations. Maximization, or the ability to evaluate the reinforcement and consequences of choices both now and in the future stands in contrast to melioration. Self-control, which is the act of foregoing an immediate smaller reinforcement for a larger, delayed reinforcer is required to maximize behavior. Pre-commitment and restructuring are two strategies of employing self-control in decision making. The present research was an attempt to correct limitations to previous research and provide validation of the ability to interrupt melioration and encourage self-control and maximization in an experimental setting. The experiments used were designed to represent a situation in which addictive process and melioration are active and then to provide possible aids in promoting maximization within that setting.

Method

General Method

A within-subjects design was used to determine whether an individual's behavior would shift toward maximization and away from melioration within the experimental session. A traditional ABA design recorded initial melioration in the first portion (baseline) followed by exposure to a visual cues exposing the internality (treatment). A final period resembled the first in which no cue was provided.

Participants and Recruitment

Participants consisted of 76 students attending Brigham Young University, Provo Campus, during winter semester 2004. Participants were recruited by Psychology 111 class instructors who were asked to advertise participation in the study during their classes. Potential participants were instructed to contact the principle researcher via e-mail to schedule a session.

When participants arrived at their scheduled time, they were required to read and sign a consent form stating the risks and benefits for participation in the study. Participation was voluntary and participants were informed they could leave the experimental session at any time they wished. Participants were instructed that in leaving, they would receive the amount of money earned to that point in the session but would not receive a $2.50 session completion fee. Participants were also informed that upon completion of Experiment 1, some participants might be invited to participate in a follow-up session. Participation for the follow-up session was also to be voluntary, and no penalty would be imposed should they choose not to return.

Only students 18 years of age and older were included in the study. The mean age of all participants was 20 years old, with ages ranging from 18 to 32 years old. Participants consisted of 38 females and 38 males. Thirty participants (40%) were freshman, twenty (26%) were

sophomore, twenty (26%) were juniors, five (7%) were seniors, and one (1%) identified as "other."

Apparatus

The "money machine" program used in this experiment was originally written in the spring of 2000 for use in the author's master's thesis. The current version was written in the fall of 2003 and consisted of a separate program for each of the 3 experiments used. All of the programs were written in Python programming language and used Microsoft Excel to record all data.

All programs were run on IBM compatible computer systems using the Windows XP operating system. Each computer console operated as an independent experiment station and was in a private room. In each of the rooms, there was only a desk (upon which sat the computer, monitor, keyboard and mouse) and a seat for the person. No clock or other timing device was available in the experimental session.

Procedure

Research assistants were kept blind as to the experimental condition that each of the participants would receive. Participants were assigned to the experimental conditions sequentially based on numbers and letters representing the experiment, cue, and laterality variables.

Once the participant had signed the consent form, a research assistant would escort the participant to an experimental room and enter information from the tracking sheet into the computer and thereby select the appropriate program to run. Once the program had begun, the research assistant would remain in the room while the participant entered her or his demographic information into the computer. Each participant was asked to enter her or his age, class status

and gender and the last four digits of her or his social security number into the program. Once this information was entered, an instruction screen was displayed. The research assistant would then move the mouse away from the participant so that only the keyboard was accessible and then exit the room until the participant had completed the experiment.

Experiment 1

All 76 participants completed Experiment 1. Twenty-six individuals completed the experiment with the graph (13 males and 13 females), 26 with the timer (13 males and 13 females), and 24 with both cues present (12 males and 12 females).

In this experiment, each participant completed a 20-minute session. The session began with an instruction screen identical to that presented in the author's master's thesis, as described above. For the combination cue, no additional instructions were given as in the procedure method described earlier; all participants received the same instructions. Next, each participant was given a practice period of 1 minute in which to become familiar with the experimental procedure. A 5-min baseline condition then began in which the participant earned money in the absence of visual cues. At the conclusion of that time, a 1-min break was taken, followed by a 5-min period in which the participant continued earning money and in which one of the three visual cue options was presented (the graph, timer, or a combination). Following that interval, another 1-min break occurred. The final 5-min period was a return to the baseline condition in which money was earned but no visual cues were present. A "thank you" screen indicating that the experiment was concluded appeared when the final 5-min period expired.

Once a participant completed the experimental session, a research assistant gave the participant a post session survey with her or his corresponding identification number. During the time that the participant filled out the survey, a research assistant would access the Microsoft

Excel file for that session and identify the total number of coins collected within the session by the participant. The program recorded the number of coins from each time period as well as the total number of coins collected over the entire session (see Appendix E). After the participant had completely filled out the post session survey, the research assistant would pay her or him 1 cent for each coin collected during the experiment plus $2.50 as an experiment completion fee.

Additionally, the software program recorded the ratios of choices corresponding to maximization for each time period as well as for the entire session. The program also recorded an indicator informing the research assistant that she or he was to invite the participant to complete a follow-up session. The indicator represented whether or not the participant had satisfied the selection criteria to be included in Experiment 2. If this indicator appeared on the participant's Excel file, the research assistant would invite the participant to complete the second experiment.

Experiment 2

Participants in Experiment 1 who responded in the second time period with at least 55% of their choice selections representing maximization were candidates for Experiment 2. Using a slightly higher criterion than chance responding (50%) was intended to include those participants who at least partially responded in a pattern representing maximization. The second criterion for inclusion in Experiment 2 was a return to a lower level of responding during the final time period by those who initially responded with more than 55% maximization in the second time period. A return to a lower level of responding was defined as an overall drop of 25% or more maximization responses in the final time period compared with responses in the second time period. In this way, participants were selected on a relative decrease in performance based on their own responding pattern.

Based on these criteria, 37 participants in Experiment 1 qualified to complete Experiment 2, and all consented to participate. Fifteen were male (40.5%) and 22 (59.5%) were female. Participants ranged in age from 18 to 23 years old, with a mean age of 20. Participants consisted of 38% freshman, 38% sophomores, 19% juniors, and 5% seniors. Nine participants received the timer cue (6 females, 3 males), 13 received the graph cue (6 female, 7 male), and 15 received the combination cue (9 female, 6 male).

The second experiment assessed whether a fading procedure would aid individuals in maintaining maximizing choice allocation following. The procedure was almost identical to that described in Experiment 1 and each participant was matched to the cue she or he had previously received. The only variation occurred in the second time period. After the second money earning portion of the experiment began, the visual cue was present for the first 10 trials made. Once those 10 trials were made, only the first 8 of the next 10 trials had the visual cue present. After 8 subsequent choices were made, the cue was removed for 2 choices. The next 10 trials consisted of the first 6 with the cue present and the remaining 4 without the cue present. Ten trial blocks with the visual cue present for 4 and 2 choices respectively concluded the time period. A 1-min break followed and a final 5-min money-earning time period concluded the session, as with Experiment 1.

Behavior choice allocation that more closely approximated maximization in the second time period compared with the first would represent exposure to the internality and resultant behavior modification. Choices more similar to maximization in the third time period compared with the first would suggest that the fading procedure was a more successful way of removing the cue and allowing the participant to maintain awareness of the internality in the absence of the visual cue.

Results

Experiment 1

In each of the time periods (baseline, treatment, baseline) the total number of responses made by each participant as well as the ratio of responses consistent with maximization within the time period were recorded. The ratio scores were used in all statistical analyses. Preliminary analyses were conducted to determine if differences in scores were evident across participant gender or across the laterality of the presentation key (left or right). An alpha level of .05 was used for all statistical tests. Group differences based on gender or laterality were not significant. Therefore, all subsequent statistical analyses were based on the full group of participants.

Treatment Effect

A one-way repeated measures ANCOVA was calculated comparing participants' ratio responses from the three time periods. A significant effect was found ($F(2,150) = 4.947$, $p < .05$). Follow-up protected *t* tests revealed that ratios representing maximization increased significantly from the first baseline period ($m = .34$, $sd = .25$) to the treatment period ($m = .42$, $sd = .24$). Ratio scores decreased significantly from the treatment period ($m = .42$, $sd = .24$) to the second baseline period ($m = .34$, $sd = .30$). No significant difference existed between the two baseline condition ratio scores.

Cue Presented

A one-way between subjects ANCOVA was calculated to examine the effect of cue presented (graph, timer, and combination) on ratio score during the treatment period, controlling for the effect of initial ratio score in the first baseline condition. First baseline scores were significantly related to treatment period scores ($F(1,72) = 16.432$, $p < .01$). The main effect of cue type was not significant ($F(2,72) = .58$, $p = .563$), with scores from groups receiving the

graph (*m* = .45, *sd* .30), the timer (*m* = .37, *sd* = .20), and the combination (*m* = .45, *sd* = .18) cue not significantly different from each other after controlling for the initial ratio score in the first baseline period.

Experiment 2

As above, in each of the time periods (baseline, treatment, baseline) the total number of responses made by each participant as well as the ratio of responses consistent with maximization was recorded. The ratio score was used in all statistical analyses. An alpha level of .05 was used for all statistical tests.

Treatment Effect

A one-way repeated measures ANCOVA was calculated comparing participants' ratio responses from the three time periods. A significant effect was found ($F(2,72) = 9.67$, $p < .01$). Follow-up protected *t* tests revealed that ratios representing maximization increased significantly from the first baseline period (*m* = .17, *sd* = .22) to the treatment period (*m* = .27, *sd* = .23). Ratio scores decreased significantly from the treatment period (*m* = .27, *sd* = .23) to the second baseline period (*m* = .15, *sd* = .20). No significant difference existed between the ratio scores of the two baseline conditions.

Cue presented

A one-way between subjects ANCOVA was calculated to examine the effect of cue presented (graph, timer, and combination) on ratio score during the treatment period, covarying out the effect of initial ratio score in the first baseline condition. The score for the first baseline period was significantly related to treatment period score ($F(1,72) = 16.26$, $p < .01$). The main effect of cue type was not significant (F (2,33) = 3.06, $p = .06$). Scores from groups receiving the graph *m* = .07, *sd* =.10), the timer (*m* = .31, *sd* = .27) and the combination cue (*m* = .35, *sd* =

.23) were not significantly different from each other after controlling for the initial ratio score in the first baseline period.

Discussion

Experiment 1

The Addictive Process Represented

In Experiment 1, a choice value decrease was represented by an increase of delay time resulting in decreased availability. The delay function equations discussed in chapter 1 set the minimum delay time for the key representing maximization to 4 seconds. During the initial period of Experiment 1, participants responded in a manner consistent with melioration. This result helps support the validity of the present research model in replicating previously cited methods. Strong preference for a melioration strategy of choice selection seems to be quickly established and maintained. The mean ratio of choices allocated to maximization across all participants was .34. This suggests that as a group, approximately 66% of all choice selections made by participants contributed to a decrease in the overall value of both choices available.

Paralleling a pattern indicative of a melioration strategy suggested by the statistical data is the finding that 30 of the 76 participants (29%) indicated on their post session surveys that they would recommend a strategy of determining which key resulted in the shortest initial delay and then to select only that key. One participant wrote, “I compared the time it took for each dispenser to drop a coin and get the coin in the cup. Once I figured out which dispenser went faster, I weighed down the arrow key to the corresponding dispenser and just watched the money come.” This participant earned much less money than those not using a choice strategy exclusively based on melioration.

Other participants indicated they had used a similar strategy of selecting the fastest key extensively with rare selections of the "slow" key. One of the participants wrote, “Don’t worry about the other side because it will be slower throughout the whole game.” During the first

baseline period of the experiment, many of the participant's choice selections and verbal reports appear to agree that a strategy of melioration was quickly set up and maintained, paralleling the primrose path to addiction.

Treatment Effect

Having established a baseline condition from which comparisons could be made, the second period of the experiment was intended to aid participants in recovery from the addictive nature of the choice situation. It was hypothesized that participants would initially respond to repeated choice opportunities in a manner more consistent with melioration and then after receiving a visual cue exposing the internality of the experiment, participants would allocate their choices more consistently with a maximizing choice strategy. For some participants, this change in choice strategy was recorded experimentally as well as verbally. Other participants demonstrated more choice variability but did not describe a strategy of maximization.

The statistical results presented in the previous chapter indicated that the treatment effect was observed. Participants in Experiment 1 demonstrated choice allocation significantly less consistent with melioration during the second time period of the session (in which the visual cue was present) than they did during the initial phase (baseline). The mean ratio of choices allocated to maximization was .42. This change of responding is notable, particularly when considering that a majority of the participants had already experienced a decrease in the overall value of their choices as a consequence of their previous selection of the key representing melioration. Participants were much more likely to go through a process of selecting the key representing maximization and waiting longer than they had previously.

In the post session written responses, more than 50% of the participants indicated that during the treatment periods, they experimented with their choice allocation based on the cues

presented. Interestingly, when this overall result was broken down by the type of cue received, it was found that only 5% of those receiving the timer cue reported a strategy of experimenting with their choice selection. Of those participants receiving the graph and combination cues, post session survey responses indicated experimentation with choice selection was a strategy used by 80% and 53% respectively. Participants receiving the two cue presentations including the graph appear to have been more likely to experiment with choosing the longer delay key (maximization) than were the participants receiving the timer cue only.

Fourteen of the participants (18%) indicated that they experimented with their choices and eventually decided to strike a balance between the two choices. One participant who received the timer cue stated, "I struck a balance between the left [maximization] and right [melioration] side machines. I took a conservative approach and hoped for equals." Another participant receiving the graph wrote, "When the pie chart came up, I found that the right side slowed the more I clicked it, so I experimented with the left and saw it sped up. Then I tried the right and saw it dropped faster than before, but slowed again, so out of curiosity I clicked the left till the whole chart was red and saw the rate stayed at a constant 5 seconds." That same participant also indicated that the graph was helpful in finding the trends of the coins that influenced her strategy for choosing.

The third time period of the experiment represented a return to the baseline condition. With the removal of the cues presented, the mean ratio of responses representing maximization dropped significantly to .34, the same ratio as in the first baseline condition. Further examination of the trends from these time periods revealed that although the mean ratio was identical, the distribution of scores was very different across the two baseline conditions (see Figure 6). In the first baseline condition, 25 of the participants (33%) allocated approximately

half or more of their responses to the key representing maximization. That number increased to 34 (44%) in the treatment condition with the cue present. During the second baseline condition, 30 participants (39%) allocated approximately 50% or more of their responses to the maximization key. That is a change of only 5% fewer than the treatment condition, and a notable increase from the first baseline period, in which only 7 participants (9%) had this type of score.

Overall, the results indicated that, for this group, a treatment effect occurred and there was a significant decrease in meliorating behavior when the cues were presented. There was also a significant increase in meliorating behavior when the cues were removed, although the total number of people maximizing after the cue was removed was higher than the baseline period.

Differences Between Cue Presentations

There were no statistically significant differences in maximization ratios across the three types of cues presented. Participants receiving the graph and combination cues consistently allocated more of their choices to the key representing maximization than did those receiving the timer cue; however, the differences were nominal.

Another indication of the compatibility of cues comes from the responses on the post session surveys. Across the three groups, 10 participants (40%) receiving the timer cue specifically stated that there was a relationship between the keys. Nine participants (36%) receiving the graph cue indicated a relationship between the keys. Ten participants (38%) stated they noticed a relationship between the keys and the delay. These responses suggest that a similar number of participants across all three cue presentations indicated awareness of part of the internality, or delay function. Identification of a relationship between choice values was one of the factors described in the restructuring process, leading to maximizing behavior (Ainslie, &

Halsam, 1992; Hayes, Stroshal, & Wilson, 1999; Herrnstein, 1997; Rachlin, 2000).

Identification of the Internality

Another interesting indicator of cue presentation efficacy is a tally of participants who were able to clearly describe the internality. Correct identification of the internality in place would suggest choice selection could be based on the overall value of the choice and the process of melioration would be less likely to be used. A total of 8 participants (approximately 10%) specifically identified the internality on their post session surveys. Five of these participants had received the timer cue and 3 of them had received the combination cue. One participant who received the timer cue wrote, "Left [maximization]-wait a few trials, it will speed up and be constant. Right [melioration]-the first few are fast, then it slows down." Another participant receiving the combination cue wrote, "The speed of the left [melioration] coin falling was proportional to the # of times the right [maximization] coin fell, increasing as the # of right coins did. The speed of the right coins also increased the more times you pressed it. Even though it's slower at first, press the right coin 10 or so times." These participants explained that they had indeed noticed that the value of individual choices had to be weighed against the overall pattern of change resulting from choice allocation. Several participants, not just those able to verbalize the internality in place described restructuring and self-control strategies such as these.

Experiment 2

The Addictive Process Established

Experiment 2 was intended to provide an alternate means of fading a cue in an attempt to promote learning. Thirty-seven participants (48%) in Experiment 1 qualified to participate in Experiment 2. As with Experiment 1, a statistically significant treatment effect was observed across the 3 time periods. During the initial baseline condition in which no cue was present, the

mean ratio of choices corresponding to maximization was .17. This suggests that among a portion of the original sample, participants allocated more than 80% of their choices to the key representing melioration during the first time period. This group of participants likely responded this way because there was little learning effect demonstrated within the previous session. Additionally, there may have been a tendency to choose exclusively according to a melioration strategy because of their exposure to the previous experiment (exposure effect/test-wise bias). Only 6 of the 37 participants (16%) allocated half or more of their choices to the key representing maximization. Overall, this group was clearly following a melioration strategy from the beginning. Several participants indicated on their post session surveys that they followed a pattern similar to that used in the previous experiment. Wrote one participant in response to a question asking about strategies used, "The same as last time, only almost no left [maximization] arrow."

Treatment Effect

During the treatment period in which the cue was intermittently presented, the mean ratio of choices allocated to maximization rose to .24. Sixteen participants (43%) allocated half or more of their choices to the key representing maximization. This was a significant increase from the first baseline time period. Participants from the graph and combination groups seemed to experiment much more than those receiving the timer cue. The overall result was that participants made many more attempts to change their patterns of responding when the visual cues were present compared to the baseline time periods.

All eleven participants who indicated that they recognized a relationship between the choices received the graph or the timer cue. Nine of them specifically indicated that they made their choice selections in an attempt to maximize overall reward. These participants seemed to

gain a greater perspective of the value of patterns of choices rather than focusing on any particular choice. Six participants indicated that they actively experimented with both choices because they noticed the cues and used them to try to increase their reward. Three participants indicated that they used a strategy of keeping a balance between their choices.

Three participants correctly stated the internality in operation. One participant who received the graph explained, "The right [maximization] continues to reward people the more you stick with it. The left [melioration] has instant gratification but slows down quickly and ruins your prospects for the investment of time with the right key." Another participant receiving the combination cue stated, "It's as if the left [maximization] gives 'gas' to the right [melioration]." This latter participant also indicated that much of his choosing was based upon using the graph. As with Experiment 1, these participants described strategies of incorporating more information into their decision making process and employed some strategies of self-control to maximize their responses.

The original hypothesis was that participants receiving a fading procedure would maintain a higher level of responding following the treatment period of the experiment. The mean ratio of choice allocation to the key representing maximization during the second baseline phase was .15. This indicates that as a group, participants did not maintain their level of responding and returned to a lower level of choice allocation to maximization. In fact, whereas 6 participants allocated half or more of their choices to maximization in the first baseline time period, only 4 participants did so in the second baseline time period.

Many of the participants indicated on their surveys that they did notice the cues presented but that they only experimented with their choosing while the cues were visible. For example, one participant said, "Use only the left [melioration] arrow unless the pie chart is present. If it is,

alternate between the arrows." Another participant said, "When the graph came up, I chose more right [maximization]." The intermittent presentation of the timer likely drew more attention to them than in previous experiments. Those participants that noticed and attended to the timers were more accurate in describing the internality. Other participants did notice the timers but chose to ignore them because they did not know what they represented.

Differences Between Cue Presentations

An interesting result of group comparisons also revealed differences between groups receiving the timer, graph, and combination cues. Of the 37 participants completing Experiment 2, all 9 of the participants receiving the timer cue followed a melioration strategy and 7 of them specifically indicated as much on their post session surveys. Only 2 of them reached or exceeded the 50th percentile in overall earnings for Experiment 2. Many participants wrote that they did notice the timers, but that they did not pay much attention to them because they were not sure how to interpret the information the timers were presenting.

Similar to the results from Experiment 1, participants in Experiment 2 who received the timer were less likely to experiment with their choice allocation. In this experiment, the participants did not seem to be using a pattern of choice allocation that balanced their selections between the two options. Participants were more likely to use a melioration choice strategy, resulting in overall lower returns.

More than half of the participants receiving the graph cue indicated there was a relationship between the two choices and indicated the need for consistency when choosing the key with the longer initial delay (one indicated that 10 choices was the criteria for delay changing). Though several participants indicated there was a relationship between the two choices available, many of them reported that they only used that information to influence their

decision when the cue was present. One participant said, “When the pie chart was present I alternated arrows, when it wasn’t, I used only the left [melioration] arrow.” It appears that some of the participants receiving the graph cue were also only willing to experiment with alternating their choices if the cue was present.

Fifteen participants receiving the combination cue completed Experiment 2. These participants seemed to represent more equality between maximization, melioration, and balancing strategies for decision making. Four participants stated there was a relationship between the two choices and indicated that they used the graph to determine which key to push, and one participant correctly identified the internality. Only one of them indicated that she used the timer at all. Six participants indicated a strategy of exclusive melioration with one stating, “I wasn’t willing to keep using the left [maximizing] dispenser.” Three participants stated that they did experiment with their choice allocation, and two said that they kept their choices balanced.

In Experiment 2, the hypothesis that a learning effect would be recorded following the fading procedure was not confirmed. There was support for a treatment effect, though the effect was more modest than expected. Participants tended to choose much more consistently with maximization (through experimentation, balancing of choices, etc.) in the presence of the graph cue than with the timer cue.

General Discussion

Experiments 1 and 2 were all intended to provide evidence that melioration is involved in the behavioral addictive process and can be documented in an experimental setting. Additionally, this research was proposed as a possible way to interrupt the melioration process and allow individuals a way to potentially maximize behavior.

The Within-Subjects Design

One of the main methodological changes used in this study was to provide a within-subjects design. The intent was to be able to compare individuals' response rates over time to measure the treatment effect and possible learning effect of the cue presented. This design maintained the same amount of actual time for the experiment as Herrnstein et al. (1993) and the author's master's thesis, while decreasing the exposure to the cue during the treatment time period. Participants on the author's master's thesis study were exposed to the visual cue for the entire 15-minute session. Participants in the current study had a maximum exposure time of 5 minutes. Because most participants indicated (in their written reports and with their patterns of responding) that a strategy of melioration was quickly set up within the first baseline condition, a 5-minute period seemed to be an adequate allotment of time for them to establish a pattern of behavior. However, a 5-minute period of time may have not have been sufficient for experimentation with the choice selections to result in exposing the internality. Future experiments may attempt to establish an appropriate level of exposure to the visual cue that would produce an optimal illumination of the internality.

Verbal Identification of a Relationship Between Choice Consequences

Comparing the results of the master's thesis and this study, large differences were recorded when comparing participants' verbal recognition of a relationship between choices. In the master's thesis, 25% of the participants receiving the timer cue stated they recognized a relationship between their choice selections. In the present study, 40% of the participants receiving the timer indicated a relationship. One possible explanation for this change in perception of the relationship may be the saliency of the cue. In the master's project, the timer was present throughout the session. Many of the participants indicated that they did not know what it was to be used for and did not pay attention to it. In the present study, during the

treatment time period, the timer was visible. This may have increased the novelty of its presentation and elicited more attention. The differences between reports from participants receiving the graph in both studies are less pronounced. Forty-four percent of the participants receiving the graph cue in the master's study indicated there was a relationship between the choices. Thirty-six percent of the participants in the present study so indicated. This small difference may also be based on the saliency of the cue. The graph in both situations was large in size relative to the hoppers and changed noticeably with the allocation of choices. In both studies, attention paid to the graph cues may have been more similar than to the timer. Additionally, the small decrease in the percentage of participants indicating a relationship may be due to the decreased exposure time discussed earlier.

The most noticeable difference between the responses from the participants in the master's study and the present study was noted from the groups receiving the combination cue. Thirty-eight percent of those participants indicated they noticed a relationship between the choices they made in the experimental session. This is a substantially lower percentage than the 83% of participants in the master's study. One methodological difference that may have influenced these results may be the instructions themselves. In the master's study, participants were given additional instructions on how they could activate and deactivate the graph, the timer, or both. All participants activated both of them in the master's study. Participants in the present study did not have the additional instructions and no option for activation of the cues was provided. Both the graph and the timer were present during the treatment time period. This change in the involvement of the participant in activating the cues may have significantly influenced the attention to and benefit from the cues. Without this additional information and action, the proportion of participants reporting a relationship between their choices was similar to

the other two cue presentations. Requiring participant activation of the cues may be another improvement on the present design that could increase detection of the internality. Future experiments may require participants to activate and deactivate the cues, increasing the possibility of the cue receiving more attention during the experimental session.

Potential Applications of the Findings

Visual cues. In these experiments, visual cues representing aspects of the internality were presented to participants to assist them in allocating their choices based on overall value, not just local value. Participants in this study demonstrated much higher variability of responding when visual cues were present. The presence of the visual cue may have promoted more behavioral experimentation, allowing the participants to notice the effects of their individual choices on the overall outcome of the series of choices. This type of restructuring may benefit people in choice situations representing specific addiction-prone behaviors. Promoting variability in choice may reduce the exclusive use of melioration and may help interrupt the addictive process.

Experimentation. One implication of these findings is that although the internality present in the choice situation might not have been completely exposed, the presence of the visual cues seemed to have fostered more experimentation with choice allocation. Many participants indicated that they did not maintain a choice strategy exclusively based on melioration in the presence of the visual cue. In these cases, the visual cues may have served as a sign to change behavior. Some participants explained that they were willing to experiment with different choice allocations when the graph was present, sometimes allowing them to become aware of the relationship between the keys. Individuals who use a choice strategy exclusively based on melioration may never be exposed to the effects of choices more consistent with maximization. By experimenting with choice selection, individuals are more likely to gain

a better perspective of the consequences of their choices. The cues presented may have promoted more choice variability, allowing the participants to experience the effects from both choice options and leading to better understanding of the relationship between choices.

Obvious exposure to the internality. This study was intended to provide basic research investigating melioration as an underlying component to the behavioral addictive process. As presented, the visual cues seem to have aided participants in allocating their choices more consistently with maximization and less with melioration. The cues were intended to decrease the cognitive demands by easing the requirements in assessing the values of choices both immediately and in the future. Making that process overt may further assist in increasing maximizing. The internality of this experiment included an increasingly larger delay to the next coin with each selection of the key representing melioration. Though several of the participants recognized there was a relationship between the choices (keys), only a few verbally described the internality specifically. Participants may benefit from an explanation of the internality either prior to or within the session. With this information, participants may experience the effects of the internality and become more sensitive to the rates of availability of the choices encountered. In the experimental situation, participants may be more sensitive to the key representing maximization.

Limitations of the Study

Sample selection. The participants for this study were recruited exclusively from undergraduate introductory psychology courses. These courses were targeted because they are required for general education requirements within the university. Because this sample of participants was not randomly selected from the population at large, generalizations are limited. In this study, participants represent students between the ages of 18 and 25 attending an

institution of higher education. This sample would not accurately represent a community sample of individuals and is therefore limited in generalizability. Future studies may be helpful in expanding the applicability of these findings to include to populations representing a more broad range of ages, levels of education, cultural backgrounds, socioeconomic statuses, etc.

Task generalizability. The program used for this experiment was designed to replicate a procedure used previously to document melioration in an experimental setting. The task of choosing between two choices (keys) was intended to represent a choice between two mutually exclusive alternatives. Often, these types of choices are much more complex than a two-choice model. Outside this experimental setting, the choice of one alternative over another will likely include a variety of other factors in addition to the internality that may contribute to the overall value assigned to that choice (e.g., time available to make the choice, clarity of the choice alternatives, physical and environmental factors, history of selection, etc.). The results of this study must be interpreted with caution because the task performed was not specific to any particular choice to be made outside the experimental setting. A possible next step for research would be to specify a choice that could be isolated and measured to extend the applicability of this research to other choice situations.

Conclusion

The present research study was intended to provide experimental support to previously stated theories of melioration and behavioral addictive processes. The involvement of melioration in general and clinical populations has been proposed as one way to conceptualize the addictive process. Basic research attempting to clarify the role of melioration was proposed as a valuable tool to identify common factors in the addictive process as provide possible interventions that would interrupt those processes.

The experimental design first introduced by Herrnstein et. al (1993) and reproduced in the author's master's study and the present research represents a valuable method of exploring melioration and addiction in human populations. It capitalizes on the immediately consumable nature of delay (waiting) to approximate situations in which humans tend to use a strategy of melioration, leading to overall low results.

The results of this research study suggest that melioration and the addictive process can be recorded in an experimental setting. As an improvement on previous methods, this study suggests that once established, melioration may be interrupted temporarily in favor of maximization by providing information about the internality present in a choice situation. Overall, participants receiving more information about the effect of their choice allocations altered their responding from a strategy of melioration. Some participants selected a strategy of balancing their choices, while others identified the internality present and adopted a strategy consistent with maximization.

Experimentation with choice allocation was also used by many of the participants in response to the visual cues presented. In relation to the process of behavioral addiction, these strategies seem to reflect choice behavior that is not exclusively based on melioration, reducing the likelihood of maintaining an addictive process. Future research designs may further clarify conditions in which human melioration may be interrupted and the internality of choice situations may be exposed, leading to more optimal behavior choices.

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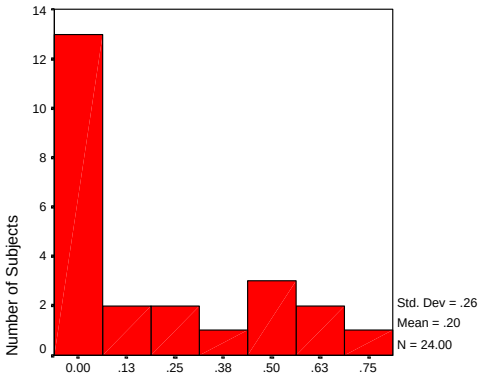
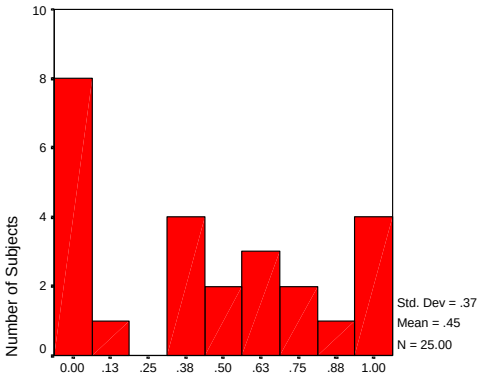
Appendix A

Master's thesis-Experiments 3,4, & 5 comparisons with control group



Experiment 1- Proportion of choices for Maximization - Half Sessio



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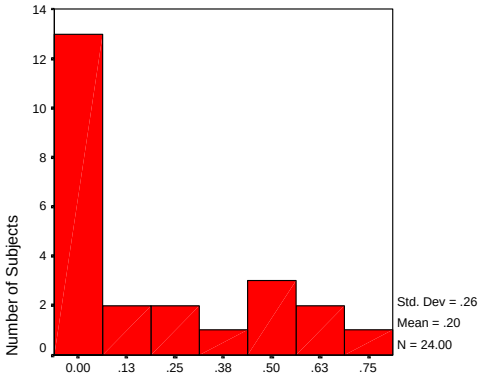

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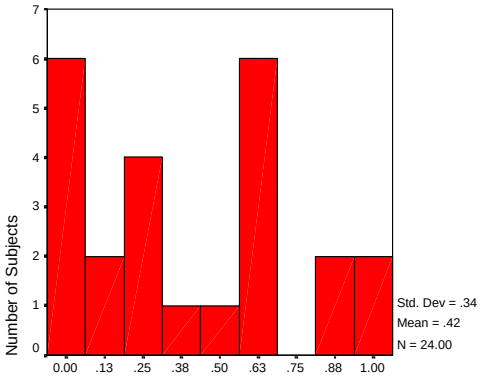
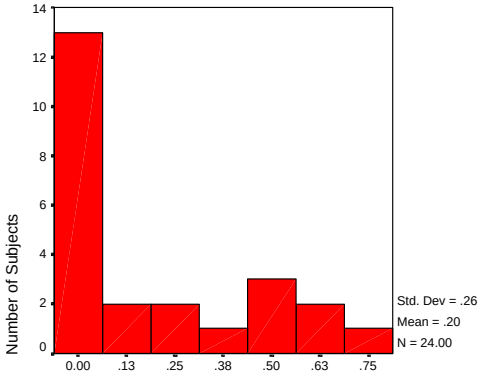
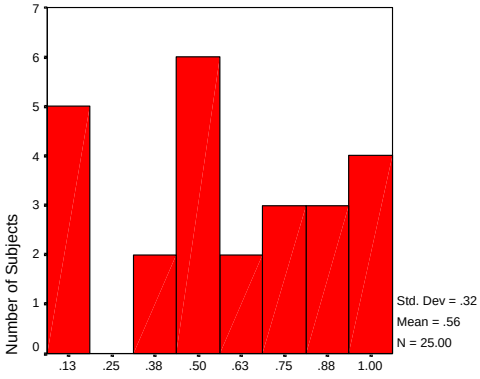


Experiment 4 - Proportion of Choices for Maximization - Half Sessio



Experiment 1- Proportion of choices for Maximization - Half Sessio



Experiment 5 - Proportion of Choices for Maximization - Half Sessio

Appendix B

Post-Session Survey

1. What strategies did you use to earn money during the session?

_____
_____
_____

2. Did you change your strategy for earning money during the session? If so, how?

_____
_____
_____

3. How would you describe the "rules" involved in earning money by pressing either the right or left key

_____
_____
_____

4. What suggestions would you give to someone else participating in this experiment for the first time to help that person earn the most money?

_____
_____
_____

*5. Did you notice (use) the timer? If so, what did you notice about it?

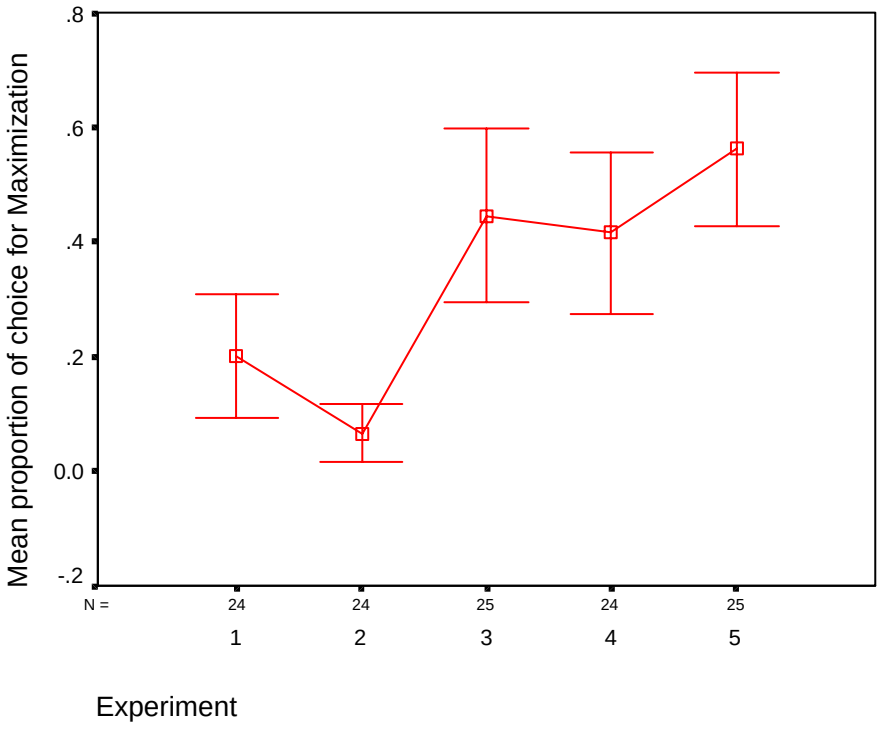
_____
_____
_____

**6. Did you notice (use) the pie chart? If so, what did you notice about it?

_____
_____
_____

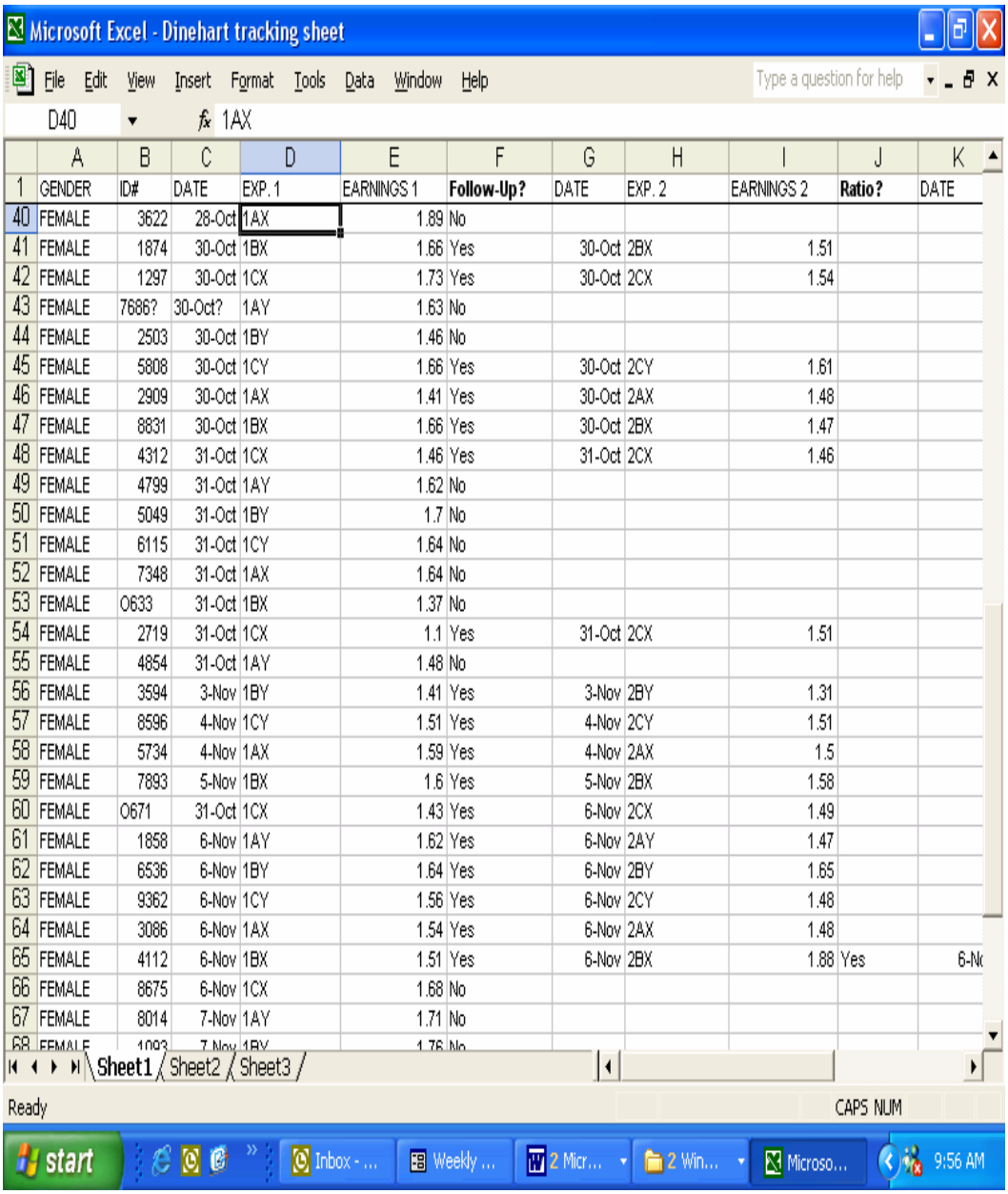
* Only included in the survey following the Time-Measure sub-experiment
** Only included in the survey following the Choice-History sub-experiment

Appendix C



Master's Thesis Group Means Comparison Graph

Appendix D



Microsoft Excel - Dinehart tracking sheet

File Edit View Insert Format Tools Data Window Help

Type a question for help

D40 1AX

	A	B	C	D	E	F	G	H	I	J	K
1	GENDER	ID#	DATE	EXP. 1	EARNINGS 1	Follow-Up?	DATE	EXP. 2	EARNINGS 2	Ratio?	DATE
40	FEMALE	3622	28-Oct	1AX	1.89	No					
41	FEMALE	1874	30-Oct	1BX	1.66	Yes	30-Oct	2BX	1.51		
42	FEMALE	1297	30-Oct	1CX	1.73	Yes	30-Oct	2CX	1.54		
43	FEMALE	7686?	30-Oct?	1AY	1.63	No					
44	FEMALE	2503	30-Oct	1BY	1.46	No					
45	FEMALE	5808	30-Oct	1CY	1.66	Yes	30-Oct	2CY	1.61		
46	FEMALE	2909	30-Oct	1AX	1.41	Yes	30-Oct	2AX	1.48		
47	FEMALE	8831	30-Oct	1BX	1.66	Yes	30-Oct	2BX	1.47		
48	FEMALE	4312	31-Oct	1CX	1.46	Yes	31-Oct	2CX	1.46		
49	FEMALE	4799	31-Oct	1AY	1.62	No					
50	FEMALE	5049	31-Oct	1BY	1.7	No					
51	FEMALE	6115	31-Oct	1CY	1.64	No					
52	FEMALE	7348	31-Oct	1AX	1.64	No					
53	FEMALE	O633	31-Oct	1BX	1.37	No					
54	FEMALE	2719	31-Oct	1CX	1.1	Yes	31-Oct	2CX	1.51		
55	FEMALE	4854	31-Oct	1AY	1.48	No					
56	FEMALE	3594	3-Nov	1BY	1.41	Yes	3-Nov	2BY	1.31		
57	FEMALE	8596	4-Nov	1CY	1.51	Yes	4-Nov	2CY	1.51		
58	FEMALE	5734	4-Nov	1AX	1.59	Yes	4-Nov	2AX	1.5		
59	FEMALE	7893	5-Nov	1BX	1.6	Yes	5-Nov	2BX	1.58		
60	FEMALE	O671	31-Oct	1CX	1.43	Yes	6-Nov	2CX	1.49		
61	FEMALE	1858	6-Nov	1AY	1.62	Yes	6-Nov	2AY	1.47		
62	FEMALE	6536	6-Nov	1BY	1.64	Yes	6-Nov	2BY	1.65		
63	FEMALE	9362	6-Nov	1CY	1.56	Yes	6-Nov	2CY	1.48		
64	FEMALE	3086	6-Nov	1AX	1.54	Yes	6-Nov	2AX	1.48		
65	FEMALE	4112	6-Nov	1BX	1.51	Yes	6-Nov	2BX	1.88	Yes	6-No
66	FEMALE	8675	6-Nov	1CX	1.68	No					
67	FEMALE	8014	7-Nov	1AY	1.71	No					
68	FEMALE	1093	7-Nov	1BY	1.76	No					

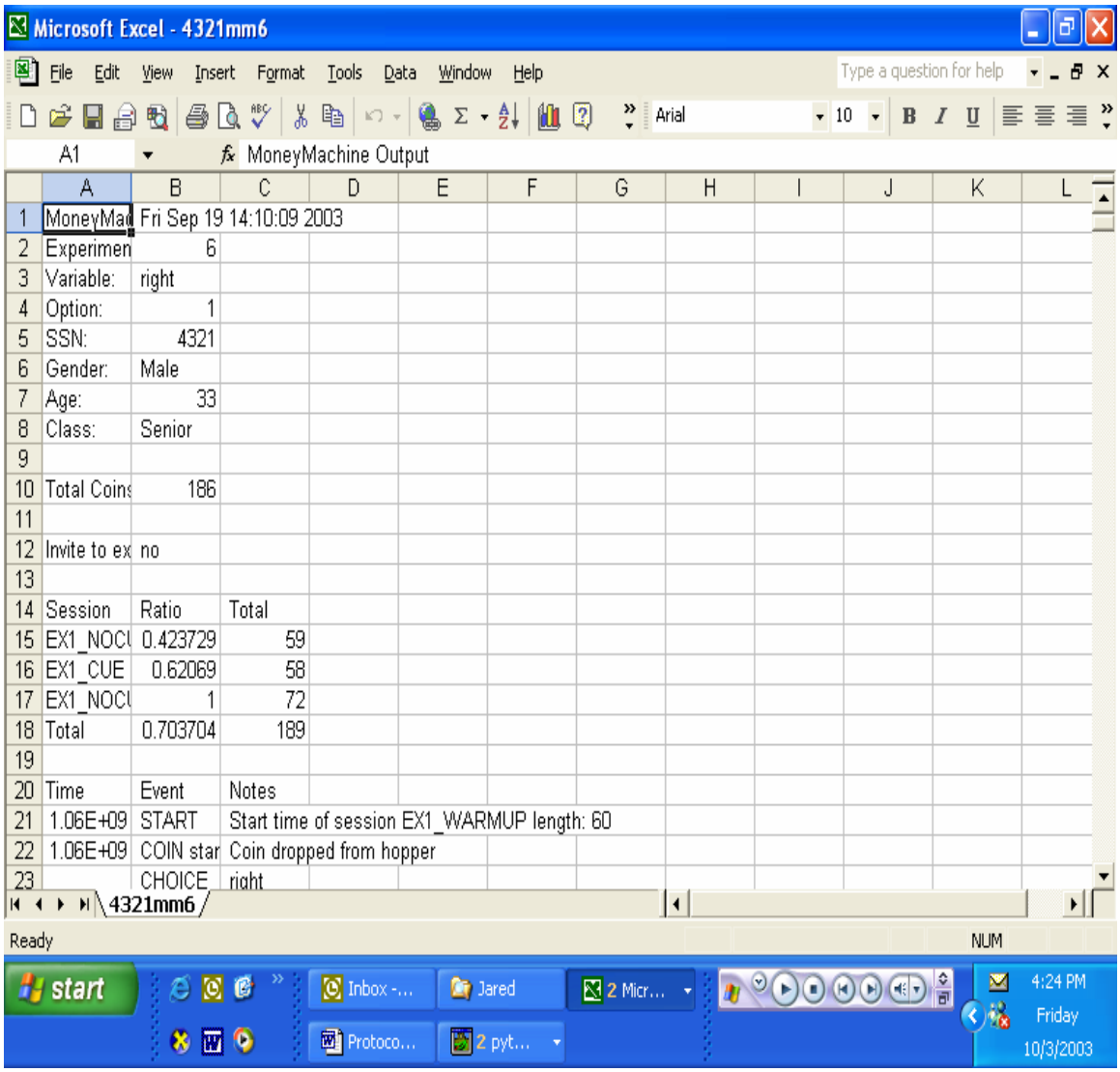
Sheet1 Sheet2 Sheet3

Ready CAPS NUM

start Inbox - ... Weekly ... 2 Micr... 2 Win... Microso... 9:56 AM

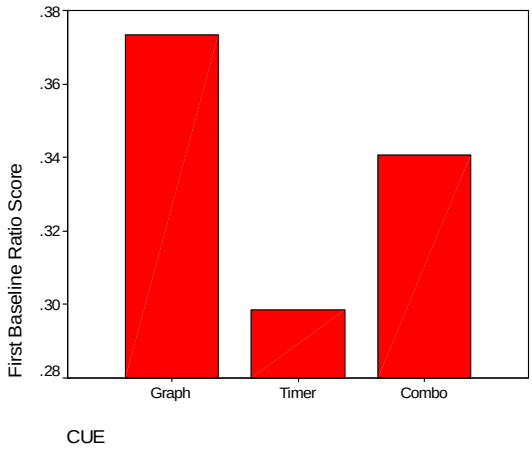
Participant Assignment and Tracking Sheet

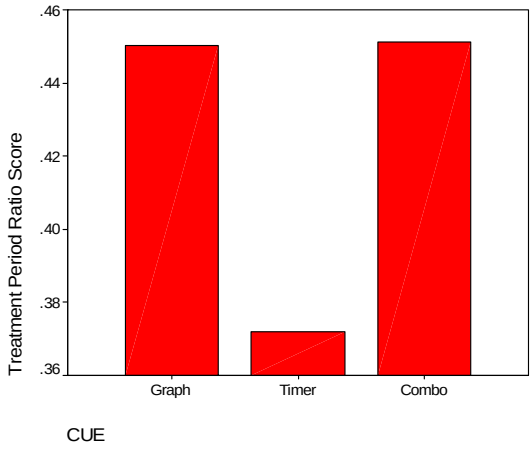
Appendix E

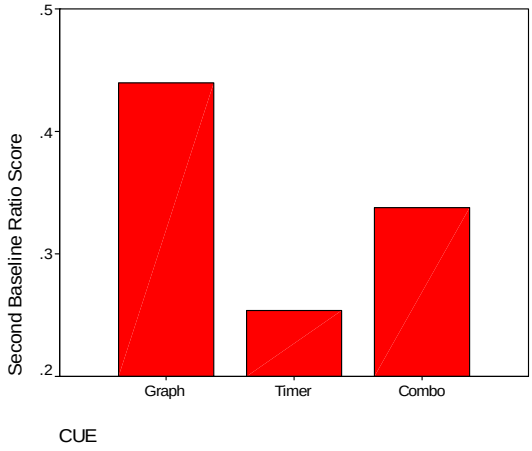


Data Output Example - Excel ® Spreadsheet

Appendix F

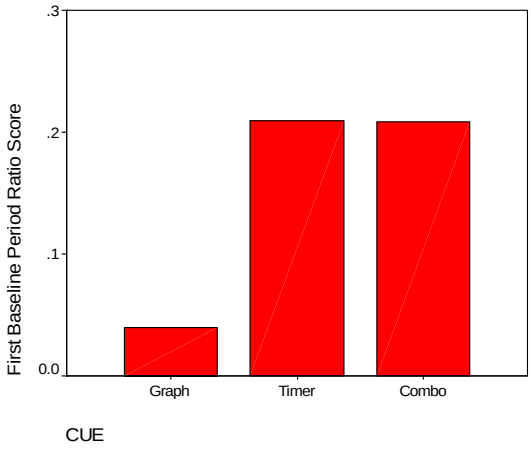


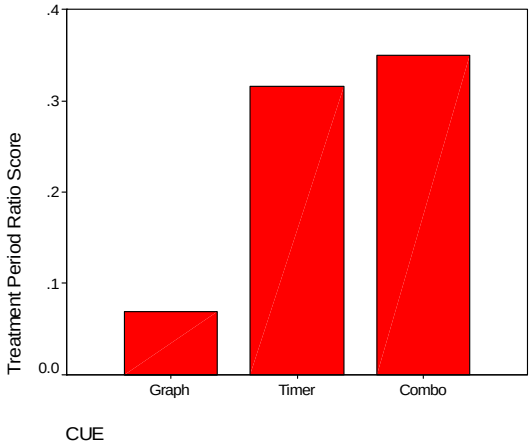


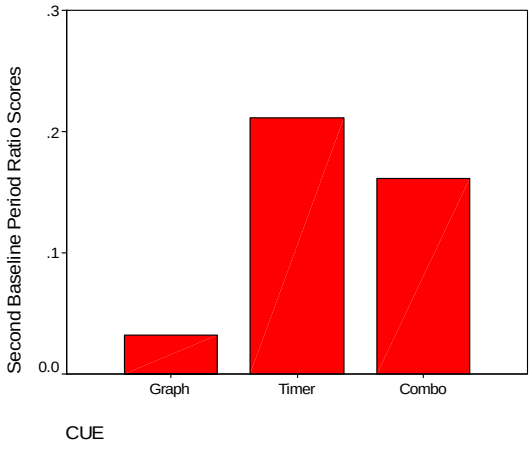


Experiment 1 Cue Group Comparison Graphs

Appendix G







Experiment 2 Cue Group Comparison Graphs