# DEPRESSIVE MOOD CHANGES DURING NICOTINE WITHDRAWAL: THEIR EFFECTS ON LEISURE ACTIVITIES FROM A BEHAVIORAL ECONOMICS PERSPECTIVE

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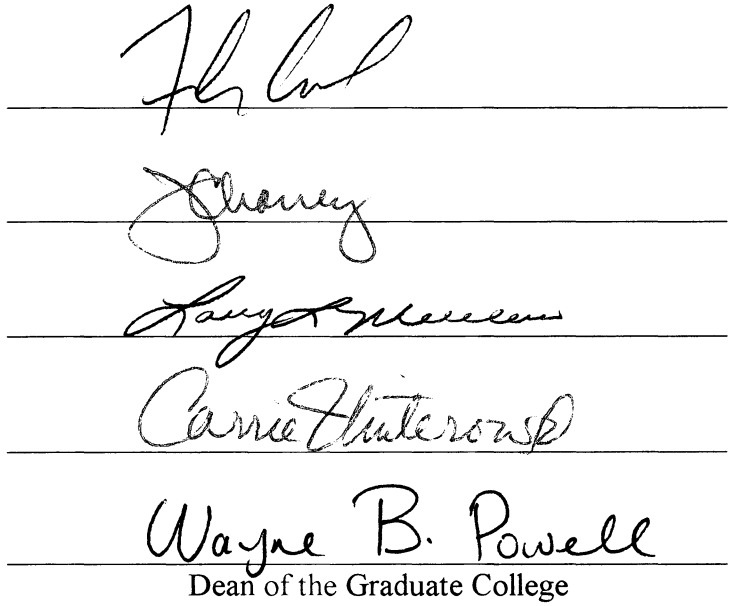

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# Depressive Mood Changes during Nicotine Withdrawal: Their Effects on Leisure Activities From a Behavioral Economics Perspective

Depressed mood and significant loss of interest or pleasure are two criteria of Major Depressive Episode, at least one of which is required for the diagnosis of various mood disorders according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association [APA], 1994). Although much attention has been given to the affective dimensions of mood disorders, Klinger (1993) argues that loss of interest is equally as important and may, in fact, partially explain depressive mood changes that take place during depression. Rather than focus on the onset of depressive mood, Klinger (1993) highlights the decrease in pleasure that is very similar to constructs such as anhedonia, apathy, and blunted affect that have long been recognized as correlates of depression.

During depression, Klinger (1993) believes there is almost always an identifiable "loss" of some kind, such as the loss of a significant relationship. This loss sets in motion an interesting process in which the lost object increases in perceived reinforcement value, while everything else decreases in perceived reinforcement value. He further asserts that this decrease in reinforcement value influences motivation/choice such that the individual no longer enjoys and/or engages in behaviors which were previously enjoyable and instead focuses on the lost object almost exclusively. The sense of loss and related negative affect develop from the inability to resolve the dilemma of the missing object.

Evidence to support Klinger's (1993) model can be found in current diagnostic criteria and instruments used to quantify depressive symptoms, all of which include aspects of loss of interest that are highly discriminative and predictive. One possible explanation for the high incidence of this depressive symptom may be that it serves an evolutionary or adaptive function. The process of devaluing everything but the lost object may provide a mechanism that makes quitting aversive enough that it is not negatively reinforced, but at the same time allows us to give up unobtainable goals and eventually move on (Klinger, 1993).

In addition to empirical support and potential adaptive mechanisms, the loss of interest model is important because it addresses potential weaknesses of strictly behavioral conceptualizations of depression. Specifically, Klinger (1993) argues that theories focusing on lack of positive reinforcement (e.g., Lewinsohn, 1974) cannot explain why goal-directed behavior would decrease across the board by relying solely on principles of extinction. Klinger (1993) adds motivational and cognitive factors (such as perceived enjoyment) to the behavioral models that can influence the reinforcement process, and can account for general reductions in previously reinforcing behaviors.

## The Problem

However, as with earlier behavioral theories of depression, Klinger's (1993) loss of interest model is useful but not without its limitations. Certain behaviors with primary and/or secondary reinforcement value such as eating, sleeping, psychomotor activity, cognitive abilities/memory, and social interactions do in fact show decreases during depression. However, there is a great deal of individual variability in depressive

symptomology, and many of the same behaviors can just as likely show increases. Other behaviors, specifically substance use, show almost exclusive increases during depression. Nicotine in particular has been consistently linked to depressive symptoms in numerous studies (Leftwich & Collins, 1994) and is the present focus of this study. A major limitation of Klinger's (1993) model is the inability to account for behaviors unrelated to the lost object that increase in frequency during depression (i.e., substance use). If perceived reinforcement for everything but the lost object is decreased across the board as Klinger (1993) asserts, then there must be another variable related to behavior and reinforcement, labeled "effort" for present purposes, which moderates the two. Behaviors that are relatively high effort with previously high reinforcing value (e.g., going out to dinner or an exciting party with a group of friends) would likely diminish as Klinger (1993) reports. Conversely, low effort behaviors with previously high reinforcing value (e.g., smoking cigarettes and drinking alcohol at home alone) should stay the same or possibly even increase precisely because they are still relatively easy to engage in, and maintain at least part of their original reinforcement value.

A second, albeit less critical, limitation of the loss of interest model (Klinger, 1993) is its focus on clinical levels of depression instead of depressive symptoms along a continuum or as part of a larger, dimensional model of emotions. Dimensional models serve as the basis for many assessments of depression, and have distinct advantages over categorical models. Over the years they have increased in their sophistication and utility, although they are by no means perfect. However, by using a dimensional model, Klinger's (1993) work could be expanded to include a much larger population while maintaining a level of sensitivity important for dealing with the individual. Furthermore,

a dimensional approach could be used to assess and treat problematic depressive symptoms that occur as part of other disorders (i.e., substance abuse and dependence) but which may not meet full diagnostic/categorical criteria.

A rapidly growing approach to studying choice behavior known as behavioral economics can be applied to Klinger's (1993) model to address these weaknesses. Behavioral economics is the application of economic principles such as cost and demand to the analysis of behavior. This approach provides alternative methods and variables for studying choices and reinforcement, and has proven especially useful for examining substance use. Using a behavioral economics perspective, it would be possible to test whether effort interacts with objective performance, reinforcement values, and decisions to engage in reinforcing activities.

## Purpose of the Study

The purpose of the present study is to examine this process in subjects experiencing subclinical depressive mood changes as a result of nicotine withdrawal. The use of nicotine withdrawal as a means of inducing negative affect was chosen for two reasons. First, it is hoped that by utilizing and studying nicotine withdrawal, a laboratory model of choice behavior and effort for drug use, depressive symptoms, and in the larger picture reinforcement can be developed and tested further. Second, it provides a reliable and convenient method of inducing negative mood changes that mimic withdrawal effects experienced by a great number of people on a daily basis (Covey, Glassman, & Stetner 1990; West, Hajek, & Belcher, 1989). In this regard, it is hoped that ethical concerns over potential risks to subjects will be greatly minimized, if not eliminated entirely.

Outline of Work

The review of the literature is divided into multiple sections. First, a more detailed discussion is given of Klinger's (1993) loss of interest model, including its history, strengths and weaknesses. Second, in order to clarify these weaknesses a review is presented of behaviors that fit the model, as well as those which do not; specifically the use of nicotine. Third, notable links between depressive symptoms and cigarette smoking are further discussed, supporting the use of nicotine withdrawal as a means for studying depressive mood changes and choice behavior. The fourth section is a discussion of the importance of dimensional models of emotion in tailoring our assessments, conceptualizations, and treatment plans to the individual. This is presented because of important but somewhat subtle differences between depression as a disorder and depressive symptomology. Finally, concepts in behavioral economics are defined and discussed in terms of their importance to Klinger's (1993) work.

Methodology for the present study is then presented, which was designed to examine: 1) negative mood changes during nicotine withdrawal, 2) the impact of these mood changes on perceptions of and engagement in of leisure activities across smoking and non-smoking conditions, and 3) the relationships among "high" and "low" levels of effort, changes in perceptions of leisure activities, and changes in engagement/performance of leisure activities across smoking and non-smoking conditions.

Loss of Interest as a Key Symptom

David Klinger (1993) focuses on "loss of interest" as a key symptom of depression. Klinger argues that motivational factors such as loss of interest are paramount to understanding depression as a disorder. According to Klinger, during a depressive episode there is typically a loss of some kind that can be identified; whether it be something tangible like loss of job or spouse, or something more psychological and subjective like perceived loss of "self-confidence" or loss of "control." If there is no resolution to the dilemma of the missing object, or if the goal of obtaining the object is simply relinquished, the depressed person focuses and ruminates on what was lost almost to the exclusion of other things. Klinger believes the result is that the lost object actually increases in perceived value (or desirability), while everything else drops in perceived value -- even if these alternatives were previously highly desirable or valued. The sense of loss results from the "perceived final failure to achieve or maintain something of importance" (Klinger, 1993, p.49). This seems similar in many ways to the old adage "You don't know what you've got until it's gone."

This is part of what Klinger (1975, 1977) terms the incentive-disengagement cycle. According to Klinger, it is as if the previously positive things have lost all value and interest for the depressed person (Klinger, 1993). This description involves what Brehm (1972) calls reactance (where the lost object gains value), and leads to decreased reinforcement efficacy because the "relative and probably absolute subjective values of other incentives decline" (Klinger, 1993, p.49). The ultimate result of decreased reinforcement value is decreased engagement in the behaviors in question.

Klinger highlights the decisions to engage or not engage in positive (i.e., reinforcing) behaviors, which is consistent with other conceptualizations of depression. Whereas much emphasis has been placed on negative affect associated with depression, the lack of positive affect has also been noted as a defining aspect of multiple types of depression (Tellegen, 1985). It has even been referred to as "almost universal among depressed patients" (Klerman, Weissman, Rounsaville, & Chevron, 1984, p.35). This lack of positive affect is similar to what other researchers and clinicians have termed apathy, anhedonia, and/or flat or blunted affect; all of which say little if anything specifically about increased negative affect, but rather depressed or blunted positive affect.

Evidence to support Klinger's position comes from several sources, including instruments designed to measure symptoms of depression and the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; APA, 1994). Examining the criteria for Major Depressive Episode (which is required to diagnose Major Depressive Disorder, either single episode or recurrent), one will find that "loss of interest or pleasure" is one of two possible symptoms required for diagnosis (the other being "depressed mood"). This was not part of the diagnostic criteria for depression until the mid 70's, when classification studies of major depression were performed which identified loss of interest as a symptom which was at least as important as negative affect (Feighner et al., 1972; Spitzer, Endicot, & Robins, 1978).

As for assessments of depressive symptoms, research on the Positive Events Scale (PES; MacPhillamy & Lewinsohn, 1982) demonstrates that several reinforcing behaviors which people choose to engage in do actually decrease. Although the PES was originally

designed to measure and quantify reinforcement value of certain events, Klinger (1993) argues that the PES can just as easily be used as a measure of choice behavior because many items consist of positive events which do not simply occur by themselves; people make choices to engage in them. Similarly, items from the Beck Depression Inventory (BDI; Beck, Rush, Shaw, & Emery, 1979) which are the most discriminative deal with diminished interest and lack of pleasure (Clark, Cavanaugh, & Gibbons, 1993). Not surprisingly, the PES has been shown to correlate significantly with the BDI, as well as with the depression scale (D) of the Minnesota Multiphasic Personality Inventory (MMPI-II; Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989), and the CES-D (Lewinsohn, Mermelstein, Alexander, & MacPhillamy, 1985).

The relative frequency and importance of loss of interest as a depressive symptom as demonstrated above is not merely a coincidence. Klinger proposes that although depression is often seen as a maladaptive, "last-ditch" effort at coping, there may be an adaptive function to help explain depression and support his claims of the importance of loss of interest. He argues that we need some sort of a "stop mechanism" that prevents us from continuing the pursuit of goals that are unrealistic and/or unattainable. However, to prevent the negative reinforcement of quitting or escape behaviors, the experience is necessarily aversive. He also proposes that this mechanism may eventually reduce the perceived value/desirability of the unobtainable goal by inhibiting appetitive systems in general (Klinger, 1993), which could explain subjective reports of anhedonia and other symptoms related to a general pattern of loss of interest.

By including subjective motivational and cognitive factors, Klinger's model helps fill in gaps left by behavioral models of depression, specifically the work done by

Lewinsohn and colleagues (Lewinsohn, 1974; MacPhillamy & Lewinsohn, 1982). Lewinsohn's model is based primarily on the idea the depression stems from a lack of positive reinforcement, and that depressive symptoms are the behavioral manifestations of extinction. However, Klinger (1993) points out that the extinction of certain goal-directed behaviors cannot explain why people would become less interested in other goal-directed behaviors across the board. Similarly, attempts to increase positive reinforcement by instructing people with depressive symptomology to engage more frequently in positive events have met with mixed results. Hammen and Glass (1975) caution of the potential for this to lead to worse depressive mood states instead of creating the expected improvements.

Klinger's work is important because it acknowledges the subjective and dynamic nature of the process of reinforcement. The apparent decreases in reinforcement value of previously enjoyable behaviors/objects that can occur during depression (and related decreases in actual engagement in related behaviors) have empirical validity (MacPhillamy & Lewinsohn, 1982) and are incorporated as a crucial part of the diagnostic criteria of depression. However, a potential weakness lies in the fact that Klinger's Loss of Interest explanation has no way to account for certain "anomalies" within his model where behaviors are not suppressed or decreased, but rather activated or increased during depression. If the appetitive systems he speaks of are inhibited, then one is left with the problem of explaining how behavioral activation related to negative mood changes occurs without drawing upon the process of reinforcement. In other words, if reinforcement value across the board has decreased for everything except the lost object, then how is it that some behaviors that are unrelated to the lost object show increases?

Such a question seems to fly in the face of the very definition of reinforcement at first glance, yet we can readily point to behaviors that do increase during depression for some individuals. The answer might be found by comparing and contrasting some of these behaviors to find a common thread among them.

Individual Differences in Depressive Symptomology

During depression, we know that certain behaviors do decrease as Klinger (1993) indicates. Many of these behaviors are enjoyable and reinforcing to the nondepressed individual, but for the depressed person their positive value seems to have markedly decreased and thus they are performed at a reduced rate as well. Examining diagnostic criteria for a major depressive episode (APA, 1994), one will find a list of behaviors that can have either primary or secondary reinforcing value, but which can also show significant changes during depression. Among these are eating, sleeping, motor activity (including speech), cognitive ability, and social interactions.

According to the DSM-IV (APA, 1994), eating may decrease during depressive episodes. Appetite may drop off dramatically, and there may associated weight loss. Patton (1993) reviews the literature on changes in eating and appetite as symptoms of depression and reports that there are very few methodologically sound studies that use direct measures of food intake and metabolism to study changes in eating and appetite. However, there have been several studies employing primarily self-report and indirect measures of food intake and metabolism to assess changes in body weight and appetite. Casper et al. (1985) indicate that 65% of patients with unipolar depressive and 45% of patients with bipolar depression report significant loss of appetite during depressive

episodes. Variables such as age and severity of depressive symptomology may have been contributing factors to appetite loss. Another study supports a similar relationship between severity of depression and weight loss, with 30% of the sample reporting an average weight loss of eleven pounds during a depressive episode (Weissenburger, Rush, Giles, & Stunkard, 1986). A separate study examining weight changes prospectively over recurrent depressive episodes indicated that approximately 50% of depressed patients demonstrated weight loss during the initial depressive episode. The direction of weight changes (in this case decreases) remained consistent across depressive episodes, and overall weight change could be predicted best by duration of depressive episode for those subjects who lost weight (Stunkard, Fernstrom, Price, Frank, & Kupfer, 1990). At this point it is unclear whether changes in food intake are due primarily to changes in appetite and/or the perceived reinforcement value of food, changes in psychomotor activity and/or metabolism, or (most probably) some combination of all of these factors. Like other depressive symptoms, the causes will vary widely from person to person, but what is clear is that for many people, appetite and weight can decrease dramatically during depression.

Another behavior disturbed and reduced by depression may be sleeping, where initial insomnia (trouble falling asleep), middle insomnia (trouble waking up in the middle of the night and then getting back to sleep), and terminal insomnia (waking up very early in the morning) are common (APA, 1994; Cartwright, 1993). Research on sleeping patterns and disturbances within depression estimate that approximately 85% of people suffering from depression report not getting enough sleep (Cartwright, 1993). The primary mechanism for this is believed to be disruption of the normal Rapid Eye Movement (REM) sleep cycles. Most people cycle through 4 stages of sleep throughout

the night, which are differentiated primarily by the type of EEG brain waves produced. At the end of the first cycle (which lasts approximately 70-90 minutes), we experience our first stage of REM sleep (which lasts about 10 minutes). Throughout the night, REM sleep increases in frequency and duration, and it is in these REM states that we experience the majority of dreams (Borberly, 1986). For the depressed person however, this process occurs in a somewhat backward fashion with the initial sleep cycles loaded with more REM sleep than later cycles. Thus, the initial stage of REM sleep begins too early (within the first hour of sleep) and lasts too long; taking up to double the normal amount of time (Cartwright, 1993). The REM sleep disruption and the progression of the stages of sleep in depressed individuals are clear, but what is unclear is how these problems originate. Basic biological changes associated with depression may play a major role, but it could also be related to choice behavior and the reinforcing value of sleep. A depressed individual may spend so much time dwelling on a missing object that getting adequate rest may become a secondary goal, thus creating a perceived decrease in the "need" for sleep.

Markedly decreased psychomotor activity may also be present as evidenced by decreased physical movement, decreased eye contact, decreased verbalization/increased verbal response latency, monotonous vocalization, decreased facial expressions, as well as more complex behaviors including decreased personal hygiene. Cloitre, Katz, & Van Praag (1993) argue that psychomotor retardation is a unitary and key symptom of depression, and can be used to predict treatment prognosis and discriminate between sub-types of depression (e.g., bipolar vs. unipolar) independent of affective and cognitive symptoms. Research done by Widlocher (1983) and Katz et al. (1984) supports this

claim, as factor analyses performed as part of their studies grouped items pertaining to motor retardation together into a single construct that yielded reasonable predictive and discriminative power. Such findings have led to the development of instruments such as the Retardation Rating Scale (RRS; Widlocher, 1983), designed specifically to measure movements that can be indicative of depression such as posture and gait. Beyond physical the effort of movement, many of the above behaviors (eye contact, speaking, facial expressions) are also significant aspects of social interactions. Such interactions may be too intimidating or otherwise too costly to engage in, especially given many of the negative cognitions associated with depression such as worthlessness and hopelessness.

Related to patterns of diminished quality/quantity of speech and exaggerated pauses between responses mentioned above, there may also be slowed intellectual abilities and problems with memory and concentration. Watts (1993) points out that while subjective reports of diminished cognitive abilities are common, studies using actual objective measures show little or no differences between depressed individuals and controls (e.g., Scogin, 1985; West, Boatwright, & Schleser, 1984). Complaints of impaired intellectual functioning may be more closely related to changes in mood than actual cognitive performance (Watts, 1993). The findings overall are mixed, as methodological weaknesses including poorly matched controls, potential practice effects, regression towards the mean, and a lack of generalizability are often confounded with claims of diminished cognitive performance (Watts, 1993). Indeed, poor performance on objective measures may reflect psychomotor retardation and impoverished speech more than actual cognitive impairments. However, even if there is only the perception that one's cognitive abilities have been diminished, this information is still clinically useful

and may potentially have a direct effect on performance due to negative expectancies and self-fulfilling prophecies (Johnson & Magaro, 1987). Again, one must consider on a case by case basis if there is a change in the reinforcement value attached to the behavior. It may be easier (i.e., more socially acceptable, resulting in a shorter conversation, etc.) for a person to report diminished ability to pay attention or remember, rather than admit they simply do not feel like talking to anyone.

The actual and perceived decreases in motor activity and cognition may contribute to a broader pattern of decreased quantity and quality of social interactions. Although this is not a definitive symptom of depression, these patterns can make living with a person suffering from depression difficult and potentially unhealthy for everyone involved. A depressed person may need social support, but may be unable to provide enough feedback and mutual interaction to foster such support. As a result, the people closest to the depressed person often have great difficulties relating to them and trying to help, which may in turn exacerbate the individual's depression (Sacco, Milana, & Dunn, 1985; 1988). Thus, it appears that the motivation to simply interact with loved can be greatly diminished, and can continue to decrease in a cyclic manner as described above.

However, we know that there can be a great deal of individual variability with regard to depressive symptomology. Given the nine symptoms listed under criterion 'A' of Major Depressive Episode in the DSM-IV (APA, 1994), as well as the fact that one of the required five symptoms must be either (1) depressed mood or (2) diminished interest, there are potentially 3,360 different symptom combinations subsumed under one deceptively simple label. Partially as a result of the heterogeneity of depressive symptoms and because reinforcement value of the above behaviors is partially determined

by subjective appraisals, not everyone shows the decreases in the behaviors mentioned above. Indeed, several of the criteria for Major Depression indicate that either decreases or increases in the behaviors may be seen.

Using some of those same behaviors as examples, eating may in fact increase for some people, especially those who are physically active as part of their occupation. Certain foods (such as sweets or other foods high in carbohydrates) may be craved and eaten more frequently, resulting in associated weight gain (APA, 1994; Fernstrom, Krowinski, & Kupfer, 1987). Similarly, with sleep disturbances, the changes seen may be sleeping too much or hypersomnia instead of insomnia. Approximately 15% of depressed people suffer from hypersomnia and often report needing a markedly increased number of hours of sleep per day, either by increasing the number of hours normally slept during the night or by increasing the number and duration of naps taken during the day (APA, 1994; Cartwright, 1993). With motor activity, increases can also be seen in the forms of "agitated depression," where behaviors such as pacing, hand movements (wringing, pulling/twisting hair, rubbing/picking at skin) occur with greater frequency than before (Cloitre et al., 1993). Presumably, something has made these behaviors more appealing, which coincides with increases in the behaviors due to possible anxiety-reducing and/or mood-elevating effects.

The remaining behaviors (cognitive function, speech, and social interactions) typically do not show the "either/or" pattern of increases and decreases. Rather, they seem to be more exclusive to the category of diminished behaviors. Conversely, there are certain behaviors that can be grouped together that most often increase during depression. Substance use is one of the most common behaviors that can increase during depression,

and is listed as an associated feature of Major Depression in the DSM-IV (APA, 1994). There is some indication that self-medication may play a major role in trying to relieve or reduce symptoms of depression (Hughes, 1988). Heston and White (1983), for example, indicate that depressed people tend to self-medicate using alcohol or other drugs, and that this can be used as a way to discriminate between dementia and atypical depression, such as retarded depression. The term "self-medication" gives some insight into why substance use increases during depression for some people, and that is because it can allow them to feel better relatively quickly without having to go to a lot of trouble.

Because of the socially accepted nature (relative to marijuana, heroin, or crack cocaine, for example) and the availability/ease of obtaining and using alcohol and nicotine, they are two common drugs of choice for the depressed person. Indeed, they can often both be found in the same individual and present special problems for the clinician working with them in a treatment program (Hughes, 1996). It seems almost paradoxical that drugs from two different drug classes and with different reinforcing effects, primarily depressant effects (alcohol) and stimulant effects (nicotine), would both show high rates of consumption during depression, not to mention the conjoined pattern discussed above. The differences in terms of neurochemical mechanisms and the reinforcing mechanisms of alcohol and nicotine are important, but the common denominator is that both drugs are highly reinforcing, readily available, and easy to use (Abadinsky, 1993). However, because nicotine has potential stimulant and calming effects (United States Department of Health and Human Services [USDHHS], 1988) consistent with varied individual depressive symptomology, and because a full discussion of both alcohol and nicotine is

beyond the scope and purpose of the present paper, only nicotine use and associations with depression will be reviewed.

Links Between Smoking and Depression

Examining diagnostic criteria for substance abuse and dependence disorders, one finds that it is not uncommon for people to develop depressive symptoms related to their drug problem(s). Depressive and dysphoric symptoms are characteristic of the course of intoxication, the "crash" sometimes experienced after intoxication, withdrawal, dependence, and abuse of many (if not all) types of substances listed in the DSM-IV (APA, 1994).

Links between tobacco smoking and depressive symptoms, especially negative affect, have been studied and reviewed extensively (e.g., Breslau, 1995; Breslau, Kilby & Andreski, 1991, 1993; Gilbert & Gilbert, 1995; Glassman & Covey, 1996; Newhouse & Hughes, 1991) and have consistently been shown to exist. While the statistical effect size of such associations has varied from study to study, the clinical significance for the individual and the family can be very influential and long lasting (Leftwich & Collins, 1994). Specifically, symptoms of depression have been linked to the initiation, maintenance, and relapse of smoking behavior.

Covey, Glassman, and Stetner (1990) postulate that depressive mood may result in the onset of smoking, which could be due in part to genetic factors including gender differences (Glassman & Covey, 1996; Perkins, 1995) and/or personality factors (Gilbert & Gilbert, 1995). Tobacco smoking may also result from psychosocial components

common to symptoms of depression, such as low SES and education levels, high stress levels, and lack of positive social supports or role models (USDHHS, 1988).

Independent of physiological addiction to nicotine, maintenance and relapse of smoking behavior also have common ties to depressive symptoms. Negative mood changes and irritability, which often result when a person addicted to nicotine abstains from smoking cigarettes (Newhouse & Hughes, 1991), have been shown to predict relapse and severity of dependence. West, Hajek, and Belcher (1989) followed a group of 227 smokers attempting to quit over a four week period, and indicate that during the first three weeks, a simple self-report rating of overall depression for one week significantly predicted abstinence for the next week. Higher depression scores were indicative of relapse, even after the effects of nicotine gum were removed. Breslau, Kilbey, and Andreski (1991) report similar results, in that the magnitude of the association between rates of major depression and nicotine dependence was predicted by the severity of a person's dependence.

Hughes (1988) argues that potential mood-elevating effects of smoking may alleviate depressive symptoms and thus negatively reinforce smoking behavior. Somewhat paradoxically, other studies by Hughes and colleagues indicate that prevalence for depression is greatest for people who are current smokers and least for people who have never smoked, due possibly to nicotine's action on reducing levels of certain anti-depressants in the bloodstream (Newhouse & Hughes, 1991). Nicotine's actions on the nervous system are somewhat paradoxical to begin with, providing both arousal and relaxation effects for some people (USDHHS, 1988), but another possible explanation is that prevalence of depression and symptom severity would be even greater than it is if the

group of people currently smoking were to abstain. A related finding is that reductions in thyroxine ($T_4$) levels (a measure of thyroid functioning which has been linked to psychiatric illnesses, particularly depression) in smoking, non-depressed individuals mimic changes in thyroid functioning experienced by non-smoking, depressed individuals (Joffe & Levitt, 1988). Levels of $T_4$ were significantly lower in a group of smoking patients vs. non-smoking patients, even after controlling for important psychosocial and demographic variables, including severity of depressive symptoms.

Much of the research pertaining to nicotine and depressive symptoms is correlational in nature, and thus many of the above explanations can just as easily be turned around in the opposite directions. In all actuality, depressive symptomology and cigarette smoking are probably linked together by a third variable which some hypothesize is genetic (e.g., Glassman, 1993; Heath, Madden, Slutske, & Martin, 1995). Such genetic influences likely predispose a person to both depressive symptoms and an affinity for nicotine and its reinforcing effects. However, Newhouse and Hughes (1991) indicate that psychosocial factors such as learned helplessness, poor social skills, and low self-esteem among other things may also lead to both depression and smoking. Smoking and depressive symptomology, once paired together, likely interact in a fashion that perpetuates one after the other in a cyclical fashion. In support of this notion, Covey et al. (1990) provide evidence that past prevalence of depression predicted poor treatment response in both placebo and active drug conditions of a smoking cessation program, and further reported higher rates of major depression in those who have attempted to quit smoking unsuccessfully compared to those who have never smoked as well as those who have successfully stopped smoking. Many of the studies above vary in whether they

focus on clinical levels of depression vs. depressive symptomology. While the difference may seem subtle, there are definite implications for populations studied, measures used, and ultimately how the findings are interpreted. Because percentages of smokers who are diagnosed with major depression are varied, and because there may significant depressive symptoms without a full-blown diagnosis in people who are nicotine dependent, a dimensional model would seem better suited to the current study and would help expand Klinger's model.

Dimensional vs. Categorical Models of Depression

Klinger (1993) focuses primarily on clinical levels of depression defined and differentiated by diagnostic categories, but much of the supportive empirical evidence he presents is derived from broader, dimensional models and assessments of emotion (e.g., Clark & Watson, 1991; Tellegen, 1985; Watson & Tellegen, 1985). For instance, the BDI (Beck et al., 1979) quantifies severity of symptoms based on self-report rankings and yields a total score that indicates whether depression is "mild" to "severe." Similarly, the PES (MacPhillamy & Lewinsohn, 1982) is based on the amount of positives you have to help buffer you, not simply the categorical presence or absence of any given positive event(s).

Dimensional models allow the quantification and specification of multiple emotions and attributes that may be defining aspects of a diagnostic category, as with depression. Research on dimensional models of emotion has consistently identified at least two orthogonal dimensions (e.g., Eyesenck, 1961), which Tellegen (1985) calls positive affect and negative affect. Other dimensions, such as arousal and valence

(Bradley & Lang, 1994; Russell, 1980), have been identified and theoretically incorporated as related diagonal axes (Barlow, 1988) within a "circumplex" (Plutchik, 1980; Tellegen, 1985) of self-rated mood.

Making a distinction between dimensional and categorical models is important because there are implications for research design and subsequent generalizability of findings. Within the present framework, employing a dimensional model of depression (i.e., studying depressive mood changes along a continuum) would allow one to study a greater number of people and ideally apply the findings to a much larger population. Nearly everyone can identify their own occasional feelings of being "blue" or "down in the dumps," although the general population would have a much more difficult time relating to Major Depressive Disorder if for no other reason than the relatively small point prevalence rate of approximately 2% to 9% (partially dependent on gender) given by the DSM-IV (APA, 1994).

Dimensional conceptualizations also have other advantages over categorical models, especially when categorical models have ambiguous boundaries and/or are superimposed upon phenomena that are believed to occur along a continuum (APA, 1994). Dimensional models can lead to increased specificity/reliability when providing clinical descriptions, a greater understanding of symptoms which overlap across disorders and heterogeneity within any given disorder (as demonstrated above by the surprisingly large number of potential symptom combinations), and the ability to account for the large number of people who are "subthreshold" or somewhere between having no diagnosis and meeting criteria for any given disorder (APA, 1994; Barlow, 1988).

However, there are also some potential disadvantages of dimensional models. Specifically, while much attention has been focused on trying to identify the most descriptive and predictive model(s) of emotion, there is still some debate over how many dimensions should be used (cf. chapter 2 of Barlow, 1988). As mentioned above, utilizing two bipolar dimensions is common but not everyone agrees on which two dimensions are most important. The work of Tellegen (1985) which identifies Positive and Negative Affect as the key dimensions and Lang (Bradley and Lang, 1994) which employs Valence and Arousal, serve as examples of the varied empirical findings. It should be noted however that these dimensions are not mutually exclusive, and seem logically and theoretically related. Barlow (1988) attempts to incorporate the two models conceptually, although a direct empirical comparison of assessments derived directly from these respective models suggests that the proposed relationships may not exist (Hutchison et al., in press).

A second potential disadvantage is that with dimensional models a new method of relaying information must be adopted. Categorical models provide everyone with the same set of labels and criteria, or jargon. While the label "depression" says nothing specific of what a given individual is experiencing, it does bring to mind for the person adhering to categorical systems such as the DSM-IV (APA, 1994) the specific sets of criteria used, defining features, prevalence data, and differential diagnostic issues. From a communications standpoint it can be more efficient, especially for collaborating clinicians, if they are able to use one word which relays so much information (provided, of course, both clinicians are educated in the same categorical system).

Despite these potential pitfalls, dimensional models still provide us with enough explanatory power to effectively differentiate, for example, between varying states of depression and states of anxiety (Barlow, 1988) which may be more difficult using categorical systems. This is important because in using categories and diagnostic criteria of the DSM-IV (APA, 1994), one is left to judge if a person who reports having 4 out of 9 symptoms (subthreshold range) from criterion "A" is qualitatively the same as or different from a person who reports only experiencing 2 out of 9 symptoms for example. A dimensional perspective that can account for subtle affective changes not only eliminates this problem, but will have potentially greater descriptive and predictive ability across a much larger number of individuals.

Klinger's description of depression and related symptoms could thus be expanded and improved by studying loss of interest along a continuum of depressive mood rather than being limited only to clinical levels of depression. It would be especially interesting if Klinger's model proves to hold for clinically subthreshold depressive mood changes, because negative mood changes and other depressive symptoms (especially loss of interest) are often present in a number of other problems and disorders. This may be particularly true for substance abuse and dependence, which include depressive symptoms as defining elements of the symptom picture and diagnostic criteria. Although clinical levels of depression may not be present, depressive mood changes can still be very important primarily because of the subjective motivational changes that may accompany negative affect (Miller & Rollnick, 1991). These motivational changes may, in turn, influence whether a person is able to initiate and maintain treatment for substance use, as well as influencing the likelihood of relapse and/or premature treatment termination as

discussed above (i.e., the "stages of change" proposed by Prochaska & DiClemente, 1982).

The Role of Behavioral Economics

Klinger (1993) argues that changes in affect and motivation are closely related to the subjective reinforcement value of certain stimuli and behaviors, which from basic operant learning principles (e.g., Premack, 1959; Skinner, 1938; Thorndike, 1932) predict individual choice. However, while loss of interest (Klinger, 1993) provides a way to explain behavioral decreases associated with decreased reinforcement values and a possible mechanism behind them, the biggest potential weakness lies in its inability to account for those behaviors, motives, and choices that increase during depression (i.e., substance use) presumably because reinforcement value has either remained at a high level or perhaps even increased. A third factor may determine for the individual how reinforcement values change and subsequently which behaviors increase and decrease. If such a factor could be identified, is could be used to help explain the great degree of individual differences in symptomology and presenting problems within depression. In order to accomplish this feat, such a construct must be able to break behavior down into its separate but related components.

An alternate explanation to Klinger's (1993) model of loss of interest (or decreased reinforcement value) could be that the perceived effort required to obtain reinforcing effects has increased relative to negative affective changes, and that it is this increase in subjective effort that makes the response too costly to engage in, or "...no longer worth the trouble" (Klinger, 1993, p.44). The two explanations (decreased

reinforcement value and increased effort) are directly related, but they are not simply two sides of the same coin. One component that would seem particularly useful to explore is the amount of "effort" required to perform a given behavior; and whether or not effort is a subjective, motivational state relative to depressive mood changes. The DSM-IV makes mention of behaviors (e.g., personal hygiene) which during a depressive episode may seem "exhausting and take twice as long as usual" (APA, 1994, p.321). As mentioned above even Klinger notes that effort can be influential although no discussion of its potential role is given despite focusing on choice behavior where effort would seem to play an especially important role.

As an illustration, if one is presented with a choice of earning a reinforcer on concurrent fixed ratio schedules of reinforcement where one schedule requires a greatly increased amount of effort (via the number of responses or the intensity of responses or both), then the reinforcer which is easiest to obtain will be chosen more frequently. This is essentially another way of phrasing the Matching Law (Herrnstein, 1961) which states that when one is given a choice between two schedules of reinforcement, responding will be divided proportionately based directly on the amount of reinforcement delivered. The scenario is made even more complex if the reinforcers vary in their relative magnitude and efficacy, either objectively (e.g., amount of a drug) or subjectively (e.g., by creating a deprivation state such as drug withdrawal).

One way to quantify the impact effort can have on perceived reinforcement value and subsequently whether a behavior increases or decreases during depressive mood changes is to incorporate principles from the field of behavioral economics. Behavioral economics is the application of concepts from microeconomics theory or "consumer-

demand theory" (Hursh & Bauman, 1987) to the study of behavior, specifically focusing on choice behaviors and the process of reinforcement. Behavioral economics was first introduced in the mid 70's (e.g., Green & Rachlin, 1975), and has since become a growing and industrious area of behavioral research. Between the years 1985 and 1995 alone the number of articles per year in the Journal of Experimental Analysis of Behavior virtually doubled (Bickel, Green, & Vuchinich, 1995).

Principles of behavioral economics have been experimentally tested and utilized in order to gain a greater understanding of choice behavior, especially within the area of substance use, abuse, and dependence (e.g., Bickel, DeGrandpre, & Higgins, 1993; Vuchnich & Tucker, 1988). As summarized by Bickel et al. (1995), behavioral economics offers new variables and methods not previously available to behavioral scientists, which allow for a greater understanding of how processes of reinforcement and choice behavior; and the context in which they occur in, are all interrelated.

These new variables and methods go beyond typical operant dependent measures of responding. Indeed, responding has been relegated to more of a secondary role (Hursh, 1993) because by using behavioral economics, a response can be broken down into smaller components that separate the subjective and objective aspects of choice behaviors. Although responding is still necessarily related to amount of reinforcement obtained, the addition of the behavioral economics principles noted above has given us alternative ways of measuring and predicting components of choice behavior, with greater flexibility and explanatory power.

For the present purposes, there are five behavioral economics concepts that are especially relevant: Consumption, unit price, the demand curve, elasticity, and

substitutability. Each concept will be defined and briefly discussed (drawing primarily on the work of Bickel, DeGrandpre, & Higgins, 1993) to help illustrate their utility in determining which behaviors drop off while other increase with the onset of depressive symptoms.

The relationship between the price of a given commodity (e.g., nicotine) and its demand is known simply as consumption. If demand is high and price is low, then there will be a high amount of consumption. Conversely, if demand is low and price is high, one would expect there to be little or no consumption of the commodity in question.

The commodity's "price" has been termed unit price (UP), and is defined generally as the cost-benefit ratio. This concept is particularly useful for explaining the reinforcing effects of drugs (both positive and negative), because it breaks down the process of reinforcement into related yet unique components, namely response requirements (cost) and dosage (benefit). Additionally, "cost" can be broken down even further into actual response requirement and response effort, while "benefit" can be similarly sub-divided into reinforcer magnitude and reinforcer probability. This is important because as mentioned above "effort" and "probability" (at least in the realm of human behavior) can involve subjective components that are influenced by affective states associated with depression as well as substance abuse/dependence.

Re-analysis of research on self-administration of nicotine (DeGrandpre, Bickel, Hughes, & Higgins, 1992) using behavioral economic principles has led to two testable hypotheses relative to UP. The first states that consumption should remain proportionally the same at different levels of a fixed-ratio schedule of reinforcement (or different reinforcer magnitudes) provided UP is also proportionally the same (e.g., consumption

based on UP 5 should be the same whether 1 dose is contingent on 5 responses, or 5 doses are contingent on 25 responses). The second hypothesis is that because everything is proportional, there should be one underlying mathematical function based on consumption and UP. Bickel et al. (1993) present a final version of this function that accounts for relative and absolute differences between alternative or competing commodities by taking the ratio of absolute UPs multiplied by the sum of UPs.

This function has indeed been supported empirically (Bickel et al., 1993) and has descriptive and predictive utility, except at very low drug doses which Bickel et al. (1993) contend are qualitatively different from higher doses. Several studies have demonstrated this "low-dose effect" when re-analyzed using behavioral economics variables and methods. In other words, the commodity is at such a small reinforcer magnitude (or at low reinforcer probability) that it may be functionally the same as no commodity at all. Even so, Bickel et al. (1993) point out that traditional dose-response (linear) models do not allow for this low-dose exception to be detected, it is only through the use of UP and consumption that the anomaly was discovered.

The plotting of consumption at varying UPs using log/log scales produces a graphic of what is known as the demand curve, which represents a positively decelerating function (i.e., there are small decreases in consumption at lower UP, and larger decreases in consumption at higher UP). The non-linear regression equation is defined mathematically by Hursh, Raslear, Shurtleff, Bauman, and Simmons (1988) as:

$$\log Q = \text{Log } L + b(\log P) - aP$$

Where Q is consumption, L is an estimate of consumption at UP of 1, b is an estimate of the slope of the demand curve, a is the rate of change in the slope of the demand curve,

and P is unit price. This function accounts for a much greater proportion of variance than linear regression equations, yielding a range of values for $R^2$ of .83 to .98 and an overall mean $R^2$ of .94 for one small set of data (Bickel et al., 1993).

The rate of change in the slope of the demand curve, noted as "a" in the equation above, and "b" or the slope of the demand curve, are closely related to the next concept of interest known as elasticity. Elasticity is essentially the sensitivity of consumption to changes in UP. A small decrease in consumption across increases in UP denotes inelastic consumption, while a large decrease in consumption across increases in UP denotes elastic consumption. Because the demand curve shows small decreases in consumption with increases in UP at first, and then large decreases in consumption with continued increases in UP later, this function is said to have "mixed elasticity" (Hursh & Bauman, 1987).

Substitutability, then, is the ability of one commodity to mimic and compete with another commodity with respect to elasticity, UP, and consumption. A pure substitute should produce the exact same demand curve as the original commodity by definition. Drug replacement therapies (e.g., Methadone) can be viewed as the implementation of pure substitutes. However, it is possible to use behavioral alternatives to compete with substance use. demonstrating at least some properties of substitutability for these behavioral reinforcers with biochemical ones. This has been demonstrated experimentally (e.g., Collins, Leftwich, Larson, & Trombley, 1994) as well as clinically (e.g., Higgins et al., 1991) and has exciting implications for the application of behavioral economics principles in the areas of substance abuse/dependence treatment, smoking

cessation, and educational/preventive efforts aimed towards reducing experimentation with drugs in high-risk populations.

Obviously, not everyone becomes depressed when there is perceived failure to achieve or maintain a desired goal. Klinger (1993) reminds us that depression is typically the last step of many in a larger process in dealing with failure or loss. One explanation is that the majority of people are able to adequately locate for themselves those behaviors and activities which are low in response requirement and/or response effort (cost), yet relatively high in reinforcer magnitude an/or reinforcer probability (benefit), and may subsequently serve as acceptable alternatives (or partial substitutes) for the lost object(s) which Klinger (1993) highlights. If low cost, high benefit activities could be identified which help relieve withdrawal symptoms including depressive mood, applications for treatment of substance-related disorders as well as depression could potentially be improved, similar to the findings of Higgins et al. (1991) using behavioral economics principles to treat cocaine dependence.

## Purpose of the Present Study and Hypotheses

The purpose of the present study is to examine the effects of negative mood changes during nicotine withdrawal on perceptions of and engagement in leisure activities across "high" and "low" levels of effort, while keeping enjoyment constant (at least initially). It is believed that (1) subjects who abstain from smoking for 48 hours will experience nicotine withdrawal, as indicated by increased scores on the Tobacco Withdrawal Symptoms Checklist (WSC; Hughes & Hatsukami, 1986), decreased levels of exhaled Carbon Monoxide (CO), and decreased blood pressure and heart rate; as well

as increased levels of associated depressive mood changes quantified by the BDI (Beck et al., 1979) and the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971). It is further predicted that (2a) subjective measures (self-report ratings of enjoyment, effort, and efficacy) will show significant changes across smoking and non-smoking phases. Specifically, it is predicted that levels of enjoyment and perceived efficacy will demonstrate significant decreases in the non-smoking session, while perceived levels of effort will show significant increases. It is expected that these significant changes will interact with the type of activity ("high" vs. "low" effort), with the greatest changes coming from "high" effort activities in the non-smoking session. Additionally, it is expected that (2b) objective measures (total time spent engaging in the activity and percentage of progress) will demonstrate significant decreases in non-smoking sessions relative to smoking sessions. Again, it is predicted that such decreases will be especially prevalent for "high" effort activities in the non-smoking session indicating a significant interaction. Finally, it is predicted that (3) changes in withdrawal scores (differences in scores from smoking and non-smoking conditions) and depressive mood changes (differences between BDI and POMS scores from smoking and non-smoking conditions) will be negatively related to changes in objective measures of engagement and changes in perceived enjoyment, effort, and efficacy. A positive relationship is predicted between changes in withdrawal and mood and changes in perceived effort.

# Methods

## Subjects

Fifty-one potential subjects from undergraduate psychology courses were identified using a brief recruitment questionnaire, which asked for basic demographic information, as well as smoking history and daily use. A copy of the recruitment questionnaire can be found in Appendix A. For their participation, subjects were offered extra credit in their course as well as a chance to win one of three gift certificate prizes ($100, $25, and $10) in a "lottery" based on the total amount of time spent in the study and the number of sessions successfully completed. Only those subjects who reported regularly smoking at least ½ pack a day, were not currently attempting to quit or cut down, and indicated they were possibly interested in research participation were approached for participation via a brief phone interview. This is consistent with previous studies involving subjects from this approximate age group considered to be moderate level dependent smokers (Payne, Smith, McCracken, McSherry, & Antony, 1994). Out of these 51 people, 21 (11 males, 10 females) successfully completed all three phases of the study (orientation to the study, smoking, and non-smoking conditions), 20 (15 males, 5 females) never started the study, and 10 (5 males, 5 females) dropped out prematurely from the study. The reasons for exclusion/attrition of the latter 30 people are detailed below.

Subjects who had psychological and/or physical conditions that would prevent participation (or make participation an unusually risky endeavor) were excluded from the study. A total of eight people were excluded from the original group of 51 potential subjects, including four people with coronary/cardiovascular conditions (e.g., tachycardia,

aortic valve leak, etc.), two people with respiratory conditions (e.g., asthma), one person with "severe clinical depression," and one person with physical handicaps that prevented free movement required for the various tasks. An additional 12 subjects were scheduled on multiple occasions (at least twice per person) to begin the study, but never kept their scheduled appointments for reasons unknown and were dropped from further recruitment. Alternatives for extra credit were available to everyone who did not participate in this study. This yielded a total of 20 who were identified as potential subjects but never started the study.

Comparisons between those who completed the study and those who never started the study indicated no significant differences in amount of cigarettes (broken down on the recruitment questionnaire into the following categories: 1 = 10-15, 2 = 16-20, 3 = 21-25, 4 = 25+) smoked per day ($M$ = 2.05, $SD$ = 1.00 for those who never started the study, $M$ = 2.00, $SD$ = .89 for those who completed the study; $t(39) = .17$, $p > .05$) and average number of years the groups had been smoking ($M$ = 4.58, $SD$ = 2.47 for those who never started the study, $M$ = 3.98, $SD$ = 2.76 for those who completed the study; $t(39) = .73$, $p > .05$). Based on the limited information available from the recruitment questionnaires, it is at least clear that smoking demographics are not related to whether or not a person started the study.

There were 10 subjects who dropped out of the study prematurely. All 10 subjects completed at least the orientation phase, allowing more detailed information to be collected than was available on the recruitment surveys. Because smoking/non-smoking conditions were counter-balanced, two subjects who dropped out completed only one phase (orientation with non-smoking condition scheduled first) while the other eight

subjects completed two phases (orientation and smoking condition with non-smoking condition scheduled last). Not surprisingly, all 10 subjects dropped out prior to or during the non-smoking condition, although one person indicated he had contracted an acute respiratory condition and that his physician had encouraged him to stop smoking. The remaining nine were unable to abstain from smoking for the required 48 hours. All subjects were given the opportunity to try the abstinence phase again if they wished, but none of the four people who tried for a second time were successful.

Comparisons between those who successfully completed the study and those who dropped out prematurely were made on mean smoking measures [self-report of amount smoked per day and number of years as a smoker, parts per million (ppm) exhaled CO after smoking a cigarette, Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) scores, and scores], mean cardiovascular data (systolic pressure, diastolic pressure, and heart rate), and mean scores on the BDI. Means, standard deviations, and independent t-test data are presented in Table 1. All tables and figures can be found in Appendix B. Similar to the group that never started the study, the group that dropped out prematurely was not significantly different on relevant measures from the group that successfully completed the study. Attrition can most likely be attributed to the nature of the study (all those who dropped out did so under the non-smoking condition), the duration of the study (the study was a repeated measures design spread across approximately 3 weeks for each subject), and the fact that subjects did not forfeit any extra credit already earned if they dropped out early (consistent with the fact that eight people dropped out before the 3rd and final phase of the study, whereas only

two people dropped out before the 2nd phase of the study). Future studies may want to use these data for predicting attrition and aiding in other decisions regarding sample size.

Additionally, demographic variables did not appear to play a factor in explaining who successfully completed the study and who did not. No significant differences were found between the average age of those who successfully completed the study ($M$ = 19.76, $SD$ = 1.48) and those who were excluded from the study ($M$ = 20.25, $SD$ = 2.38; $t(39) = .79$, $p > .05$). Subjects who dropped out of the study were similarly close in age to the successful subjects, also yielding a non-significant comparison ($M$ = 19.90, $SD$ = 1.45; $t(29) = .244$, $p > .05$). No comparisons for ethnicity were possible because this variable was not assessed during subject screening.

The 21 subjects who successfully completed the study ranged in age from 18-22 ($M$ = 19.76, $SD$ = 1.48) and were divided almost equally across gender (11 males, 10 females). None of the subjects reported any serious and/or chronic medical conditions, and only three (two females, one male) reported any immediate family history of psychological problems requiring treatment, including themselves. The first indicated that her paternal grandfather had a history of a mood (depressive) disorder. The second reported being currently treated for bipolar disorder, in addition to reporting a history of mood (depressive) disorders in her mother and a maternal uncle. The third indicated that he had been treated as a child/adolescent, but did not wish to elaborate further as to the nature of treatment or the diagnosis.

As indicated previously in Table 1, subjects reported smoking approximately 16-20 cigarettes (roughly a pack) per day for an average of 3.98 years ($SD$ = 2.76), had an average exhaled CO of 19.19 ppm ($SD$ = 7.70), and an average FTND score of 3.86 ($SD$

= 1.93). These data support assumptions of regular tobacco use and are indicative of nicotine dependence, although some scores are not as high as other samples in previous smoking research (e.g., Payne, Smith, McCracken, McSherry, & Antony, 1994; Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994). However, 15 out of 21 indicated at least one previous failed attempt to quit, and 8 out of 21 indicated they had been unsuccessful at quitting smoking within the previous six months. The present demographics are consistent with this sample's relatively young age and shorter smoking history than that found in the studies cited above.

Materials

Subjects were asked to fill out a number of paper and pencil assessments. Copies of instruments that are not copyrighted can be found in Appendix A. Assessments given included the Beck Depression Inventory (BDI; Beck et al., 1979) which is a brief (21 items) questionnaire assessing symptoms of depression. This is one of the measures used to determine possible changes in mood in smoking vs. non-smoking phases. The instrument yields an overall score that can be compared with norm samples to determine the severity of depression. Because high scores have been correlated with major depression and because question #9 asks about suicidal thoughts, all subjects who participated were given referral information to the in-house Psychological Services Center and other community mental health services. This was done to prevent any one subject from being singled out (and unnecessarily embarrassed) during the study, and because no measures were examined/scored until after the subject had completed the study to minimize experimenter bias. The BDI has been used in numerous studies

involving college students and has been empirically shown to be a reliable and valid measure of depressive symptomology. BDIs were administered to each subject a total of three times, once per session.

The Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971) was utilized as another measure of emotion, but as a measure of mood just for that day compared to that day including the previous week for the BDI. The POMS yields scores across several subscales, namely: Depression-Dejection, Fatigue, Vigor, Confusion-Bewilderment, Anger-Hostility, and Tension-Anxiety. Each subscale is derived from 7-15 non-overlapping items. The POMS is a 65-item assessment asking subjects to rate descriptive emotional words (e.g., friendly, tense, angry, worn out, etc.) on a 0-4 rating scale, ranging from 0 = "not at all" to 4 = "extremely." Like the BDI, the POMS has show acceptable levels of reliability and validity in assessing emotions in several populations, including clinical and non-clinical samples.

Also given was the Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991), which is a self-report measure of tobacco dependence. The FTND assesses details of a person's smoking behavior, such as number of cigarettes smoked daily and how soon a person smokes after they wake up in the morning. The instrument was derived from numerous empirical studies of nicotine dependence and withdrawal, and has been shown to be a reliable and valid measure when used as for these purposes. Smokers who are nicotine dependent typically score in the 6 ±2 range according to the literature (e.g., Payne et al., 1994; Pomerleau et al., 1994). The FTND was administered once at the beginning of the study.

The Tobacco Withdrawal Symptom Checklist (WSC; Hughes & Hatsukami, 1986) was used to measure self-report withdrawal symptoms during the experimental phases. The WSC is a 12-item survey assessing symptoms of nicotine withdrawal and the severity of each symptom on a 0-3 Likert-type scale, ranging from 0 = "not present" to 3 = "severe." There is also room at the end of the survey to report additional somatic difficulties. The items on the WSC overlap greatly with symptoms given in the DSM-IV (APA, 1994) for nicotine withdrawal.

Instruments designed especially for this study included Leisure Activity Rankings Scales, which asked subjects to rank all the activities they performed (from highest to lowest) for dimensions of enjoyment and perceived effort. A second study-specific self-report measure was the Leisure Activities Ratings Scales, which instructed subjects to indicate their perceived levels of enjoyment, effort, and efficacy (how well they think they performed on the activity given the amount of time they had) on a seven-point Likert-type scale, ranging from one (lowest enjoyment, effort, or efficacy) to seven (highest enjoyment, effort, or efficacy). These ratings were used to determine which activities were used in experimental sessions 2 and 3 based on a set of decision rules. These rules specified that the activities used must both be initially rated greater than or equal to a four on the enjoyment rating scale, and separated by at least two points on the effort rating scale. If there were no activities that met both criteria, then the rankings were used to find two activities, which fit these criteria. Ratings were seen as preferable over rankings because they were assessed immediately after each activity, whereas rankings were completed after all activities had been performed and asked subjects to compare/contrast effort and enjoyment relative to all activities. Also assessed were subjects self-reported

skill levels for each of the activities in question, rated across the categories of novice, intermediate, advanced, or expert.

Physiological measures taken included a measure of exhaled ppm Carbon Monoxide (CO) in the lungs, using a Vitalograph, Inc. Model 29.700 Breath-CO monitor that required subjects to exhale through a disposable mouthpiece into the monitor. The CO monitor is a hand-held device that can conveniently and accurately determine if subjects have CO levels indicative of having smoked cigarettes or not. The CO monitor is accurate within ±2 ppm CO, and has been used in previous smoking research (e.g., Martin, Prue, Collins, & Thames, 1981) using cutoffs of ≥12 ppm for people who report smoking regularly, and <10 ppm for those who are not regular smokers or for regular smokers who have not smoked within the past several hours. CO levels were recorded on the Data Recording Sheet.

The other physiological data included measures of systolic and diastolic blood pressure as well as heart rate. Nicotine is known to directly affect the cardiovascular system, and changes in blood pressure (particularly diastolic pressure) and heart rate can be used as evidence of withdrawal and indirect measures of changes in blood nicotine levels (USDHHS, 1988). Blood pressure and heart rate were assessed using an IBS Corp. Model SD-700A Blood Pressure/Pulse Monitor, a self-inflating blood pressure machine that gives digital systolic and diastolic pressure in mmHG as well as an estimate of heart rate beats per minute (bpm) using pulse rate.

The experimenter and/or trained lab assistants also observed performance on each of the leisure activities. Subjects were required to record their score for each game on a sheet of paper for the three computer tasks, and the experimenter tallied the number of

correct responses relative to the total number of possible responses for the other four tasks. The total time spent on an activity as well as a progress percentage score were recorded on the Data Recording Sheet.

## Procedure

The study consisted of a total of three 1-hour sessions. The first session was used to obtain informed consent, gather baseline data, and practice using assessments and performing leisure activities to be used later in the study, and served primarily as an introduction/orientation to the study. Sessions 2 and 3 were the experimental sessions and were identical in that they both consisted of gathering needed measures, having the subjects perform an activity, rating that activity, perform a second activity, and then rating the second activity. The 2nd and 3rd sessions differed, however, in the smoking status of the subject. One session was performed under each subject's normal level of cigarette smoking outside the laboratory, with subjects smoking one cigarette at the beginning of the session. The other session was performed after each subject had abstained from smoking for 48 consecutive hours. Each subject was studied under both smoking and non-smoking conditions. Each session was approximately one week apart to reduce the likelihood of practice effects as well as possible contamination across smoking measures, which could be caused by anticipatory withdrawal. A detailed description of what took place in each session, what measures were gathered, and specific predictions for the study are presented below.

Session 1

A copy of the consent form can be found in Appendix C. After the consent form had been discussed, read, and signed, the initial measures were explained and taken. These included a CO measure via breath exhaled into the Breath-CO monitor after smoking a single cigarette, the FTND, the WSC, the BDI, and the POMS. Blood pressure and heart rate were then measured (this was done after approximately 15-20 minutes of sitting while filling out the paper-and-pencil measures, and after the subjects had arrived at the lab and given their CO sample).

The subjects were then introduced to seven different leisure activities and asked to perform each for approximately 5 minutes. The first activity was a word search, which required the subject to locate and circle a set of key words hidden among nonsense letters. The second activity was the computer game "Minesweeper," which involves finding and tagging imaginary mines with a computer mouse as quickly as possible using reasoning skills and clues provided by the game. The third activity was the construction of small, three-dimensional, Lego block structures from a set of printed steps and instructions given to the subjects. The fourth activity was computer "Poker," which is a simulation of five-card draw poker requiring subjects to indicate with a computer mouse which cards to keep, which to discard, when to deal, and how many computer points to bet on any given hand. The fifth activity was working on a jigsaw puzzle, requiring subjects to place as many pieces in their correct places as quickly as they could given a set of pieces sorted by colors and a partially completed puzzle (i.e., the edges and approximately 5/6 of the total puzzle was completed, leaving the lower right corner for subjects to complete). The sixth activity was a computer simulation of the card game "Solitaire," which consists of turning

cards over and moving them from pile to pile with a computer mouse with the objective of placing as many cards as possible in numerical order and based on card suits. The seventh activity was a set of crossword puzzles, which required the subject to fill in a set of overlapping empty boxes with letters of key words based on clues given for each of the "across" and "down" words. Standard instructions were used for the computer activities (these were the tasks that subjects had the least understanding/experience with as a whole) and can be found in Appendix D.

After each activity, subjects rated how much they enjoyed the activity, how much effort they felt the activity required, and how efficacious they think they were on the activity using the simple seven-point Likert-type ratings scales mentioned in the 'Materials' section. When all seven activities had been completed, subjects were then asked to create a numerical ranking of all of the activities based on how much overall effort and enjoyment were involved relative to the other activities.

Appointments for sessions 2 and 3 were then made for approximately the same times on the same days of the upcoming two weeks. Subjects were told 48 hours in advance which condition, smoking or non-smoking, they would be in for each session. Because subjects were voluntarily abstaining from smoking (vs. actually quitting smoking), and because it was advantageous to run subjects on the same day/time for each session, no subjects were asked to abstain over the course of a Friday evening or a Saturday (prime smoking time for college students based on their reports). Similarly, because of previous experiences scheduling subjects on Friday afternoons and unusually high "no-show" rates in our lab, no subjects were run on Fridays, effectively limiting study days to Tuesdays, Wednesdays, and Thursdays.

Smoking conditions were assigned based on counter-balanced ordering of subjects (with initial randomization for the first subject) to help eliminate possible order effects. Again, the smoking condition was defined by each subject's normal level of cigarette smoking outside the lab, with subjects smoking one cigarette at the beginning of the session. Subjects were reminded ahead of time to bring their cigarettes and lighters, told where they could smoke, and were asked to "smoke the cigarette as you normally would, taking as long as you normally would." The non-smoking condition took place after subjects were told to abstain from smoking for 48 consecutive hours, verified via CO measures and self-report (subjects were asked an open-ended question about how things went during the 48-hour abstinence period, then asked specifically if they had smoked at all if they hadn't already addressed this).

Sessions 2 & 3

The second and third sessions began by gathering CO, WSC, BDI, POMS, and cardiovascular measures. Subjects then performed the first of their two designated activities. Determining which activity came first (the "high" or "low" effort task obtained from session 1) was done in a counter-balanced fashion (with initial randomization for the first subject) to prevent order effects. The first activity was performed for a required minimum of 10 minutes, followed by a 15-minute "choice" period in which subjects could continue with the activity or sit quietly and relax. As soon as a total of 25 minutes had passed, ratings of how enjoyable the activity was, how much effort was required, and how well they feel they performed were taken. The total time actually spent on the activity was recorded, as was a measure of performance. The performance measure

varied depending on the activities used, but was converted to either a percentage correct score (the number of correct responses or divided the total number of responses; as with crossword puzzles, word searches, jigsaw puzzles, Minesweeper, and Lego blocks) or a percentage progress score (final score divided by beginning amount; as in computer Solitaire and Poker).

Leisure Activity Descriptives

Table 2 shows the mean ratings for each of the seven leisure activities across the dimensions of beginning skill level, enjoyment, effort, and efficacy. Each activity was rated on a 1-7 Likert-type rating scale after it was initially sampled during the study orientation phase (session 1). These initial ratings were used to determine which tasks would qualify as "high" and "low" effort tasks in the experimental phases of the study.

As was anticipated, the activities chosen as "high" and "low" effort tasks for each subject did not differ significantly on any dimension except effort. Furthermore, both "high" and "low" effort tasks were initially rated as relatively high on enjoyment (both tasks rated approximately a 5 on a 1-7 Likert-type scale). Table 4 presents the comparisons between tasks for each rating dimension. The decision rules used to choose tasks for each subject therefore accomplished their intended goal.

Experimental Design and Analyses

The design of the study is primarily a repeated measures 2 x 2 MANOVA, with two levels (smoking vs. non-smoking phases) of the within subjects independent variable (IV) "smoking condition," and two levels ("high" and "low" effort) of the within subjects

IV "activity type." Dependent variables (DVs) were grouped according to whether they are subjective (self-reports) vs. objective (experimenter-observed and behavior-based) and separate MANOVAs were computed for each.

Three primary types of analyses were performed to test the hypotheses described above. For hypothesis (1), separate paired-samples t-tests were computed to verify changes in WSC, BDI, POMS, blood pressure, heart rate, and CO scores indicative of abstinence and withdrawal from nicotine. These analyses served primarily as manipulation checks to insure subjects were indeed experiencing nicotine withdrawal. Hypothesis (2a) was analyzed with a 2 X 2 repeated measures MANOVA using subjective measures (self-reported enjoyment, effort, and efficacy) as the collective DV. Main effects as well as their interaction were tested. Follow-up 2 X 2 repeated measures ANOVAs were computed as necessary for each individual DV. Hypothesis (2b) was also tested using a 2 X 2 repeated-measures MANOVA, except that objective measures (total time spent and activity performance) were used as the primary DV. As before, main effects and their interaction were examined, and follow-up 2 X 2 repeated measures ANOVAs performed as needed. Hypothesis (3) was examined by generating a correlation matrix of the following variables: WSC difference scores, BDI difference scores, self-reported enjoyment, self-reported effort, self-reported efficacy, total time spent engaging in the activity, and objective overall performance (percent correct or points per game).

# Results

For hypothesis (1), one-tailed t-tests for paired samples were conducted. All manipulation checks for experimental phases of the study (smoking vs. non-smoking conditions) were significant in the direction predicted. In the non-smoking condition subjects reported experiencing greater withdrawal symptoms as measured by the WSC, had much lower exhaled CO levels, and showed cardiovascular changes (decreased diastolic or "state" blood pressure and decreased heart rate) compared to their smoking condition, consistent with abstinence from smoking and lower blood nicotine levels (USDHHS, 1988). Comparisons based on smoking variables are presented in Table 5. All tables and figures are contained in Appendix C.

Similarly, subjects reported negative changes in mood during the non-smoking condition relative to their mood when allowed to smoke as predicted. However, significant differences were only seen for BDI scores [$t(20) = -2.43$, $p$ (one-tailed) = .01] and POMS Tension-Anxiety subscale scores [$t(20) = -2.94$, $p$ (one-tailed) = .00]. All other POMS subscale comparisons were non-significant using one-tailed $t$-tests [Depression-Dejection, $t(20) = .54$, $p > .05$; Fatigue, $t(20) = .68$, $p > .05$; Vigor, $t(20) = .06$, $p > .05$; Confusion-Bewilderment, $t(20) = -1.14$, $p > .05$; Anger-Hostility, $t(20) = -1.12$, $p > .05$], although the Confusion-Bewilderment and Anger-Hostility subscale scores were in the predicted direction. It was surprising to see that the Depression-Dejection and Fatigue subscales were not only non-significant, but were in the opposite direction from what was originally predicted. Figure 1 illustrates BDI and POMS subscale differences for smoking and non-smoking conditions.

For hypothesis (2a), a 2 X 2 repeated measures MANOVA was computed to compare differences between experimental smoking conditions (smoking vs. non-smoking), between activities ("high" and "low" effort tasks), and their interaction. Ratings for each activity of perceived enjoyment, effort, and efficacy served as the collective dependent variable. Analysis yielded a significant main effect for activity [$F(3, 18) = 8.95$, $p = .00$], but neither smoking condition [$F(3, 18) = 2.37$, $p = .11$] nor the interaction between activity and smoking condition [$F(3, 18) = .24$, $p = .87$] were significant.

Follow-up univariate analyses (2 X 2 repeated measures ANOVAs) were conducted for each DV separately to see more specifically how smoking condition and activity type might affect subjective ratings. The ANOVA for enjoyment demonstrated a significant main effect for smoking condition [$F(1, 20) = 6.19$, $p = .02$] but not activity [$F(1, 20) = .33$, $p = .57$] or the condition by activity interaction [$F(1, 20) = .35$, $p = .56$]. Subjects in the non-smoking condition reported significantly decreased enjoyment of both "high" and "low" effort tasks compared to their perceptions and reports during the smoking condition. With regards to the ANOVA for effort, a significant main effect was found for activity [$F(1, 20) = 21.15$, $p = .00$] but the main effect for smoking condition [$F(1, 20) = 3.02$, $p = .10$] and the condition by activity interaction [$F(1, 20) = .21$, $p = .65$] were non-significant. The ANOVA for efficacy was the weakest of the three, with the main effects [$F(1, 20) = .39$, $p = .54$ for activity; $F(1, 20) = 1.26$, $p = .28$ for condition] and the interaction [$F(1, 20) = .42$, $p = .52$] all non-significant. Figures 2 and 3 illustrate the changes in mean enjoyment and effort ratings for both "high" and "low" effort tasks across smoking conditions, along with the obvious lack of any kind of interaction. The

decrease in enjoyment and the increase in effort are consistent with the significant changes in mood reported earlier.

For hypothesis (2b), another 2 X 2 repeated measures MANOVA was computed, with objective/behavioral measures of activity performance and efficiency serving as the collective dependent variable. Performance was defined as percent progress (e.g., someone who correctly completed half of the jigsaw received a 50% score, someone who doubled their money in poker scored 200%, etc.) and efficiency was defined as the amount of progress per minute.

Efficiency was used in lieu of total time spent on the activity for two reasons. First, there were four subjects who completely finished the Legos (100% performance) in less than the 25 minutes maximum time. Clearly these subjects were different from those who simply stopped performing an activity during the 15-minute choice period – preferring instead to "sit quietly and relax." But without considering the relationship between total score and total time spent with an activity, the two subgroups could not be differentiated. Second, it became apparent over the course of the data collection that 25 minutes was not a long enough interval to cause most people to stop. At the same time the relatively high attrition rate was starting to unfold, leaving the experimenter with a practical and methodological dilemma.

The MANOVA yielded no significant main effects or interactions. For smoking condition, $F(2, 19) = .60$, $p = .56$. Activity as a main effect was similarly weak, producing values of $F(2, 19) = 1.60$, $p = .23$. The outcome of the condition by activity interaction was $F(2, 19) = .90$, $p = .43$. An exploratory univariate 2 X 2 repeated measures ANOVA was performed using total time spent on the activity as the dependent

variable, with the four subjects who completely finished the Legos early excluded from analysis so that shorter times would mean the same for all remaining subjects (i.e., they stopped the activity prematurely and sat quietly). However, like the MANOVA for behavioral measures, no significance was found for the main effects of smoking condition [$F(1, 16) = .86$, $p = .37$], activity [$F(1, 16) = 1.93$, $p = .18$] or their interaction [$F(1, 16) = .50$, $p = .49$]. When taken together, the results of the MANOVAs suggest that while a person's perceptions of activities may change along dimensions of enjoyment and/or effort during nicotine withdrawal, this does not necessarily translate behaviorally into decreases in engagement and/or performance.

This interpretation is further supported by results based on hypothesis (3). Correlation matrices were created to determine if negative changes in mood along with increases in withdrawal symptoms (specifically, changes in BDI scores, POMS Tension-Anxiety and Anger-Hostility subscale scores, and WSC scores) were related to decreases in perceived enjoyment, increases in perceived effort, and/or decreases in task efficiency. A separate matrix was created for "high" and "low" effort tasks. None of the objective measures of activity performance were included in further analyses based on the non-significant results found in the MANOVAs above. For each variable, change scores were computed by taking the difference between smoking and non-smoking conditions. Where increases were predicted (BDI scores, WSC scores, effort ratings, and POMS subscale scores) across smoking and non-smoking conditions, the smoking data were subtracted from the non-smoking data to yield a positive difference score. Where decreases were predicted (enjoyment ratings and efficiency score), the non-smoking data were subtracted from the smoking data to yield a difference positive score. Mathematically, it is the

absolute value (magnitude) that is critical for change scores, the order of subtraction in this study was altered merely for convenience and ease of interpreting resulting correlations based on the directional hypotheses.

Pearson r correlation coefficients and their respective one-tailed p values are presented in Table 6 for the "high" effort tasks. Of particular interest are the significant correlations between changes in perceived enjoyment and perceived effort ($r = .44$, $p = .02$) and between changes in perceived enjoyment and in POMS Anger-Hostility scores ($r = .37$, $p = .05$). Changes in perceived effort were also significantly correlated with changes in POMS Tension-Anxiety scores ($r = .37$, $p = .05$) as well as changes in WSC scores ($r = .37$, $p = .05$). The similarity in correlation coefficients is purely coincidental and due in part to rounding coefficients and actual p values to two decimal places. Other significant correlations are indicative of the internal reliability and/or construct validity of the measures in question.

Table 7 presents the Pearson r correlation coefficients and their respective one-tailed p values for the "low" effort tasks. The relationships between changes in perception, mood, and behavior were much less robust overall, yielding only one noteworthy significant correlation between change in perceived enjoyment and change in efficiency ($r = .39$, $p = .04$). As above, other significant correlations are the expected relationships due to consistency/overlap between and within measures.

Based on these relationships and trends, exploratory stepwise multiple regression analyses were performed for high and low effort activity types to see if differences in enjoyment could be predicted from differences in mood, withdrawal, efficiency, and effort: and/or if changes in effort could be predicted from changes in mood, withdrawal,

efficiency, and enjoyment. However, simple change scores were not used in the regression analyses. Instead, predictors from the smoking session were entered in the first block of variables, and predictors from the non-smoking session were then allowed to enter in a stepwise fashion in the second block, effectively covarying smoking scores out from non-smoking scores to gain a clearer picture of predictor variables. Covaried measures included enjoyment, effort, efficiency, BDI, WSC, and POMS anger/hostility and tension/anxiety subscale scores from the smoking and non-smoking sessions.

A total of four regression equations were calculated, one for each combination of activity (high and low effort) with the two criterion variables (changes in effort and enjoyment). Because of the modest correlations reported above and the relatively small sample size, the alpha level for a variable to enter the regression model was relaxed to .10 to reduce any Type II errors. This necessarily runs the risk of increasing Type I error, but with the majority of the relevant correlation coefficients all being in the predicted direction and statistically significant or approaching significance the risk is relatively low. An overall alpha of .05 was kept in place for rejecting the null hypothesis with respect to F Change scores in the final regression models, so that any model that met significance would also account for a substantial portion of unique variance in the criterion measures. This would also imply that standardized beta weights of predictors would be relatively large and thus more meaningful in a behavioral context.

The regression predicting perceived effort for the high effort task in the non-smoking condition did not produce a significant F change score for block 2, despite POMS tension/anxiety scores entering as a significant predictor under the relaxed alpha ($\beta = .42$, $t = 1.93$, $p < .10$), indicating little unique variance added by non-smoking

variables [$R^2$ Change = .14, $F(1, 13) = 3.73$, $p > .05$]. This was due in part to the fact that even forced entry of the variables in block 1 did not produce a significant regression equation [$R = .62$, $R^2 = .39$, $F(6, 14) = 1.49$, $p > .05$], along with the fact that the final model was non-significant overall as well [$R = .73$, $R^2 = .53$, $F(7, 13) = 2.01$, $p > .05$].

Predicting perceived enjoyment for the high effort task in the non-smoking condition also yielded a non-significant regression equation [$R = .60$, $R^2 = .36$, $F(6, 14) = 1.29$, $p > .05$]. The F change score for block 2 was not calculated because none of the predictors in block 2 met the inclusion criteria. Again, this suggests that predictors were weak overall, and non-smoking predictors in particular did not add a significant amount of unique variance above and beyond smoking measures.

The regression predicting perceived effort for the low effort task in the non-smoking condition produced a significant F Change score [$R^2$ Change = .25, $F(1, 13) = 4.84$, $p < .05$] when efficiency in the non-smoking session ($\beta = .58$, $t = 2.20$, $p < .10$) entered the equation. However, the lack of a significant overall regression model [$R = .58$, $R^2 = .33$, $F(7, 13) = 1.29$, $p > .05$] makes interpretation of the statistical and behavioral significance of the efficiency predictor difficult at best. By itself, the beta weight suggests that as efficiency with the low effort task in the non-smoking session increases, so does perceived effort when variance accounted for by efficiency for the same task under the smoking condition is statistically removed.

Similarly, a significant F Change score [$R^2$ Change = .31, $F(1, 13) = 8.62$, $p < .05$] was seen when efficiency in the non-smoking condition entered in block 2 as a significant predictor ($\beta = .70$, $t = 2.94$, $p < .10$) of perceived enjoyment of the low effort task in the non-smoking condition. However, the overall model was again non-significant [$R = .73$,

$\underline{R}^2 = .54$, $\underline{F}(7, 13) = 2.15$, $\underline{p} > .05$]. The relatively large beta weight would suggest that as efficiency in the non-smoking condition for the low effort task increases, so does perceived enjoyment. This finding is somewhat intuitive (the better you do at a task the more enjoyable it seems), but again means little and is difficult to interpret in light of the weakness of other predictors and the lack of significant overall regression equations.

# Discussion

## Review of Present Study and Findings

The primary purpose of this study was to examine the impact of nicotine withdrawal and related changes in mood on perceptions of and engagement in leisure activities; in particular, those leisure activities previously reported by subjects to be similar in enjoyment but different in effort. Effort was hypothesized to be a key variable in the study, consistent with using terms and concepts from a behavioral economics perspective (e.g., Bickel, DeGrandpre, & Higgins, 1993; Bickel, Green, & Vuchinich, 1995, Vuchnich & Tucker, 1988) to test and ideally expand Klinger's (1993) loss of interest model of depression. Specifically, the concept of Unit Price (UP), or the ratio between cost and benefit, was applied to a laboratory simulation of the loss of interest model. Keeping benefit (comprised of reinforcer magnitude and reinforcer probability) constant, an attempt was made to manipulate cost (specifically the response cost or "effort" while keeping the other aspect of cost, response requirement, constant) under both smoking and non-smoking conditions. Contrary to Klinger's assertion that all enjoyable activities lose their effectiveness as reinforcers, it was predicted that nicotine withdrawal, subsequent depressive mood changes, and the perceived effort of a task would all interact to cause significant decreases in enjoyment and performance, especially in the non-smoking, high effort activity condition.

In order to pursue this global hypothesis, it was first necessary to demonstrate that three basic assumptions of the study were valid. First, a sample of subjects who were regular smokers had to experience nicotine withdrawal. This was effectively accomplished by recruiting nicotine dependent (as measured by the FTND and exhaled

CO) undergraduate psychology students who reported smoking more than half of a pack of cigarettes per day and offering them token incentives for voluntary participation. Self-report measures of nicotine withdrawal and physiological measures of exhaled CO, blood pressure, and heart rate all changed significantly in the predicted directions, verifying that a state of nicotine withdrawal was at least partially induced. Furthermore, It was demonstrated that those who volunteered did not differ significantly from those who were excluded from or dropped out of the study on relevant smoking and mood measures.

Second, the subjects as a group needed to experience negative changes in mood relative to the nicotine withdrawal. The was verified through significant increases in BDI scores and POMS Tension-Anxiety subscale scores. The POMS Confusion-Bewilderment and Anger-Hostility showed non-significant increases in the predicted direction, and when one subject who had unusually high POMS data in the smoking condition was excluded from exploratory re-analysis, these scales also demonstrated significance at or below the $p < .05$ level. Potential discordance was seen between the BDI and the POMS subscales believed to tap into similar depressive symptomology, specifically Depression-Dejection and Fatigue. This could be a result of the different time frame subjects were asked to think about when responding ("today" for the POMS and "today including the past week" for the BDI), reduced reliability for the POMS subscales due to fewer items (as few as seven items per subscale in some cases), or a combination of the two.

Third, subjects had to engage in activities that varied significantly on the dimension of effort but not enjoyment. This was accomplished by using feedback from the subjects during an orientation/introduction to the study to operationally define two

activities which were both relatively enjoyable (greater than or equal to 4 on a 1-7 Likert-type rating scale) but differentiated along the dimension of effort (at least 2 points apart on a 1-7 Likert-type rating scale). For the five subjects who did not demonstrate enough "spread" in their activity ratings, rank-ordering of activities for effort and enjoyment were used to find the two activities, and significant differences were still observed between initial ratings of effort for the activities eventually used as high and low effort activities in the experimental sessions.

Establishing these three premises was critical to the amount of certainty one could have in subsequent results and analyses. Once these assumptions had been met, relationships between the variables could be tested and clearer conclusions drawn about the role perceived effort plays in perceptions and behaviors and any changes that take place during nicotine withdrawal and negative mood states. Analyses using behavioral measures of engagement (performance, efficiency, and total time) were surprisingly non-significant. Possible explanations for this are given below in the discussion of the study's limitations. However, analyses using self-report data were significant for at least one main effect (either smoking condition or activity type), but no interaction was seen.

These data seem to primarily support Klinger's view of decreased enjoyment despite levels of effort at first glance. However, absence of evidence is not evidence of absence, and methodological weaknesses may account for the lack of significant interactions and poor predictability in the follow-up correlations and regressions. Thus, this study should not be seen as empirical support for Klinger's model, but rather a first (and unfortunately a partially failed) attempt at testing his model in a laboratory setting with a novel experimental methodology.

Strengths, Weaknesses, and Implications

Critical to the final interpretation of the data and this study's overall utility is an examination of the study's relative strengths and weaknesses. The strengths lie primarily in the way the study was designed. Using a repeated measures design reduced variability and increased statistical power. The design was also truly experimental and a relatively high amount of control was achieved by studying the phenomena in question in a laboratory setting. These factors make for a relatively clean and simple design and allow causal statements to be made about significant MANOVA relationships.

The study also utilized procedures that accommodated individual differences within a design aimed at studying group differences. Specifically, while subjects as a whole were studied under smoking and non-smoking conditions using high and low effort tasks, the tasks themselves were tailored to each individual's subjective appraisal of the activities. This is believed to be essential in order to tap into something equally as subjective as a person's enjoyment and perceived effort of different leisure activities. Imagine the difficulties testing the same hypotheses if, for example, the experimenter had decided to use computer poker as the high effort task and crossword puzzles as the low effort task for each subjects – remember that no one in this sample enjoyed the crossword puzzles enough to qualify for a low (or high, for that matter) effort task, nor did anyone initially rate the poker high enough on enjoyment/effort to qualify as a high effort task. Only by assessing these individual differences up front and adapting the study's procedures to a person's preferences and opinions would the study have the best chance of actually testing the relevant variables as opposed to confounding ones.

As mentioned above, a priori assumptions were demonstrated to be accurate, which is also a strength of the study. Given the population this sample was drawn from (young, relatively intelligent and capable college students), it was pleasantly surprising to see that the manipulation checks were consistent with those found in older, more depressed and/or more nicotine dependent samples (e.g., Payne et al., 1994; Pomerleau et al., 1994). This has implications on whether or not findings might generalize or be able to be replicated using a slightly different sample.

Similarly, while the overall attrition rate was discouraging (roughly 50% not counting those excluded for medical reasons), the data collected on those who dropped out of the study for various reasons and comparisons with the final study sample were encouraging. The comparisons suggest that the sample who completed the study were not potentially able to do so because they smoked significantly less per day and/or had smoked for significantly fewer years (implying decreased dependence on nicotine), or because they were significantly less depressed than those who dropped out. Subjects dropped out, quite frankly, because they were asked to stop smoking for 48 hours and were unable/unwilling to do so. Although incentives were in place to promote completion of the study, they were tokens at best. It was believed based on basic behavioral theory (e.g., Premack, 1959; Skinner, 1938; Thorndike, 1932) and previous experiences in our lab that a token incentive would be better than nothing. On the other hand, an incentive which was too high could cause subjects to distort data (particularly self-report data) in such a way as to increase probability of inclusion in the study (e.g., when we paid every subject $75 for participation in a previous grant-funded study, we had one potential subject indicate she was a "regular smoker" only to show up to the lab

smoking clove cigarettes and blowing a very low CO). If there had been differences between the two groups, any conclusions made would be limited to samples even more narrow and specific as this one (i.e., smokers who are likely to volunteer and be successful at completing studies).

Finally, the study made use of multiple measures, both subjective and objective, to test the hypotheses. Using multiple measures to assess and verify data is critical to sound experimental design (e.g., Barlow, Hayes, & Nelson, 1984), and thus was a methodological goal of this study. The combination of self-report measures, behavioral observation, and physiological data used were believed to be the best possible balance between functionality and practicality. Relying on multiple measures required more statistical tests (and thus increased the chances of a Type I error) but allowed further explanation and exploration of what took place during the study, which was critical given that the study was relatively unique in application and design.

Ironically, the design of the study also led to the majority of the limitations discovered over the course of the data collection. The biggest weakness had to do with the procedures that engaged subjects in the activities. Specifically, instead of having subjects perform high and low effort activities for equal amounts of time in the non-smoking condition, it would have been ideal to let the subjects choose which activities they wanted to do for a given period of time. The way the study was conducted, subjects were inadvertently given a choice between something relatively enjoyable and variable effort (the activities) and something presumably not very enjoyable and little or no effort (sitting quietly and "relaxing" in the laboratory). The fact that very few subjects stopped performing the activities prior to the 25 minute time limit speaks to this flaw. It would

not have been practical to extend the time spent on each activity from 25 minutes to an hour, for example, to see if subjects would voluntarily disengage from them. But it could have been highly beneficial to take the time that was already set aside for both activities (approximately an hour total) and let the subjects decide between the high and low effort activities, tracking time spent on each as well as efficiency and all the subjective variables (enjoyment, effort, and efficacy).

Similarly, although the activities themselves showed a significant difference in perceived effort, it is not clear if this difference is meaningful in a broader sense. Subjects were told in the standard instructions to consider amount of physical movement, skills required, and level of difficulty when estimating the effort of a given task on the 1-7 Likert-type rating scale. However, allowing subjects to demonstrate via choice behavior which task they preferred to perform as outlined above would have provide a valuable operational definition of the potential impact of effort, especially if the enjoyment ratings stayed relatively consistent, instead of the numerical estimate which was obtained in the study as it was conducted.

Another potential weakness related to the difference between statistical significance and significance in a broader, behavioral realm is found with the negative mood changes. One could argue that although BDI scores increased significantly during the non-smoking condition, this increase did not represent a clinically significant change. Anecdotally, it was directly observed that most if not all subjects were more edgy, more anxious to finish the session, and generally impatient during the non-smoking phase, supporting the notion that although the mood changes as measured by the BDI and POMS may not have been elevated in clinical ranges, they still represented both statistical and

clinically significant changes. The utility of a dimensional model seems to be supported by the present data, as very few subjects had BDI scores in a clinical range at baseline – meaning that if they had been in a smoking cessation program that used the BDI, their negative mood change might not have been seen as clinically significant because it did not reach a certain cutoff. Nevertheless, using a clinically depressed sample would most likely demonstrate more robust effects than those found in the present sample, who overall experienced minor depressive symptomology as a direct result of nicotine withdrawal and not an existing mood disorder.

An additional limitation can be found in the methods used to assess nicotine withdrawal. The present study relied on self-report data and exhaled CO as indicators of nicotine withdrawal. It is possible that subjects could have obtained nicotine through various methods (e.g., over-the-counter nicotine gum and transdermal patches; smokeless tobacco) and simply feigned withdrawal on the self-report measures. As mentioned above, direct observation of subject behavior does not suggest this was the case. Also, the short half-life of nicotine and the fact that absorption through the skin or mouth of nicotine takes much longer than inhaling through the lungs (USDHHS, 1988) make it reasonable to assume with a high degree of confidence that at the very least subjects experienced withdrawal as a function of not smoking as much as they normally do and/or not receiving the same amount of nicotine in the fashion they were accustomed to. A biological marker of nicotine (e.g., in the blood or saliva) would be needed to insure that subjects were 100% abstinent as their reports and CO levels suggested. It is unfortunate that such measures were not feasible for the present study, as this would have eliminated any doubts. However, it should be mentioned that CO is being used as a measure of

abstinence in smoking cessation research conducted by top clinical researchers in the area of behavioral economics (S.T. Higgins, personal communication, March 18, 1999), and therefore appears to have some credibility among authorities in the field as an abstinence outcome measure.

Finally, although a sample size of 21 yielded adequate statistical power overall, it was still small enough that special considerations had to be made when considering alpha levels of statistical tests and Type I/Type II errors. Directional hypotheses helped, but even so there were more 20 statistical procedures performed in the present study; and using an overall alpha of .05 with that many tests virtually guarantees that at least one of tests may have capitalized on chance in reaching significance. A larger sample would have been helpful, but at the same time was not practical for the present study, especially given the time frame for the study (three to five hours per subject spread out over approximately three weeks) and the high attrition rate. This is where having an older, more dependent, more depressed sample could have made a big difference in terms of effect sizes and individual p levels for each test.

## Directions for Future Research

This study could be seen as a good pilot for future studies that incorporate and address many if not all of the suggestions and criticism given above. It could be expanded in several areas, including using various samples. It might be interesting to see how a group of subjects who are actually quitting smoking compares to this sample, which was merely asked to stop smoking for 48 consecutive hours. This might

approximate the loss of interest model more closely, because cigarette smoking would then truly be a "lost object" instead of a one that was temporarily suspended.

Similarly, using an older sample that smokes more per day and has smoked longer might help tease apart legitimate effects from artifacts and marginal relationships. This could also hold true for a sample of clinically depressed and/or anxious patients. An inpatient sample would also allow for better control/observation of abstinence from nicotine, especially if a biological marker of nicotine in the saliva or blood is not used.

Finding activities with better spread among effort ratings would also be beneficial to more closely simulate "high" and "low" effort. Allowing subjects to choose between activities during the non-smoking condition would also be an improvement as mentioned above, as you would have a true behavioral measure of choice/preference between high and low effort instead of a measure of choice between something and nothing. In the pursuit of control and keeping enjoyment constant, the situation created was unnecessarily artificial and forced a choice between things of differing effort and enjoyment. During nicotine withdrawal, it seems highly likely that performing a leisure activity vs. doing nothing would be preferred for several reasons, most notably the mood-enhancing and anxiety-reducing effects of doing something fun.

This study is not so much definitive proof of Klinger's model as it is proof that effort and enjoyment are both critical to choice behavior. Predicted interactions were not found, but significant correlations were – and in the process a serious design limitation was identified that, if corrected, would allow Klinger's model to be put to a better test and likely prove the utility of behavioral economics as a way to account for "anomalies" such as substance use that the loss of interest model does not address. Replication of

significant effects and tighter methodology to corroborate non-significant effects and relationships in the current study are needed before final conclusions about the utility of behavioral economics principles in combination with Klinger's work are reached. It is hoped that this study serves as the first of many programmatic studies for the experimenter, and that legitimate effects can be uncovered which might ultimately improve smoking cessation interventions and assessments.

By being able to identify what if any role perceived effort and enjoyment have on leisure activities that a person might engage in when trying to quit, cut down, or simply pass time when a craving for a cigarette arises, an individual could prepare a list of activities ahead of time to increase their chances of success. This might be because the activity in question requires little if any effort but would be high in enjoyment that it would still be performed and enjoyed.

Conversely, the activity could be performed more frequently if it was enjoyable and high effort if the person saw the effort as a challenge (and not overwhelmingly demanding) and a way to distract from nicotine craving and withdrawal. It seems plausible that once methodological limitations are addressed, one might find that a person's perceived efficacy could dictate whether an effortful task is fun or not.

Although the present data do not help answer this question as was originally hoped, what they do tell us is that doing something active and enjoyable was preferred over doing something passive and likely not that enjoyable in a lab environment (sitting quietly and relaxing). Only further research and refinement of these and similar methods used will help address the questions put forth here, and if nothing else this project demonstrates the complexities of studying human choice behavior. It is hoped that this

study serves as an important initial step towards a better understanding of why some people turn to chemicals when they feel depressed vs. turning to something more healthy/rewarding but potentially more demanding, and will help lead to the development of better methods to assess this and similar phenomena.

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# Appendix A

# Research Questionnaire

Please Print Clearly **(All information will remain confidential)**

Name: _____ Age: _____
Address: _____ Sex: _____
Phone: _____ Best Time to Call: _____
Psychology Instructor: _____ Section: _____

1. Do you have any medical problems (for example, heart problems)? Yes No
   If yes, what type:_____

2. Do you currently use tobacco products? (circle one of the four choices)
I am a smoker I use smokeless tobacco I am a smoker and use smokeless tobacco

I do not use tobacco **(IF YOU DO NOT USE TOBACCO, DO NOT COMPLETE THE REST OF THIS FORM).**

3. Approximately how many time do you smoke a cigarette per day? (circle one)
   <10 10-15 16-20 21-25 >25

4. How long have you smoked? Years_____ Months_____

5. Have you ever tried to quit before? (circle one) Yes No
   If yes, when was the last time you tried? (Month/Year)_____

6. Are you currently trying to quit or cut down? (circle one) Yes No

Subject number: _____ Date: _____

**Fagerström Test for Nicotine Dependence (FTND)****

1. How soon after you wake up do you smoke your first cigarette (in minutes)?

2. Do you find it difficult to refrain from smoking in places where it is forbidden (e.g., in church, at the library, at the movies, etc.)?

3. Which cigarette would you hate most to give up?

4. How many cigarettes per day do you smoke?

5. Do you smoke more frequently during the first hours after waking than during the rest of the day?

6. Do you smoke if you are so ill that you are in bed most of the day?

**Adapted from Heatherton, Kozlowski, Frecker, and Fagerström (1991). Permission to use this scale for other than research purposes should be obtained from Dr. Fagerström, President, Fagerström Consulting and Smokers Information Center, Berga Alle 1, S-254 52 Helsingborg, Sweden.

Subject number: _____ Date: _____

Smoking phase: Baseline Non-smoking Smoking

**Withdrawal Symptoms Checklist (WSC)**

DIRECTIONS: Please rate (circle) the degree to which each of the following descriptive phrases applies to you **AT THIS MOMENT.**

| | NOT PRESENT | MILD | MODERATE | SEVERE |
|---|---|---|---|---|
| 1. Craving to smoke and/or chew/dip | 0 | 1 | 2 | 3 |
| 2. Feeling irritable | 0 | 1 | 2 | 3 |
| 3. Feeling anxious | 0 | 1 | 2 | 3 |
| 4. Having difficulty concentrating | 0 | 1 | 2 | 3 |
| 5. Feeling restless | 0 | 1 | 2 | 3 |
| 6. Experiencing a headache | 0 | 1 | 2 | 3 |
| 7. Feeling drowsy | 0 | 1 | 2 | 3 |
| 8. Experiencing stomach pains and/or nausea | 0 | 1 | 2 | 3 |
| 9. Feeling tired/fatigued | 0 | 1 | 2 | 3 |
| 10. Feeling impatient | 0 | 1 | 2 | 3 |
| 11. Feeling hunger | 0 | 1 | 2 | 3 |
| 12. Feeling down/depressed | 0 | 1 | 2 | 3 |
| 13. Feeling angry | 0 | 1 | 2 | 3 |
| 14. Feeling frustrated | 0 | 1 | 2 | 3 |

15. Did you have trouble sleeping last night? YES NO (circle one)

Heart rate: _____

Subject number: _____ Date: _____

**Leisure Activities Ranking Scales**

**You have just sampled each of the following seven activities:**

**Word Searches**
**Computer Mine Sweeper**
**Legos**
**Computer Poker**
**Jigsaw Puzzles**
**Computer Solitaire**
**Crossword Puzzles**

**Please rank the activities from highest to lowest based on how much EFFORT (amount of physical movement, skills required, level of difficulty, etc.) each one requires. Rank them by writing the name of the activity next to the numbers below using each activity only once.**

1. **(HIGHEST OVERALL EFFORT)**

2.

3.

4.

5.

6.

7. **(LOWEST OVERALL EFFORT)**

Subject number: _____ Date: _____

**Leisure Activities Ranking Scales (Cont.)**

**You have just sampled each of the following seven activities:**

**Word Searches**
**Computer Mine Sweeper**
**Legos**
**Computer Poker**
**Jigsaw Puzzles**
**Computer Solitaire**
**Crossword Puzzles**

**Please rank the activities from highest to lowest based on your overall ENJOYMENT (fun, ability to make time "fly," etc.) of each one. Rank them by writing the name of the activity next to the numbers below using each activity only once.**

1. **(HIGHEST OVERALL ENJOYMENT)**

2.

3.

4.

5.

6.

7. **(LOWEST OVERALL ENJOYMENT)**

Subject number: _____ Date: _____

**Activity:** _____ **Skill:** _____
(novice, intermediate, advanced, expert)

## Leisure Activity Ratings Scales

**Please circle the number that corresponds best to your overall ENJOYMENT (fun, ability to make time "fly," etc.) of the activity you just finished on the scale below. A "1" is the lowest possible enjoyment, and a "7" would be the highest possible enjoyment. Please circle only one number and please do not mark in between whole numbers (e.g., "3.5").**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| I did not enjoy this activity at all and would never do it again | | | | | | I enjoyed this activity very much and would like to do it again |

**Please circle the number that corresponds best to how much EFFORT (amount of physical movement, skills required, level of difficulty, etc.) was required by the activity you just finished on the scale below. A "1" is the lowest possible effort, and a "7" would be the highest possible effort. Please circle only one number and please do not mark in between whole numbers (e.g., "3.5").**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| This task required little if any effort | | | | | | This task required a very high amount of effort |

**Please circle the number that corresponds best to your overall EFFICACY (how well you feel you performed) with the activity you just finished on the scale below. A "1" is the lowest possible performance, and a "7" would be the highest possible performance. Please circle only one number and please do not mark in between whole numbers (e.g., "3.5").**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| I performed very poorly on this task; I "bombed" it | | | | | | I performed extremely well on this task; I "aced" it |

**Data Recording Sheet**

Subject number: _____ Date: _____

Smoking phase: Non-smoking Smoking (circle one)

CO level: _____

ACTIVITY #1: _____

Total time spent on activity: _____

Number of correct responses: _____

Total number of possible responses: _____

Percentage of task correctly completed: _____ % (correct divided by total)

ACTIVITY #2: _____

Total time spent on activity: _____

Number of correct responses: _____

Total number of possible responses: _____

Percentage of task correctly completed: _____ % (correct divided by total)

# Appendix B

Table 1
Comparisons between subject groups across smoking, heart rate, and mood variables

| | Completed Study (N = 21), M (SD) | Dropped out of Study (N = 10), M (SD) | t(29)[b] |
|---|---|---|---|
| Amount Smoked per day[a] | 2.00 (.89) | 2.00 (.94) | .00 |
| Number of Years Smoking | 3.98 (2.76) | 4.55 (1.86) | .59 |
| ppm CO after Smoking | 19.19 (7.70) | 23.80 (7.30) | 1.58 |
| FTND score | 3.86 (1.93) | 4.10 (2.02) | .32 |
| WSC score | 8.05 (5.49) | 6.50 (3.81) | -.80 |
| Systolic Pressure | 120.24 (15.48) | 121.50 (12.19) | .23 |
| Diastolic Pressure | 69.48 (9.03) | 71.10 (4.86) | .53 |
| Heart Rate (bpm) | 86.76 (14.74) | 80.70 (14.89) | -1.07 |
| BDI score | 5.52 (6.10) | 7.90 (9.26) | .86 |

[a]As reported on the recruitment survey, broken down in to the following categories: 1 = 10-15, 2 = 16-20, 3 = 21-25, 4 = 25+
[b]For all tests, $p > .05$

Table 2
Average ratings of leisure activities for entire sample (N = 21)

| | Beginning Skill[a] M (SD) | Enjoyment M (SD) | Effort M (SD) | Efficacy M (SD) |
|---|---|---|---|---|
| Word Search | 2.05 (.67) | 4.10 (1.34) | 3.10 (1.26) | 3.24 (1.00) |
| Minesweeper | 1.43 (.68) | 4.33 (1.88) | 3.62 (1.88) | 3.05 (1.53) |
| Legos | 1.90 (1.00) | 5.14 (1.68) | 3.52 (1.63) | 4.86 (1.96) |
| Poker | 1.76 (.77) | 4.71 (1.59) | 2.81 (1.44) | 3.19 (1.21) |
| Jigsaw | 1.33 (.48) | 4.52 (1.54) | 4.33 (1.77) | 3.38 (1.32) |
| Solitaire | 2.29 (.72) | 5.29 (1.23) | 3.14 (1.39) | 4.29 (1.65) |
| Crossword | 1.24 (.44) | 2.86 (1.31) | 4.48 (1.54) | 1.90 (.94) |

[a]Rated on a 1-4 scale, where 1 = "novice", 2 = "intermediate", 3 = "advanced", and 4 = "expert"

Table 3
Frequency of activities used for "high" and "low" effort tasks

| | High Effort (N) | Low Effort (N) |
|---|---|---|
| Word Search | 3 | 3 |
| Minesweeper | 8 | 3 |
| Legos | 3 | 4 |
| Poker | 0 | 6 |
| Jigsaw | 6 | 1 |
| Solitaire | 1 | 4 |
| Crossword | 0 | 0 |
| TOTAL | 21 | 21 |

Table 4
Comparisons of activity ratings across "high" and "low" effort tasks

| | High Effort (N = 21) M (SD) | Low Effort(N = 21) M (SD) | t(20) |
|---|---|---|---|
| Beginning Skill | 1.81 (.93) | 2.00 (.71) | -.68 |
| Enjoyment | 5.52 (.93) | 5.29 (1.31) | .69 |
| Effort | 4.52 (1.32) | 2.71 (1.27) | 7.38**** |
| Efficacy | 3.81 (1.33) | 4.19 (1.47) | -.93 |

****$p < .0001$

Table 5
Comparisons of smoking measures and cardiovascular data across smoking conditions

| | Smoking (N = 21) M (SD) | Non-Smoking (N = 21) M (SD) | t(20) |
|---|---|---|---|
| WSC score | 8.05 (5.49) | 13.81 (5.98) | -2.99** |
| ppm CO | 19.19 (7.70) | 3.62 (2.33) | 9.35**** |
| Systolic Pressure | 120.24 (15.48) | 122.00 (11.09) | -.571 |
| Diastolic Pressure | 69.48 (9.03) | 65.14 (7.00) | 2.17* |
| Heart Rate (bpm) | 86.76 (14.74) | 71.71 (13.20) | 6.44**** |

*p < .05
**p < .01
****p < 0001

Figure 1. Self-Reported Mood Across Smoking Conditions

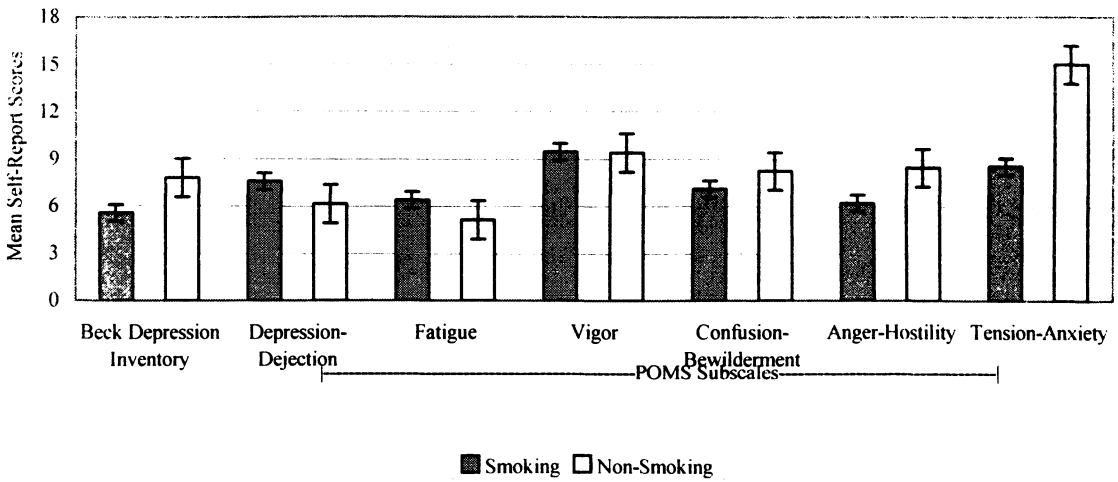

Figure 2. Enjoyment ratings for activity by smoking condition

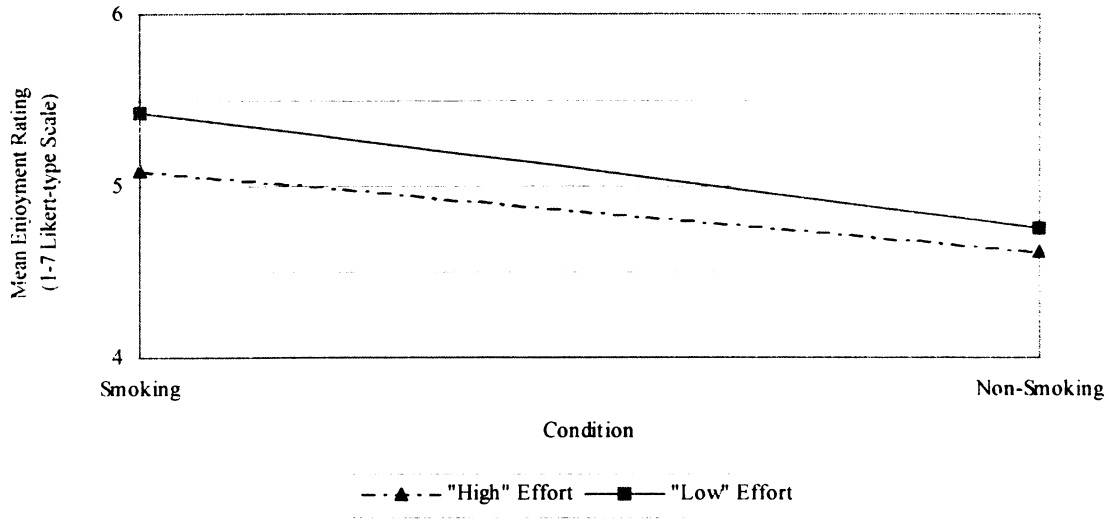


Figure 3. Effort ratings for activity by smoking condition

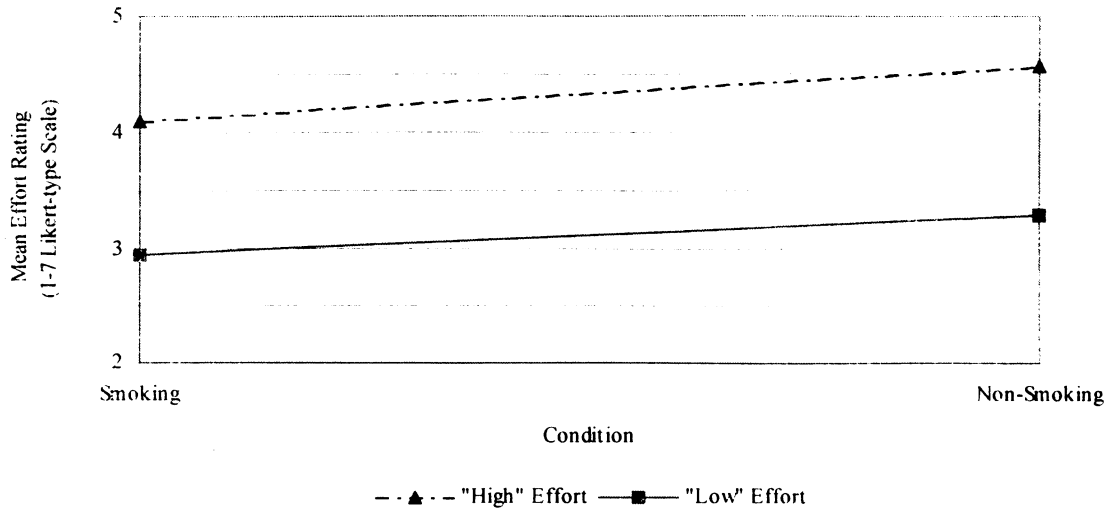

Table 6

Bivariate Correlation Coefficients for difference scores with "high" effort tasks[a]

| | BDI | Tension-Anxiety | Anger-Hostility | SSWTSS | Enjoyment | Effort | Efficiency |
|---|---|---|---|---|---|---|---|
| BDI | | | | | | | |
| r | 1.00 | .54** | .29 | .44* | -.23 | .32 | -.08 |
| p | --- | .01 | .10 | .02 | .15 | .08 | .37 |
| Tension-Anxiety r | .54** | 1.00 | .74*** | .81*** | .34 | .37* | .07 |
| p | .01 | --- | .00 | .00 | .07 | .05 | .39 |
| Anger-Hostility r | .29 | .74*** | 1.00 | .65*** | .37* | .08 | .09 |
| p | .10 | .00 | --- | .00 | .05 | .36 | .34 |
| WSC | | | | | | | |
| r | .44* | .81*** | .65*** | 1.00 | .30 | .37* | .22 |
| p | .02 | .00 | .00 | --- | .09 | .05 | .17 |
| Enjoyment | | | | | | | |
| r | -.23 | .34 | .37* | .30 | 1.00 | .44* | .34 |
| p | .15 | .07 | .05 | .09 | --- | .02 | .07 |
| Effort | | | | | | | |
| r | .32 | .37* | .08 | .37* | .44* | 1.00 | .14 |
| p | .08 | .05 | .36 | .05 | .02 | --- | .27 |
| Efficiency | | | | | | | |
| r | -.08 | .07 | .09 | .22 | .34 | .14 | 1.00 |
| p | .37 | .39 | .34 | .17 | .07 | .27 | --- |

[a]All coefficients based on ($N = 21$) Pearson $r$ calculations, using 1-tailed $p \leq .05$ as cutoff for significance testing

*$p < .05$

**$p < .01$

***$p < .001$

Table 7
Bivariate Correlation Coefficients for difference scores with "low" effort tasks[a]

| | BDI | Tension-Anxiety | Anger-Hostility | SSWTSS | Enjoyment | Effort | Efficiency |
|---|---|---|---|---|---|---|---|
| BDI | | | | | | | |
| r | 1.00 | .54** | .29 | .44* | -.24 | -.06 | .20 |
| p | --- | .01 | .10 | .02 | .15 | .40 | .20 |
| Tension-Anxiety r | .54** | 1.00 | .74*** | .81*** | -.14 | .25 | .17 |
| p | .01 | --- | .00 | .00 | .48 | .14 | .24 |
| Anger-Hostility r | .29 | .74*** | 1.00 | .65*** | .03 | .22 | -.10 |
| p | .10 | .00 | --- | .00 | .46 | .18 | .33 |
| WSC | | | | | | | |
| r | .44* | .81*** | .65*** | 1.00 | -.30 | .22 | .07 |
| p | .02 | .00 | .00 | --- | .10 | .17 | .38 |
| Enjoyment | | | | | | | |
| r | -.24 | -.14 | .03 | -.30 | 1.00 | -.05 | .39* |
| p | .15 | .48 | .46 | .10 | --- | .42 | .04 |
| Effort | | | | | | | |
| r | -.06 | .25 | .22 | .22 | -.05 | 1.00 | -.01 |
| p | .40 | .14 | .18 | .17 | .42 | --- | .48 |
| Efficiency | | | | | | | |
| r | .20 | .17 | -.10 | .07 | .39* | -.01 | 1.00 |
| p | .20 | .24 | .33 | .38 | .04 | .48 | --- |

[a]All coefficients based on ($N = 21$) Pearson $r$ calculations, using 1-tailed $p \leq .05$ as cutoff for significance testing
*$p < .05$
**$p < .01$
***$p < .001$

# Appendix C

**Consent Form: Smoking Withdrawal, Emotion, and Leisure Activities**

Smoking Research Program
Frank L. Collins, Ph.D.

Participants should note that neither Oklahoma State University nor its researchers endorse or encourage continuation of smoking; rather, the purpose of this study is to research certain effects upon those who are currently smoking.

"I, _____, hereby authorize or direct Dr. Frank Collins or associates or assistants of his choosing, to perform the following treatment or procedure."

You are being asked to participate in a research study which will look at smoking and leisure activities. This is not a smoking cessation project.

During this study, you will be asked to sample several types of leisure activities. Based on your preferences, you will then perform two of these leisure activities. You will be asked to perform the designated activities on two separate occasions. On one occasion you will be asked to perform the activities under your normal smoking circumstances, and will smoke one cigarette immediately before beginning the activities. On the other occasion, you will be asked to perform the activities after abstaining from smoking for 48 consecutive hours. You will be notified in advance which condition, smoking or non-smoking, you will be in for each occasion.

Before you begin the activities, we will take a measure of the carbon monoxide (CO) in your breath. This is done by having you blow into a monitor that computes the CO. CO is an indication of smoking exposure. Also, before each cigarette you will be asked to rate how much you want a cigarette and fill out a brief survey on your current mood. Ratings and surveys will use simple ratings scales; you will circle the number that best represents your opinion.

This research project requires that you attend 3 sessions in order to complete all phases of the study. The first session will last approximately 1 hour. At this time all aspects of the study will be explained to you (including this consent form), you will be familiarized with the lab computers and the activity choices, you will practice using the rating scales, and you will practice taking your CO. If you agree to participate, you will be asked to come to the lab for 2 more times, 1 hour each time.

Because there is no direct benefit for you in participating in this study, you will be compensated in some way for your time. There may be some discomfort associated with not smoking for 48 hours straight. Common symptoms may include one or more of the following: craving, irritability, frustration, anger, anxiety, difficulty concentrating, restlessness, decreased heart rate, increased appetite, and/or weight gain. If you become too uncomfortable during the 48 hours of non-smoking, you will not be penalized in any way if you withdraw early from the study. All participants are given information about the Psychological Services Center, an on-campus clinic available to students, which they may choose to utilize or not should they experience levels of discomfort or distress requiring professional help.

Smoking Research Program
Consent Form (Cont.)
Page 2

All information obtained during the study will remain confidential. Records will be coded by number and your name will not appear on any forms other than this consent form. The only individuals who will have access to this data are Dr. Frank Collins and the research assistant(s) conducting the project with you. The nature of this study and the information provided by your participation will not be revealed.

"This is done as part of an investigation entitled Smoking Withdrawal, Emotion, and Leisure Activities."

"The purpose of the procedure is to investigate the withdrawal of nicotine and the impact of certain variables on aspects of withdrawal."

"I understand that participation is voluntary, that there is no penalty for refusal to participate, and that I am free to withdraw my consent and participation in this project at any time without penalty after notifying the project director."

"I may contact Dr. Frank Collins at (405) 744-6027 should I wish further information about the research. I may also contact Gay Clarkson, IRB Executive Secretary, University Research Services, 203 Whitehurst, Oklahoma State University, Stillwater, OK 74078; (405) 744-5700."

"I certify that I am 18 years of age or older and that I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me."

"Date: _____ Time: _____ (a.m./p.m.)"

"Signed _____"
(Signature of Subject)

"I certify that I have personally explained all elements of this form to the subject before requesting the subject to sign it."

"Signed _____"
(Project director or his/her authorized representative)

# Appendix D

# Computer Task Instructions

## Minesweeper

**The object of Minesweeper**

The object of Minesweeper is to find all the mines as quickly as possible without uncovering any of them.

**To play Minesweeper**

- To start the timer, left-click any square on the playing field.
- To start over, left-click the yellow happy-face.
- Record the number of mines left (upper left corner) and the time (upper right corner) after each game.

Notes

- The game area consists of the playing field, a mine counter, and a timer.
- You can uncover a square by left-clicking the mouse over it. If you uncover a mine, you lose the game.
- If a number appears on a square, it indicates how many mines are in the eight squares that surround the numbered one.
- To mark a square you suspect contains a mine, right-click the mouse over it.

**Strategies and tips**

- If you are uncertain about a square, right-click it twice to mark it with a question mark (?). Later, you can either mark the square as a mine or uncover it by right-clicking again once or twice.
- When you have marked all mines around a numbered square, you can quickly uncover all empty squares around it by clicking that square with both mouse buttons. If not all mines touching the square are marked, the uncovered touching squares will flash.
- Look for common patterns in numbers, which often indicate a corresponding pattern of mines. For example, the pattern 2-3-2 at the edge of a group of uncovered squares indicates a row of three mines next to the three numbers.

## Five-Card Draw Poker

**The object of Five-Card Draw Poker**

The object of Five-Card Draw Poker is to win money by getting the best possible combination of cards or "hands" (e.g., a "Royal Flush" is the rarest/hardest hand to get in 5-card draw poker, and therefore has the highest payoff).

**To play Poker**

- On the Game menu, left-click Deal.
- Right-click to see your starting hand of five cards.
- Left-click a card if you want to "hold" or keep it (left-click again if you change your mind).
- Once you have decided which cards to hold, right-click to "draw" or see your new cards.
- The computer will tell you if you have a winning hand or not and tally your winnings for each hand.
- If you win a hand of poker, you have the option to "double up" your winnings or go double-or-nothing in a one card draw with the dealer (high card wins).
- If you do not wish to double up, simply click "deal" to start the next hand.
- Record your remaining money whenever a round of poker ends (the screen with the gray buttons pops up).

Notes

- You will start with $100.
- Each hand costs you $5 to play.
- Winnings are based on your initial bet ($5) and the statistical probability of your hand (listed by name in order at the top right of screen, rarer hands have higher payouts).

# Solitaire

**The object of Solitaire**

The object of Solitaire is to use all the cards in the deck to build up the four suit stacks in ascending order, beginning with the aces.

**To play Solitaire**

- On the Game menu, left-click Deal.
- Double-click any aces on the seven stacks to move them to the spaces at the upper right of the screen, and then make any other plays available on the board.
- When you have made all available plays on the board, left-click the deck to begin turning over cards.
- The card that is face up on the deck is always available for play.
- Record your money at the end of each game (whenever there are no more moves to make or when you have won).

**Notes**

- You will be building Row Stacks and Suit Stacks.
- You build Row Stacks to free up cards that you need to build the Suit Stacks.
- For Row Stacks, the cards are stacked in descending order, alternating between red cards and black cards. For example, you can play the two of hearts on the three of clubs.
- For Suit Stacks, Cards are stacked in the four areas at the top right of the screen in ascending order, beginning with aces. For example, you can play the two of hearts on the ace of hearts.
- To move a card or a stack of cards from one row stack to another, drag (click and hold) the card or stack.
- To move a card to a suit stack, double-click it.

**Vegas scoring**

- You start the game with a debt of 52 dollars, which represents your wager.
- You win 5 dollars for every card you play on a suit stack.

The object of the game is to earn more money than you wagered.

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

**DATE: 10-08-98** **IRB #: AS-99-011**

**Proposal Title: SMOKING WITHDRAWAL, EMOTION AND LEISURE ACTIVITIES**

**Principal Investigator(s):** Frank Collins, Michael Leftwich

**Reviewed and Processed as:** Expedited

**Approval Status Recommended by Reviewer(s):** Approved

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Signature: Carol Olson Date: October 8, 1998

Carol Olson, Director of University Research Compliance
cc: Michael Leftwich

**Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modification to the research project approved by the IRB must be submitted for approval. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.**

# VITA

Michael James Thomas Leftwich

Candidate for the Degree of

Doctor of Philosophy

Dissertation: DEPRESSIVE MOOD CHANGES DURING NICOTINE WITHDRAWAL: THEIR EFFECTS ON LEISURE ACTIVITIES FROM A BEHAVIORAL ECONOMICS PERSPECTIVE

Major Field: Clinical Psychology

Biographical:

Education: Graduated from Fair Grove High School, Fair Grove, Missouri in May 1987; received Bachelor of Arts degree in Psychology from University of Missouri at Kansas City, Kansas City, Missouri in May 1991; received Master of Science degree in Clinical Psychology from Oklahoma State University, Stillwater, Oklahoma, in July 1993. Completed the requirements for the Doctor of Philosophy degree with a major in Clinical Psychology at Oklahoma State University in July, 1999.

Experience: Employed as a graduate teaching assistant at the University of Missouri at Kansas City 1991-1992, as a research assistant and graduate teaching assistant at Oklahoma State University 1992-1997, and as a clinical practicum student and research project coordinator at the University of Oklahoma Health Sciences Center 1993-1997. Clinical internship completed at the University of Alabama-Birmingham School of Medicine psychology training consortium 1997-1998. Most recently employed as a Psychology Fellow at the University of Oklahoma Health Sciences Center in the Chemical Dependency Fellowship, 1998 to present.

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