TEMPORAL DISCOUNTING, STRESS, AND CRAVING IN CIGARETTE SMOKERS

By

LAURA C. CARTER

Bachelor of Science
Ripon College
Ripon, Wisconsin
1994

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1999

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Dissertation Advisor

Dean of the Graduate College

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Temporal Discounting, Stress, and Craving in Cigarette Smokers

Cigarette smoking is acknowledged as one of the most profound causes of disease and death (American Cancer Society [ACS], 1997). It is associated with several types of cancer, is a primary cause of coronary heart disease, cardiovascular disease, stroke, emphysema, and chronic bronchitis, and exacerbates even minor illness, such as colds and gastric ulcers. Though smoking-related diseases are more preventable than many others, each year 400,000 Americans die as a result of the effects of smoking. With cessation, however, much functioning can be regained, disease risk greatly reduced, and better overall health status achieved (Manley, 1997).

Though the rewards of cessation are promising, it is exceedingly difficult to accomplish for many smokers. More than 25% of Americans over the age of 18 continue to smoke (ACS, 1997), yet 93% of smokers agree that smoking is harmful, and 70% report that they would like to quit (Glass, 1990). Nevertheless, only a small percentage of those who attempt are able to quit, and when they do, relapse is common (ACS, 1997). A primary reason that cessation is so difficult may be that it smoking serves important functions for the smoker. These could include calming and relaxation (Gilbert, 1979; Gilbert & Gilbert, 1998; Nesbitt, 1973), reduction of negative affect including anxiety and stress (Byrne, Byrne, & Reinhart; 1995Gilbert, 1979), increase in cognitive alertness (Gilbert, 1979), avoidance of weight gain (Ogden & Fox, 1994), social contact, and avoidance of withdrawal symptoms (Perkins, Hickcox, & Grobe, 2000). To the extent that smoking fulfills any of these or other functions, it is reinforcing, and in order to quit, it is necessary to find alternate behaviors that satisfy the functions.

A factor that has recently emerged in the literature as an influence on substance abuse is temporal discounting, a concept rooted in behavioral economics (Higgins et al, 1993; Kirby, Petry, & Bickel, 1999; Vuchinich & Simpson, 1998). Temporal discounting refers to the degree to which a reinforcer's current value is affected by the delay until it is available. When a reinforcer is unavailable for a period of time, its current reinforcement value is less than if it were available immediately. For example, if food from a vending machine were not delivered immediately, its value would be less, especially if another vending machine close by were delivering food immediately (Madden, 2000). Though the concept of temporal discounting can extend to all reinforcers, it has typically been conceptualized within an addictions framework. Within this framework, temporal discounting holds that substance abusers are inherently choosing a smaller more immediate reinforcer (the substance) over a larger, delayed one (e.g., health, relationships, employment). In so doing, they discount, or de-value, the long-term benefits of abstention in favor of the more immediate reinforcement derived from the substance. Generally, the more difficult it is to choose the delayed reinforcer, the more abstinence will be hindered. On the other hand, if ways can be identified by which substance abusers can be taught to override their desire to choose immediate reinforcement and to identify and use alternative non-drug reinforcers in place of the preferred substance, treatment may be greatly improved (Higgins et al., 1993; Vuchinich & Tucker, 1998). In this way, understanding temporal discounting can facilitate development of more effective substance abuse treatments.

Temporal discounting has been shown to be more pronounced in substance abusers than in non-substance abusers (Kirby et al., 1999; Madden, Petry, Badger, &

Bickel, 1997; Vuchinich & Simpson, 1998), in that delayed reinforcers generally have even less value for substance abusers than for non-abusers. Research indicates that, within the substance-abusing population, this holds true for both substances (Vuchinich & Simpson, 1998) and for non-substance reinforcers such as money (Madden et al., 1997). Though research is unclear as to whether discounting in substance abusers is a manifestation of a personality trait or the result of environmental factors such as withdrawal, craving, and transient emotional states, theoretical approaches to discounting tend treat it as a trait phenomenon (Mischel, Shoda, & Rodriguez, 1989; Ostaszewski, 1996, 1997; Vuchinich & Simpson, 1998). However, until the effects of environmental factors on discounting are addressed empirically, we will be unable to more precisely define the role of trait versus environmental, or state, features in discounting. The current study attempted to define the relationship between discounting and laboratory-induced stress in an effort to determine whether stress impacts the rate of temporal discounting. With regard to the state-view versus the trait-view, it was reasoned that, if discounting was shown to change following an increase stress, it would suggest that discounting may be a state-induced phenomenon, because it was affected by transient environmental factors.

The following review will begin with an overview of behavioral economic theory with the goal of providing a framework for discussion of temporal discounting. Literature addressing theory and application of temporal discounting will then be provided, followed by a review of literature describing the relationship between smoking and temporal discounting and smoking and stress in order to provide a foundation for discussion of the current study.

Overview of Behavioral Economics

Behavioral economics combines economic principles with behavioral principles of reinforcement in order to conceptualize consummatory behavior and develop treatment formulations that may be more effective than traditional treatments such as those utilized by twelve-step programs. Behavioral economics conceptualizes addictive behavior as arising from environmental factors including complete lack of alternate non-drug reinforcers, lack of alternate non-drug reinforcers that seem viable to the individual, and perceived balance of cost versus benefit of drug and non-drug reinforcers (e.g., comparative reinforcement value of two reinforcers and length of delay until each is available). Familiarity with the following terms will facilitate understanding of behavioral economics and temporal discounting.

Demand. Demand, or consumer demand, refers to the relationship between the price of a reinforcer and its consumption (Hursh et al., 1988). This relationship can be described by the law of demand, which states that the rate of demand for, and thus consumption of, a commodity will decrease with an increase in its price. According to this law, the higher a reinforcer's price, the less of it will be consumed. This is true of addictive reinforcers, in that the higher the monetary cost or cost in terms of effort to obtain the substance, the less of it will be consumed. With regard to smoking in particular, consumption of cigarettes will generally decrease with substantial increases in their price (Perkins et al., 2000).

Price. Price, also referred to as unit price, is the amount of effort required to obtain one unit of a reinforcer (Hursh et al., 1988), where a "unit" is defined according to the specific reinforcer itself. For instance, a unit of cocaine may be one ounce while

a unit of nicotine may be one cigarette. Price can be a financial expenditure or it may refer to an expenditure of time, energy, or risk involved in obtaining or consuming a reinforcer. For example, the price of nicotine may be financial, or it may be energy involved in obtaining nicotine products, time involved in consumption-related activities such as smoking, and risk of illness such as cancer or emphysema. Further, delay until a reinforcer is available may be considered a price. With increases in each of these, demand and consumption of nicotine-related products will generally decrease.

Elasticity. Elasticity refers to the extent to which demand for a reinforcer is affected by increase in its price. When increase in a commodity's price significantly lowers its demand, demand is elastic. Commodities whose demand is elastic are not typically necessary for survival and are often thought of as luxuries (DeGrandpre, Bickel, Hughes, & Higgins, 1992). Examples are automobiles, computer products, large homes, movie tickets, and many foods. If the price of any of these increased significantly, a significant decrease in their demand and consumption would ensue. However, when price increase has little effect upon a commodity's consumption, demand is inelastic. Examples of commodities with inelastic demand are basic foods, water, electricity, clothing, and shelter. These are fundamental to survival and/or daily functioning and their consumption is generally stable regardless of increase in price, thus, they are often thought of as necessities (DeGrandpre et al., 1992).

With regard to addiction, elasticity of demand varies across individuals depending upon the degree to which they are addicted (Perkins et al., 2000). For example, demand for cigarettes is inelastic in individuals who are severely addicted to nicotine, whereas individuals who are less dependent on nicotine have more of an

elastic demand in that their consumption is more responsive to increases in price. Thus, environmental manipulations such as price increase will have greater impact upon individuals with less severe addictions. Hursh (1980) suggested that temporal discounting may be an indirect measure of elasticity, since commodities that are elastic are typically more reinforcing at low price and less reinforcing at high price. Further, reinforcers available at low price are often more immediate while those available for high cost are more typically delayed. As such, discounting might be conceptualized as a measurement of the degree to which a commodity is reinforcing as a function of its availability at a high or low price.

Commodity Relationships. Demand for one reinforcer can be affected by availability of other reinforcers that fulfill a similar function. This is referred to as a commodity relationship, which defines reinforcers as complementary, substitutable, or independent (DeGrandpre & Bickel, 1996). Reinforcers that are complementary exist in a dependent relationship to each other such that consumption of one increases consumption of the other. An example is the relationship between cigarettes and alcohol, where alcohol consumption in smokers often leads to increased smoking (Gulliver et al., 1995; Mitchell, de Wit, & Zacny, 1995). Reinforcers that are substitutes can be used interchangeably, such that increased cost or unavailability of one leads to increased consumption of the other. For example, crack may be substituted for cocaine when cocaine is unavailable or the cost too high. With regard to nicotine, it has been shown that chewing gum can be used as a substitute for cigarette smoking, so that when cigarettes are unavailable or smoking is impossible, chewing gum can fulfill a similar as cigarettes by satisfying cravings (Cohen, Collins, & Britt, 1997). Further,

different forms of nicotine may be used interchangeably, such as cigarettes and chewing tobacco. Reinforcers are independent if consumption of one has no effect upon consumption of the other, regardless of availability or cost of either. An example is the relationship between nicotine and cocaine such that consumption, cost, and availability of one has no known bearing on consumption of the other.

In the following section, theory and constructs of discounting will be discussed with emphasis upon its relationship to addictive behaviors.

Temporal Discounting

Temporal discounting is a behavioral economic principle and refers to the current reinforcement value of a delayed reinforcer. Temporal discounting occurs when the value of a reinforcer is decreased, or discounted, based upon the delay in time until it is available. An example of temporal discounting is choosing to buy an older automobile because it is immediately available, rather than waiting for an equally-priced new one to be ordered, built, and delivered. Another example is using weight-loss supplements to lose weight more quickly rather than exercising, which would result in slower, but healthier, weight loss. Discounting is typically referred to by rate (rapid, or steep, versus slow), wherein rapid discounting occurs when the value of a delayed reinforcer is discounted greatly and slow discounting occurs when a reinforcer's value is discounted to a lesser extent. Appendix A illustrates an example of rapid versus slow discounting. In this example, the slope for rapid discounting (B) shows that the delayed reinforcer loses values more quickly than for slow discounting, where the slope is more gradual and the reinforcer loses value more slowly (A). Research has established that the rate at which the delayed reinforcer's value decreases is more rapid in substance

abusers than in non-abusers (Kirby et al., 1999; Madden et al., 1997; Vuchinich & Simpson, 1998). Appendix B will be referred to in detail later, but it also serves as an illustration of the difference between rapid and slow discounting of delayed reinforcers. Substance abusers, who tend to discount more rapidly, would be slower than non-abusers to begin choosing the delayed amounts of money over the immediate amounts. Thus, they are quicker to discount the value of the delayed monetary reinforcer than non-abusers. In other words, they discount the value of the delayed reinforcer more steeply or rapidly.

Measurement of Temporal Discounting

Discounting has been conceptualized using two models: an exponential model and a hyperbolic model, both of which are explained below, followed by a brief discussion addressing their differences.

Exponential Model of Temporal Discounting. The exponential model originates in economics and is used primarily by economists. It focuses upon the risk involved in waiting for a reinforcer and assumes that delay equates to risk of not receiving the reinforcer. In this model, once the length of delay is set, the risk inherent in waiting for a reinforcer is constant rather than increasing. Thus, there is the assumption of a constant rate of hazard (Myerson & Green, 1995). This model expresses delay of discounted rewards in the following manner:

$$V=Ae^{-kD}$$

where V is the discounted value of the reinforcer, A is the amount of reinforcer available after delay, e is the expected value of the reinforcer, D is the length of the delay, and k is the rate at which the value decreases. The slope of the discounting curve

is denoted by k, thus a larger k indicates a steeper rate of discounting and a smaller k indicates a more constant, shallower rate of discounting (Green & Myerson, 1996).

Hyperbolic Model of Temporal Discounting. The hyperbolic model is generally preferred by psychologists (Green & Myerson, 1996) and assumes decrease in a reinforcer's value over time as well as decrease in the risk of non-receipt over time, rather than a constant rate of risk, as assumed in the exponential model. Discounting is expressed as follows:

$$V=A/(1+kD)$$

where V, A, and D serve the same functions as in the exponential equation, but k indicates a constant decrease in the value of the reinforcer. As in the exponential model, large k-values indicate steeper rates of discounting, represented by a more steeply-declining discounting curve. Small k-values, however, are indicative of shallower rates of discounting depicted by more gradually declining discounting curves (See Appendix A).

Differences Between the Models. These models differ primarily with regard to the assumptions each makes about the delay until reinforcement is delivered. Green and Myerson (1996) explain that, in the exponential model, the risk inherent in waiting for a reward is constant across time, whereas in the hyperbolic model, the risk of non-receipt is high initially and then decreases with time. So, in the exponential model, with each unit of time until the reinforcer is obtained, there is a constant probability that something may happen to prevent delivery of the reinforcer. Here, a larger k suggests greater risk. The hyperbolic model, on the other hand, suggests that the risk of non-receipt is great at first but it decreases with each unit of time that passes.

Hypothetical Money Choice Task

Temporal discounting is typically measured using a hypothetical money choice task (HMCT; Rachlin, Raineri, & Cross, 1991; Simpson & Vuchinich, 2000). The objective of this instrument is to identify the amount of money available immediately that is equivalent to a larger amount of money available after a specific delay (Vuchinich & Simpson, 1998). Individuals are asked to choose between various amounts of money hypothetically available immediately and various amounts hypothetically available after specific delays. For example, a choice may be made between hypothetically receiving $1000 today or $10,000 in two years. Both the amounts of hypothetical money and the delays change such that both figures begin with the same amount ($1,000 today or $1,000 tomorrow), and with each choice, the amount of money offered immediately decreases, and the delay increases (e.g., $500 today or $1,000 in six months). Typically, individuals begin by choosing the immediate amount if that amount and the delayed amount are equal. They will then typically then begin choosing the delayed amount until the delay becomes too long (e.g., $100 immediately or $1,000 in 10 years), at which time they will switch back to the immediate amount, even if that is the smaller of the choices.

According to Vuchinich and Simpson (1998), offering hypothetical rather than real amounts of money has both advantages and disadvantages, the main advantage being the convenience of not paying participants. This is especially important since the amounts hypothetically offered can become high and choices may be made for money to be received years into the future. However, the primary disadvantage according to Vuchinich and Simpson (1998), is that, by using hypothetical monies participants do not

come into contact with genuine contingencies of their choices. Based upon findings of studies using the HMCT, however, the use of hypothetical monies yields results that are similar to those found in studies offering a variety of other reinforcers including real money (Kirby, Petry, & Bickel, 1999) and drugs (Madden et al., 1997).

Temporal Discounting as an Adaptive Behavior

It has been hypothesized that discounting occurs because of the risk of waiting for reinforcers that may never arrive due to unexpected circumstances interfering with their delivery (Green & Myerson, 1996; Green, Myerson, & McFadden, 1997; Myerson & Green, 1995). Therefore, the longer the delay before a reinforcer can be obtained, the less conceivable it may seem that the reinforcer will actually be delivered, and thus the less valuable it may seem. Herein lies a basic rule of behavioral economics: the value of a future reward decreases with increasing length of time to its receipt (Myerson & Green, 1995). Kagel, Green, and Caraco (1986) suggest that discounting in the face of uncertain receipt of reinforcement may be adaptive if the reinforcer is necessary to survival, and Green et al. (1997) suggest that discounting may even have a basis in evolution. Raineri and Rachlin (1993) discuss an economic view of the basis for discounting that also accounts for biological factors. They suggest that consumption of a reinforcer may be constrained by a number of factors. For example, an animal may be able to ingest only small amounts of a food-reinforcer due to the size of its mouth or digestive system. Further, consumption of large reinforcers often takes longer than consumption of small reinforcers, leaving risk for spoiling in the case of food, or other factors preventing receipt of the full reinforcer. Although these hypotheses regarding

evolution and biology may account for some predisposition to discount, they do not seem to explain discounting wholly, especially in the context of addictive behavior.

Temporal Discounting and Addictive Behaviors

Discounting has been studied within the context of drug and alcohol abuse with the goal of defining more effective treatments. Within this context, it has been examined theoretically and empirically from a number of aspects, including availability of alternative non-drug reinforcers (Vuchinich & Tucker, 1998), treatment outcome (Higgins, Budney, Bickel, Foerg, et al., 1994; Higgins, Budney, Bickel, Hughes, et al., 1993), severity of addiction (Vuchinich & Simpson, 1998), and impulsivity and self-control (Bickel, Madden, & Petry, 1998; Madden et al., 1997). In this section, research examining discounting from a substance abuse perspective will be reviewed and discussed. The study of discounting within a psychological context is relatively new, and the specialized study of discounting in relationship to addiction is even more recent. Thus, the majority of the literature is theoretical and there are very few empirical studies examining discounting from an addictions perspective. Those reviewed, however, appear to make valuable contribution to the understanding of the relationship between discounting and substance abuse behavior. Empirical studies of alcohol will be reviewed first, followed by heroin/opioids, cocaine, and finally, nicotine.

Vuchinich and Simpson (1998) compared discounting in individuals who were either social or problem drinkers. Based on the theory that high rates of temporal discounting increase severity of addiction, these authors hypothesized that rates of discounting should show a positive dose-response relationship. Two studies were done to test this. In the first, participants were divided into two groups, heavy and light

drinkers, based on information they gave at an initial screening. They were then asked to complete am HMCT in which they chose from two hypothetically available amounts of money when one was delayed and other was immediate. Results of this first study showed that heavier drinkers demonstrated slightly higher rates of discounting than light drinkers. Based on the marginal level of statistical significance of this finding, the authors hypothesized that there may be additional variables beyond discounting that motivate social drinking. Further, they hypothesized that when the level of drinking surpasses that which would be considered socially acceptable, some of those variables may drop out, leaving discounting as one of the strongest remaining variables. Thus, the drinking-discounting relationship should be stronger in problem drinkers than it is in non-problem drinkers. In Study Two, this hypothesis was tested by dividing individuals again into two groups: light drinkers without problem drinking and heavy drinkers whose drinking was problematic. It was found that problematic drinkers had higher rates of temporal discounting than the light drinkers, this time with a stronger effect. Further, in both studies, light drinkers scored lower on a measure of impulsivity and higher on a measure of future-orientation, though these particular results were not correlated strongly with temporal discounting. The authors concluded that their findings suggest that, in non-addicted individuals, factors other than discounting that account for variability in drinking behavior and that discounting is higher in severely addicted individuals.

Madden et al. (1997) compared discounting in individuals addicted to opioids with discounting in non-drug users in order to confirm their hypothesis that discounting is greater in those who are drug-addicted and to determine whether discounting is

greater for drug reinforcers or for monetary reinforcers in those individuals. All participants were administered an HMCT in which monetary rewards were hypothetically available either immediately or after a delay. Further, the opioid-dependent individuals were asked to choose between immediate and delayed hypothetically-available amount of heroin. Results suggested that drug-addicted individuals demonstrate higher discounting rates than do non-drug controls and that drug-addicted individuals demonstrate higher discounting for the delayed heroin than for delayed monetary rewards.

Kirby et al. (1999) compared discounting rates in heroin users versus non-drug users in order to test whether heroin addicts had higher rates of discounting than non-drug controls when real monetary rewards (vs. hypothetical) were offered, and to determine the degree to which these discounting rates were indicative of participants' impulsiveness. They administered an HMCT to both groups and found that opioid-dependent participants discounted approximately twice as much as controls. Further, the two groups differed significantly on measures of impulsiveness, where the opioid patients were significantly more impulsive than controls. The authors pointed out that, although the addicted individuals had high rates of discounting, from these data it was impossible to tell whether the tendency to discount at higher rates was a function of the substance abuse or whether it existed prior to the onset of addiction. They suggested that future research examine this question as well as the relationship between discounting and relapse.

Higgins et al. (1993) studied individuals' success maintaining abstinence from cocaine in a Community Reinforcement Approach (CRA) program. In this program,

individuals were able to earn vouchers contingent upon submission of clean urine specimens. Two groups of cocaine addicts were compared, where one received 24 weeks of standard drug abuse counseling (control) and the other received 24 weeks of CRA, consisting of contingency management (clean urine specimens) plus behavioral treatment. Results suggested that the CRA was more efficacious than the standard counseling treatment, as indicated by a number of findings. Significantly fewer individuals dropped from the CRA group (85% of the CRA group finished while 42% of the control group finished). Further, a significantly greater percentage of those in the CRA group was abstinent between the third week and the end of treatment, and 82% of those in the CRA group were abstinent for three or more contiguous weeks, whereas the same was true for only 33% of those in the control group. The authors concluded that these findings yield strong support for the contingency-management approach several reasons: (a) the CRA treatment was more acceptable to patients, yielding higher attendance rates; (b) CRA treatment retained more clients than the standard treatment; (c) the CRA yielded significant periods of abstinence for more clients than the standard treatment did; (d) these results replicated those found in an earlier study (Higgins et al., 1991); (e) many cocaine addicts use cocaine intravenously and a treatment that works with IV users may be especially important to decreasing the spread of HIV; and (f) the CRA treatment used in this study may be efficacious for polysubstance abuse.

In a later study, Higgins et al. (1994), tested the efficacy of the use of similar incentives (vouchers) on treatment outcome for cocaine dependence. Participants were assigned to either a CRA treatment group with an incentive program, or a CRA treatment group without an incentive program. Again, the incentives were vouchers

available contingent upon submission of clean urine specimens. Results indicated that treatment outcome was strikingly improved by the vouchers. Seventy-five percent of those in Group 1 completed treatment, whereas only 40% of those in Group 2 completed. Further, the clients in Group 1 averaged 11.7 weeks of contiguous cocaine abstinence, where the rate was only 6.0 weeks for those in Group 2. Taken together with the findings in the earlier Higgins study (Higgins et al., 1993), these findings indicate that using vouchers can significantly improve treatment outcome.

In an effort to extend drug and alcohol discounting research to nicotine, Bickel, Odum, and Madden (1999) studied discounting and impulsivity in current smokers, ex-smokers, and never-smokers. In this study, they also examined current smokers' discounting of delayed hypothetical cigarettes in order to determine whether smokers showed greater discounting of the drug of dependence than they do of money, as is shown in heroin users (Madden et al., 1997). The authors also attempted to gain insight with regard to whether the discounting they observed in their participants was trait-driven or state-driven, due only to nicotine dependence. The three groups of participants were administered an HMCT in order to measure temporal discounting. Following the HMCT, the current smokers were asked to choose between hypothetical cigarette vouchers in varying amounts in order to compare their discounting of hypothetical money with equivalent amounts of cigarettes. Findings indicated that current smokers showed more rapid discounting of monetary reinforcers than ex-smokers or never-smokers, and that the latter two groups showed equivalent rates of discounting. Further, smokers discounted cigarettes to a greater extent than the monetary reinforcers, which is consistent with the findings of Madden et al. (1997) in

heroin abusers. In effect, these findings suggest that, in drug abusers, the drug of dependence is more reinforcing than money. With regard to the trait versus state element examined in this study, the slower rate of discounting in ex- and never-smokers compared to more rapid rates in smokers may suggest that discounting is state-driven and is an effect of nicotine dependence which, as such, is reversible with cessation. The authors point out, however, that this effect may be more accurately the result of a selection bias in that those with relative low rates of discounting in the first place may be more easily able to quit smoking. To test this hypothesis, the authors suggest a longitudinal study comparing discounting in smokers who quit versus those who continue smoking.

Treatment Implications

In the temporal discounting literature, substance abuse treatment is conceptualized as consisting of two components: teaching individuals to delay their choices and favor long-term outcomes over immediate reinforcers, and teaching individuals to choose from a variety of non-drug reinforcers, with the goal that non-drug reinforcers become as reinforcing as the drug-reinforcers (Vuchinich & Simpson, 1998; Vuchinich & Tucker, 1998). Substance abusers are taught to override the choice for the drug reinforcer in favor of a delayed reinforcer by learning to decrease the reinforcement value of that drug. This is done by increasing the drug's cost as well as increasing the value of delayed reinforcers (Perkins et al., 2000). With regard to nicotine, the cost of smoking could be increased, and thus the demand and reinforcement value decreased, by keeping cigarettes in an inconvenient location, limiting smoking behavior to one location, limiting the amount of cigarettes purchased,

and smoking only at scheduled times. Other strategies more directly increasing the cost of smoking include requesting the smoker to pay money or engage in some undesirable activity for each cigarette smoked (Perkins et al., 2000). In order to increase the reinforcement value of delayed reinforcers obtained by quitting smoking, such as better health and more money, smokers could increase their investment in health. This could be done by having them become more educated with regard to the health benefits of quitting smoking, engaging in physical exercise or other health-related activities, and renewing health and life insurance policies at lower cost upon prolonged abstinence. Finally, with regard to the financial rewards of quitting, smokers could save money for each pack they would have bought had they been smoking (Perkins et al, 2000).

In the treatment of substance abuse, including smoking, emphasis is also placed upon utilization of non-drug alternatives. The CRA system utilizing non-drug reinforcers, for example, has shown good outcomes (Higgins et al., 1993, 1994). By offering reinforcers after each clean urine specimen, these programs reward progress toward a goal rather than rewarding completed achievement of the goal (abstinence), and the reinforcement value of the non-drug activities can show clients that these activities are also rewarding. Though this type of substitution can result in abstinence, treatment can be compromised when the alternative choices are delayed, as is often the case. For example, when vouchers or monetary reinforcers are offered in place of drug reinforcers, there is often a delay before they can be redeemed for material goods. Thus, when alternative reinforcers are delayed, they become inherently less rewarding than the substance of choice, which is often effective immediately. The most effective

alternate reinforcers, then, may be those which are obtainable immediately rather than after even a short delay.

Temporal Discounting as a Trait or a State

Taken together, the results of the studies reviewed earlier indicate that substance abusers tend to show more rapid rates of discounting than non-substance abusers. As implied by Kirby et al. (1999), this could mean that they either have the tendency to discount rapidly in the first place and they also have the tendency to abuse drugs, or the rapid rates of discounting could be a product of substance abuse. This distinction raises the question of whether discounting is a manifestation of a state (e.g., environmental contingencies) or the result of a trait-like constitutional tendency to discount more rapidly.

Trait View of Temporal Discounting. The literature seems to approach discounting from a trait-perspective, treating it as something individuals "just do," rather than something that is influenced or can be controlled by environmental contingencies. In addition, the theory that discounting and impulsivity are related has been addressed in much of the discounting-addictions literature (Green et al., 1997; Ostaszewski, 1996, 1997; Vuchinich & Simpson, 1998). Further, related traits such as sensation-seeking and introversion-extraversion have also been included in temporal discounting studies (Barratt, 1983; Green et al., 1997; Ostaszewski 1996, 1997). Theoretically, the view that discounting may be internally-driven implies that choosing a drug-related activity over a non-drug activity is indicative of some trait-like impulsive process. The treatment implications for this view are important. If discounting is the result of a trait, it may be important to address that in treatment prior to addressing the

discounting itself or attempting to intervene using any of the traditional methods. If sensation-seeking, for example, particularly influences discounting, specific skills designed to control sensation-seeking behavior may need to be mastered in order to see improvements in discounting rates and subsequent greater ease of smoking or drug-abuse cessation.

Impulsivity has been defined as "the choice of less rewarding over more rewarding alternatives," or simply, the choice of a "poorer, smaller, or more disastrous of two alternative rewards" (Ainslie, 1975, pg. 463). Empirically, it has been demonstrated that drug abusers who are high discounters also show greater levels of impulsivity than non-drug controls who are also lower discounters (Kirby et al., 1999; Madden et al., 1997; Vuchinich & Simpson, 1998). As mentioned earlier, however, it is impossible to determine whether a drug-user's impulsiveness is the result of using drugs or whether it existed prior to drug-use-onset. This question is important since such a determination would permit definition of impulsivity, and perhaps even discounting, as either trait-driven or state-driven. The focus on impulsivity is important for theoretical and treatment implications because the theory that impulsivity could influence one choice over another implies that drug-abuse behavior is not strictly controlled by environmental events but instead at least partially controlled by an internally-driven mechanism. If this is true, treatment approaches may need revision in order to address this component of drug abuse. Further, if traits play a role, then treatment may need to be designed from a much more idiographic standpoint in order to account for varying degrees of impulsivity between clients.

Ostaszewski (1996) addressed the impact of impulsivity and similar traits by performing a study designed to better define the relationship between discounting and sensation-seeking, extraversion-introversion, and impulsivity. He hypothesized three ways in which these traits and discounting could be related. First, discounting of delayed rewards may be due to the risk involved in waiting for them, such that with the increased passage of time, it is more likely that something will happen so that the rewards are not received (Bjorkman, 1984; Green and Myerson, 1996). In this way, lower discounting rates may be related to increased willingness to risk non-receipt of the delayed reward. High sensation-seekers may be more willing to take these risks, as might individuals who are more impulsive. Second, individuals for whom time seems to pass quickly may be less apt to discount the value of future rewards, since the delay may seem less than to someone for whom time passes slowly. Impulsive individuals and extraverted individuals tend to perceive the passage of time as being slower than non-impulsive and introverted individuals (Barratt, 1983; Eysenck, 1959). For them, discounting of delayed rewards may be greater, because the delay between choice and delivery of a reward would seem greater than the same delay would to non-impulsive and introverted individuals. Third, for individuals who are highly influenced by temptation, discounting of delayed rewards may be much higher, because the immediate rewards may seem much more tempting. Extraverted and impulsive individuals tend to be much more strongly susceptible to rewards, or influenced by temptation, than introverted or non-impulsive individuals (Gray, 1970; Nicholson & Gray, 1972).

Results of the Ostaszewski (1996) study suggested that (a) discounting did not differ significantly between high and low sensation-seekers; (b) discounting did not

differ significantly between extraverts and introverts for low amounts ($100) but it did for high amounts ($1000), such that extraverts discounted the higher amounts significantly more than introverts; and (c) impulsive participants discounted both low and high amounts significantly more steeply than non-impulsive individuals. Ostaszewski concluded that these findings lended support to the theory that temperament traits, specifically extraversion and impulsivity, may influence discounting rate. Another study was published by Ostaszewski the following year in which similar results were found (Ostaszewski, 1997).

State View of Temporal Discounting. Contrary to the trait view, the state view of discounting holds that choice of one activity over another is the result of learning history and current environmental contingencies (Ainslie, 1975; Bickel, Madden, & Petry, 1998; Kirby, Petry, & Bickel, 1999; Rachlin, 1995). This view would not consider traits such as impulsivity, sensation-seeking, or extraversion to be factors influencing discounting. According to Kirby et al. (1999), addicted individuals choose immediate rewards because long-term benefits of alternate choices are too far in the future. Further, discounting of the value of the future reinforcers may result in greater negative reinforcement, such as relief of withdrawal symptoms. Behavioral choice theory also addresses discounting behaviorally. It focuses on two types of environmental events that influence drug-use behaviors: environmental constraints preventing access to drugs, and opportunities to engage in reinforcing non-drug activities (Vuchinich & Tucker, 1998). Behavioral Choice Theory proposes that the decision to engage in a behavior is the result of an interaction between the constraints on access to the substance and the alternative activities available. It is well-established

that increased access to a substance leads to increased use of that substance (DeGrandpre & Bickel, 1996; Vuchinich & Tucker, 1988). Further, the literature shows that with increased constraints on non-drug activities, drug use increases (Higgins, 1997; Vuchinich & Tucker, 1988). Behavioral Choice Theory conceptualizes these two concepts within the context of temporal discounting, stating that immediate reinforcers will be chosen when there are few constraints on access to drugs and few opportunities to engage in non-drug activities.

With regard to other state-like conditions that are induced by the environment, Madden et al. (1997) found that opioid-dependent subjects, when offered money or heroin, discounted the value of the money much more rapidly than the heroin. In this study, the authors cited both negative reinforcement of withdrawal-avoidance and positive reinforcement of drug use as factors influencing discounting. Experiences such as withdrawal, and even urges and craving, may not only serve as states that addicted individuals attempt to avoid, but the experience of these states themselves may lead to more rapid discounting. This has not yet been explored in the literature. The current study, however, will examine the impact of environmentally-induced stress and craving on discounting rates. Though the relationship between stress and discounting, and craving and discounting has not been addressed in the literature, the impact of stress on smoking has been explored and will be discussed below.

Stress and Cigarette Smoking

Cigarette smoking and psychological distress interact in a number of ways influencing initiation and continuation of smoking (Breslau, Kilbey, & Andreski, 1993; Dalack & Glassman, 1992). It is well documented that life stress in particular is an

antecedent for increased smoking rates and maintenance of smoking (Hutchison, Collins, Tassey, & Rosenberg, 1996; Schachter, Silverstein, Kozlowski, Herman, & Leibling, 1977), and hinders smoking cessation efforts (Gunn, 1983; Westman, Eden, & Shirom, 1985). Further, it has been shown that smokers are able to tolerate stress longer and at a greater intensity while smoking (Nesbitt, 1973). The following section will include description of theory and research detailing similar findings.

Smoking as a Reaction to Stress

A number of studies have explored the link between smoking and stress or anxiety. Breslau et al. (1993) found that individuals with anxiety disorders have a higher prevalence of smoking than those without such disorders. In comparison to smoking prevalence in participants with no psychiatric illness, the prevalence was twice as high in participants with an anxiety disorder but no depression, three times as high in participants with lifetime history of major depression but no anxiety disorder, and four times as high in participants with co-morbid anxiety and depression. Further, they found that higher smoking prevalence led to more difficult smoking cessation. In contrast, results from another study suggest that, although anxiety and depression together impede quitting, prevalence of anxiety alone does not influence ability to quit (Glassman & Covey, 1996). Together, these findings suggest that anxiety is strongly correlated with a high prevalence of smoking, but that the presence of depression is more strongly linked to smoking rate, and that anxiety and depression together act to further increase the prevalence rates of smoking and increase difficulty quitting. It has been shown that smokers with anxiety disorders report more severe withdrawal symptoms than those without anxiety disorders (Breslau et al., 1993). Other research

shows that, although both anxiety and depression are correlated with severe nicotine withdrawal symptoms, depression is more strongly correlated than anxiety (Breslau et al., 1993; Glassman, 1993; Hughes & Hatsukami, 1986).

Panic has also been studied in relation to smoking. Research has shown that women with panic disorder tend to have a high prevalence of smoking, especially at the onset of their illness, whereas men with panic disorder do not show a higher smoking prevalence than controls at any time during their illness (Pohl et al., 1992). Symptoms of post traumatic stress disorder (PTSD) have been studied as well. One study found that smokers with PTSD reported more severe symptoms including depression and anxiety than non-smokers with PTSD. Veterans in that study reported that they often smoked in response to military-related memories (Beckham et al., 1995). These results further support the link between stress/anxiety and smoking, and present implications for the treatment of smoking in individuals with these disorders, suggesting that it may be most effective to treat the anxiety disorder before treating the smoking behavior.

Himle et al. (1988), examined the prevalence of smoking in psychiatric outpatients being treated for simple phobia, social phobia, agoraphobia, panic disorder, generalized anxiety disorder, and obsessive-compulsive disorder. Results suggested that those with agoraphobia, simple phobia, and panic disorder smoked most frequently, whereas those with obsessive-compulsive disorder, social phobia, and generalized anxiety disorder smoked least. In another study (Glassman, 1993) found that, in clients with anxiety disorders, the rate of smoking was highest in those with agoraphobia and panic disorder.

Westman, Eden, and Shirom (1985), studying work-related stress, found that job stress is related to smoking intensity and that it hinders smoking cessation as well. They also examined social support as a buffer to job stress. They administered measures of job stress and smoking intensity to smokers and ex-smokers. In addition to assessing smoking intensity and attempts at cessation, the questionnaires included items inquiring about overall job stress, role conflict, role ambiguity, amount of time allotted to do work, responsibility for other workers, hours of work, work addiction, social pressure, and intrinsic impoverishment. Also assessed were status at work, degree of participation in work activities, degree of influence over decision making and other work environment factors, quality of working conditions, and degree of peer support.

The factors found to be correlated with increased smoking intensity were hours of work, work addiction, lack of influence over the work environment and decision making, lack of intrinsic reward for work, and lack of support in the work environment. Factors found to be correlated with difficulty achieving cessation were high amounts of responsibility and conflict, hours of work, low status at work, lack of influence over the work environment, and harsh working conditions. Of these factors, only hours of work, work addiction, and overload were shown to predict smoking intensity. In terms of social support, the authors believed that social support would serve as a buffer to stress, thereby lowering smoking intensity. It was found that individuals reporting low levels of peer support smoked significantly more than those who reported high levels of peer support. However, for most of the variables assessed, peer support does not reveal a buffering effect for job stress or smoking intensity. The authors concluded that job stress does in fact lead to smoking intensity and difficulty quitting smoking and that

peer support is helpful to some degree but is not a significant buffer between stress and smoking intensity.

Adolescent Smoking

A review of adolescent smoking research could shed a great deal of light on the link between stress and smoking. The study of adolescents is important because the majority of adults who smoke began during this time (Penny & Robinson, 1986), and the unique stressors experienced in adolescence may be major contributors to smoking initiation and maintenance, indicating that these individuals may begin and even maintain smoking as a stress management technique. Byrne, Byrne, & Reinhart (1995) attempted to better establish the link between stress and smoking onset in adolescents. They asked participants to complete a questionnaire detailing their smoking behavior at intake and at a 12-month follow-up. In addition, at the follow-up, participants were assessed for sources and degree of life stress. The stresses they measured were broken down into seven types: school attendance, family conflict, parental control, school performance, future uncertainty, perceived educational irrelevance, and opposite sex interactions. Smoking status was broken down into (a) non-smokers at intake who remained non-smokers at follow-up, (b) non-smokers at intake who became smokers by follow-up, and (c) smokers at intake who remained smokers at follow-up. Of the categories of stressors, it was found that those related to school followed by those related to family were the most stressful in this sample. Except for school performance, age was statistically unrelated to experience of stress. Gender, however, was related: female participants tended to experience significantly more stress than male participants. Of both boys and girls, stress was lowest in the

group who remained non-smokers and highest in participants who remained smokers. Further, it was found that participants who remained non-smokers scored significantly lower than those in either of the other groups on each of the seven stress categories with the exception of stress of opposite-sex interactions. Finally, participants who became smokers showed significantly higher stress on the scale of school attendance than participants who remained smokers.

Of male participants, it was found that 81.3% remained non-smokers, 9.6% became smokers, and 9.1% remained smokers. Of female participants, 74.4% remained non-smokers, 13.1% became smokers, and 12.5% remained smokers. Girls were more likely to be regular smokers, and girls who were non-smokers at intake were more likely to smoke at follow-up than boys who were non-smokers at intake. The significance of this study lies in the finding that stress is not only associated with current smoking status (smoking status at follow-up) but also with smoking onset from an original non-smoking status (onset of smoking between intake and follow-up). The authors concluded that girls may be more likely to experience stress than boys and may react to this experience by engaging in behaviors such as smoking in order to aide in coping. Other factors, however, that could account for this gender difference in smoking could include peer pressure and modeling of adult women.

Another study examined the incidence of stress, coping skills, and smoking behavior in adolescents. Penny and Robinson (1986) believe that adolescents may begin smoking in order to cope with stressors related to the adjustment demands of this developmental period and that those with fewer coping skills would be more likely to smoke. They examined self-esteem, locus of control, and trait anxiety, hypothesizing

that adolescents with fewer resources to cope, as indicated by low self-esteem, external locus of control, and higher trait anxiety, would be more likely to smoke. The questionnaires also included assessment of happiness and satisfaction with factors related to home, school, peers, and self. The sample consisted of adolescent smokers and non-smokers matched on age, sex, socioeconomic status, family variables, and employment. It was found that adolescent smokers scored lower than their non-smoking peers on self-esteem and higher on trait anxiety, and had a more external locus of control than the non-smokers. Further, the authors found that the smokers experienced lower levels of general happiness and self-satisfaction than their non-smoking peers. Specifically, it was found that smokers rated themselves as being less satisfactory than their non-smoking peers in the areas of family life and school. These findings are consistent with those of Byrne et al. (1995) described earlier. One of the anxiety measures also revealed a significantly greater level of trait anxiety in smokers than non-smokers. The authors cite this finding in support of the idea that, if smoking reduces anxiety, individuals who smoke may experience greater levels of anxiety between cigarettes. The authors conclude that adolescents who smoke do indeed have fewer psychological and coping resources than non-smoking adolescents. They discuss two explanations for this phenomenon. First, it is believed that adolescents who smoke may place lower value on health, and second, adolescents may be using smoking in order to modify mood and manage stress.

Sussman et al. (1993) evaluated coping effort, coping strategies, and perceived stress in adolescent smokers. Coping effort was defined as, "the amount of 'work' the person is willing to do to accomplish an outcome, regardless of specific strategies used

or feelings of self-efficacy to accomplish the objective" (pg. 601). Thus, coping effort does not include specific stress-coping techniques but rather an overall, general willingness or motivation to work to accomplish a goal. In this study, coping effort referred to self-report measures of how hard a participant indicated he or she was willing to try not to smoke. Coping strategies, then, include specific behavioral and cognitive techniques used to accomplish a goal, such as distraction and relaxation. Participants completed instruments assessing smoking behavior and intentions, coping effort, coping strategies, and perceived stress. Results indicated that lower coping effort predicted smoking within seven days prior to testing, lower coping effort coupled with greater stress predicted smoking within seven days prior to testing, greater perceived stress and lower coping effort predicted intentions to smoke in the future, and of specific coping strategies, partying and getting revenge were predictors of current smoking and intention to smoke. These findings suggested that adolescents may smoke if they have a low willingness not to smoke, if they experience stress together with a low willingness not to smoke, or if they use maladaptive means of managing stress. Here, stress combined with low motivation to remain non-smoking is predictive of smoking status in adolescents.

Limitations of Existing Research

Research on the principles and mechanisms of behavioral economics and discounting is excellent, with very few empirical gaps. Further, there is abundant evidence that smoking is influenced by stressors and a smaller but compelling body of evidence that stress influences craving in smokers. With regard to factors that impact discounting, there has been some focus on traits but significantly less on environmental

contingencies that may affect it. The relationship between discounting and impulsivity has been studied, and it is clear that the two may be linked. But, there is still very little understanding of the impact of factors such as stress and craving, which are environmentally induced. Finally, discounting has been studied within the context of drug self-administration and drug treatment, but research examining the relationship between discounting and other drug behaviors such as relapse remains unaddressed. The current study will attempt to fill in some of these gaps by examining the relationship between discounting, stress, and cigarette craving.

Purpose of This Study

This study was designed to examine two questions with regard to the relationship between stress, discounting, and craving. The first was, does stress, which may be best understood as a state phenomenon, increase the rate of temporal discounting in smokers and non-smokers? The second was two-fold: does stress exacerbates cigarette craving in smokers? If so, what factors best predict that increased post-stress craving? To answer these questions, participants were divided into four groups: smokers and non-smokers who were to complete a stress-task (Stress Groups), and smokers and non-smokers who were not to complete a stress-task (Non-Stress Groups). In all groups, discounting was measured at the onset of the study (Time 1, pre-stress), and then following completion of the Stress Groups' activity or corresponding non-stressful activity for the Non-Stress Groups (Time 2, post-stress). Stress and craving, if applicable, were measured at the study's onset, immediately prior to the stress-task, immediately following the stress-task, and at the conclusion of the study.

The first question was addressed by comparing the hyperbolic function (k-values) of each group's Time 1 discounting rates with their Time 2 discounting rates. If stress increased temporal discounting, stressed participants' discounting rates should have increased between Time 1 and Time 2, and the non-stressed participants' discounting rates should have remained unchanged between Time 1 and Time 2.

The second question was to be addressed by first determining whether craving was significantly higher in Stressed Smokers than Non-Stressed Smokers following the stress task. Times 1, 2, and 3 scores on the instruments measuring craving were compared. If stress increased craving, Times 2 and 3 (post-stress) scores should have been significantly higher than Time 1 (pre-stress) scores for Stressed Smokers but not Non-Stressed Smokers. If craving was found to increase as a function of stress, the degree to which Time 1 craving, group (Stress versus Non-Stress) and Time 1 temporal discounting each predicted the higher post-stress craving in Stressed Smokers would be evaluated.

Hypotheses

In regard to the first question, we hypothesized that stress would significantly increase the rate of discounting in smokers and non-smokers. Specifically, we expected that stressed participants' Time 2 discounting rates would be significantly higher than their Time 1 discounting rates. Further, we expected non-stressed participants' discounting rates to remain unchanged between Time 1 and Time 2. If discounting rates increased following stress induction, we would consider this to be an indication that discounting may be state-driven rather than purely trait-driven.

With respect to the second question, we expected to find that stress exacerbated craving in Stressed Smokers but not in Non-Stressed Smokers. With regard to factors predicting higher post-stress craving, we expected that the group (stressed versus non-stressed smokers) would account for most of the variance in craving, followed by Time 1 craving, and finally by Time 1 discounting.

Method

Participants

Participants were 68 undergraduate students in psychology courses at Oklahoma State University and were recruited as volunteer participants in this study. Of these, six were excluded from data analysis, five because of changes in the HMCT computer program and one due to failure to collect HMCT data. Inclusion criteria consisted of being 18 years of age or older and self-reported smoking of a minimum of 10 cigarettes per day. Obtaining statistically significant k-values, as measured by the HMCT, was the criterion for inclusion in data analysis. The procedure for determining the significance of k-values and the rationale for inclusion of only statistically significant k-values will be discussed below.

Measures

Two types of measures were used: descriptive measures and dependent measures, which included measures used to asses the effectiveness of the stress-task (STAI-S and EAS). An outline of the study procedure and schedule of measures is provided in Appendix C.

Descriptive Measures

Measures used for describing the sample were administered only once, at the beginning of the session. These were a demographic instrument, the Fagerström Test for Nicotine Dependence (FTND), Beck Anxiety Inventory (BAI), Inventory to Diagnose Depression (IDD), and Substance Abuse Questionnaire (SAQ).

Demographic Questionnaire. This nine-item measure was developed by the experimenters and inquires about participants' age, sex, grade level, income, smoking status, and number of quit attempts.

Fagerström Test for Nicotine Dependence (FTND; Fagerström, 1978; Heatherton, Kozlowski, Frecker, & Fagerström, 1991). The FTND is a self-report, 6-item inventory designed to assess dependence on nicotine as indicated by smoking habits. The instrument assesses number of cigarettes smoked per day, time until first cigarette, and which cigarette would be most difficult to give up. Scores range from zero to 10 with higher scores indicative of more severe nicotine dependence. The FTND has been found to be a valid measure of nicotine dependence (Heatherton et al., 1991). It is a revised version of the Fagerström Tolerance Questionnaire (FTQ; Fagerström, 1978), and revisions from the FTQ have been reported to have improved the scale. Further, the FTND yields higher face and predictive validity than the FTQ (Heatherton et al., 1991).

Beck Anxiety Inventory (BAI; Beck, Brown, Epstein, & Steer, 1988). The BAI is a 21-item self report measure designed to assess severity of anxiety by inquiring about symptoms of anxiety such as feeling unsteady, shaky, nervous, fear of losing control, and sweating. Participants are instructed to rate each item on a scale ranging

from "not at all" to "severely: I could barely stand it." Scores range from zero to 63, with higher scores indicating more severe anxiety. The BAI has been shown to have high test-retest reliability with a coefficient of .75 and high internal consistency, with a coefficient of .92 (Beck et al., 1988).

Inventory to Diagnose Depression (IDD; Zimmerman, Coryell, Corenthal, & Wilson, 1986). The IDD is a 26-item self-report instrument designed to assess duration and severity of depression based upon criteria described in the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV; American Psychiatric Association, 1994). Participants are instructed to indicate which of four statements associated with each item best describes the way they have been feeling during the previous two weeks. Scores range from 0-88, with higher scores indicating more severe depressive symptomology. The IDD has been shown to have good concurrent validity, as indicated by strong correlations between it and other measures of depression (Zimmerman & Coryell, 1987; Zimmerman, Coryell, Corenthal, & Wilson, 1986).

Substance Abuse Questionnaire (SAQ). This instrument was developed by the experimenters and is designed to assess for alcohol and other drug abuse. Its seven items inquire about participants' frequency of alcohol and drug use within the past 12 months as well as the types of drugs used. This brief assessment was done on the basis of findings that substance abuse is correlated with high rates of discounting (Bickel et al., 1998; Green et al., 1997), and was used only as a screening tool to identify participants whose self-report of substance use was markedly high compared to that of other participants.

Dependent Measures

The dependent measures consisted of one measure designed to assess discounting rate, two measures designed to assess degree of craving, and two designed to assess anxiety. The discounting measure (HMCT) was administered twice, and the other measures were administered four times. The HMCT was administered to the participant first upon his/her arrival (Time 1, pre-stress), and once again following preparation for the stress-task (Time 2, post-stress). The craving and anxiety measures were administered upon participant arrival (Time 1), following introduction of the stress-task (Time 2), immediately prior to the stress-task (Time 3), and following completion of the stress-task (Time 4). These measures were administered at commensurate times for non-stressed participants. See Appendix C for study procedure and schedule of measures.

Hypothetical Money Choice Task (HMCT; Rachlin, Raineri, & Cross, 1991). This instrument was developed as a measure of temporal discounting. More specifically, the HMCT is used to derive k-values, which describe the rate at which the value of a reinforcer is discounted. It has both paper-and-pencil and computer administrations, and the computer version will be used in this study. Both require approximately 20 minutes to complete. On the HMCT, participants are asked to choose between pairs of monetary values, one of which is hypothetically available immediately and the other of which is hypothetically available after a period of delay. Both the amounts available and the periods of delay are varied. The instrument is designed to determine the point at which participants begin to value the immediate amount over the delayed amount. In the HMCT, 480 pairs of monetary values are presented. One of the

pair is always offered immediately, and the other is offered at delays of one week, one month, six months, and one, three, five, ten, and twenty-five years. During the first 240 presentations, the amounts of money offered immediately descend from $1000 to $1 while the amount offered at the delays is held at $1000. During the second 240 presentations, the amount of money offered immediately is held at $1000 while the amounts of money offered at the delays ascend from $1 to $1000. Test-retest reliability has been shown to be good both over the course of one testing session and after a period one week, with coefficients ranging from .74 to .91. Further, it is indicated that this measure of temporal discounting correlates with other behavioral measures of the same construct (Simpson & Vuchinich, 2000).

Questionnaire of Smoking Urges (QSU; Tiffany & Drobes, 1991). The QSU consists of 32 self-report items assessing desire to smoke, anticipation of pleasure gained from smoking, anticipation of relief from negative affect and withdrawal symptoms, and intention to smoke. Participants are instructed to indicate degree of agreement with each item on a 7-point Likert scale, where 1 is "Strongly Disagree" and 7 is "Strongly Agree." Scores range from 32 to 224, with higher scores indicating greater urge to smoke. Factor analyses on this instrument revealed two separate factors. Factor 1 describes desire to smoke, intention to smoke, and anticipation of positive outcome gained by smoking, while the majority of Factor 2 items indicate relief of withdrawal symptoms and relief of negative affect. The analyses of these factors suggest that the QSU is a highly reliable instrument, with internal consistency for Factor 1 and Factor 2 .95 and .93 respectively and an intercorrelation coefficient of .71 (Tiffany & Drobes, 1991). For this sample, Chronbach's alpha was .93 for Time 1, .95

for Time 2, and .96 for Time 3 in non-smokers and smokers with any FTND score. In non-smokers and smokers with FTND scores of four or greater, Chronbach's alpha was .92 for Time 1, .95 for Time 2, and .96 for Time 3.

Nicotine Abstinence Scale (NAS; McChargue et al., 1997). The NAS is a modified version of the Withdrawal Symptoms Checklist (Hughes & Hatsukami, 1986). It consists of 14 self-report items assessing presence and severity of withdrawal symptoms, including feeling irritable, restless, impatient, angry, and frustrated. Participants are asked to rate each symptom on a 4-point Likert scale, where 0 is "None," and 4 is "Severe." Scores range from 0 to 39, with higher scores reflecting more severe nicotine withdrawal symptoms. For this sample, Chronbach's alpha was .86 for Time 1, .85 for Time 2, and .87 for Time 3 in non-smokers and smokers with any FTND score. For non-smokers and smokers with FTND scores of four or greater, Chronbach's alpha was .84 for Time 1, .77 for Time 2, and .83 for Time 3.

State-Trait Anxiety Inventory-State (STAI-S; Spielberger, Gorush, & Lushene, 1970). The STAI is an instrument with subscales measuring state anxiety (STAI-S) and trait anxiety (STAI-T). They can be used separately, and only the State subscale was used in this study. This subscale is a 20-item instrument assessing transient, state-induced anxiety. It is a self-report measure on which participants are asked to indicate the degree to which they are currently experiencing a variety of symptoms indicative of either anxiety or calmness (feeling tense, strained, worried, jittery, secure, at ease, satisfied, steady). Responses range from 1 ("Not at All") to 4 ("Very Much So"). Half the items are reverse-scored, after which scores range from 20 to 80, where higher scores indicate greater levels of state anxiety. This instrument has been demonstrated to

have good psychometric properties. Test-retest reliability for the State scale ranged from .16 to .62 and for the Trait scale ranged from .65 to .86. The lower test-retest reliability demonstrated by the State subscale may be attributed to environmental factors present at the time of testing (Spielberger et al., 1970). In fact, this instability may be an indication of good construct validity, since measures of state-dependent emotions would be expected to fluctuate to a greater extent than measures of trait-dependent emotions. For this sample, Chronbach's alpha was .91 for Time 1, .93 for Time 2, and .92 for Time 3 for non-smokers and smokers with any FTND score. For non-smokers and smokers with FTND scores of four or greater, Chronbach's alpha was .92 for Time 1, .91 for Time 2, and .92 for Time 3.

Emotion Assessment Scale (EAS; Carlson et al., 1989). The EAS is a 24-item, self-report instrument. It was designed to measure current emotional state and is divided into eight subscales: Surprise, Fear, Disgust, Anger, Guilt, Anxiety, Sadness, and Happiness. Only the Anxiety and Fear subscales were used in this study. Responses range from 1 ("Least Possible") to 7 ("Most Possible"), and scores range from 3 to 21, where higher scores reflect greater levels of that emotion. This instrument demonstrates good psychometric properties, with coefficients for interitem reliability ranging from .70 to .91 and a split-half reliability coefficient of .94. Content validity was established, and the EAS demonstrates good criterion validity as well, correlating with other measures of mood (Carlson et al., 1989). For this sample, Chronbach's alpha was .83 for Time 1, .79 for Time 2, and .77 for Time 3 for non-smokers and smokers with any FTND score. For non-smokers and smokers with FTND scores of four or greater, Chronbach's alpha was .70 for Time 1, .71 for Time 2, and .65 for Time 3.

Procedure

Sixty eight individuals participated in the study. Both smokers and non-smokers were randomly divided into two groups: Stress Group, which would be assigned the public speaking task, and Non-Stress Group. Thus, four groups were formed: Stressed Smokers, Stressed Non-Smokers, Non-Stressed Smokers, and Non-Stressed Non-Smokers.

All potential participants were recruited from undergraduate psychology classes at Oklahoma State University. Instructors of these classes were approached and asked to distribute a short survey regarding smoking habits. Based upon responses to these surveys, potential participants were contacted by telephone. Only those indicating that they were 18 years of age or older and, for smokers, smoking at least 10 cigarettes per day, were contacted. When contacted, they were told that there may be an opportunity to participate in a study investigating the influence of personality factors on smoking behavior and that they may be able to earn extra credit in the psychology class for their participation. Those indicating further interest were asked to confirm their age and the number of cigarettes smoked per day. Those who met inclusion criteria and remained willing to participate were scheduled for an experimental session. They were told that the session would last approximately two hours, and smokers were asked to bring their current brand of cigarettes. Reminder calls were placed the day prior to the experimental session, at which time smokers were again asked to bring their current brand of cigarettes.

Appendix C contains an outline of the study procedure and measures administered. Upon arrival to the experimental session, participants were received into

the laboratory, the investigator briefly explained the study, and they were asked to read and complete an informed consent form. After its completion, they were asked whether they had any questions, their questions were answered, and they were given a copy of the consent form to keep. Smokers were directed into a separate room and asked to smoke a cigarette. Non-smokers were given a 10-minute break and asked to read magazines, which were provided for them. All groups were then asked to complete the Demographics Questionnaire, SAQ, BAI, IDD, STAI-S Time 1, and EAS Time 1. Smokers also completed the FTND, QSU Time 1, and NAS Time 1. These measures were collected at this time in order to gain a description of the sample on variables of anxiety and depression, drug and alcohol use, and nicotine dependence. They were also given in order to obtain baseline, pre-manipulation measures of current anxiety, fear, surprise, urge to smoke, and withdrawal symptoms. Following completion of the instruments, participants were seated in front of a computer and asked to read instructions for taking the HMCT, which were presented on the computer screen. These instructions were then verbally reviewed with participants, and they were asked whether they had any questions. Questions were answered, and participants were instructed to begin the HMCT Time 1. Completion of all these instruments, including the HMCT, took no more than 60 minutes.

Following completion of the HMCT Time 1, the stress-task was introduced to participants in the Stress Groups. They were told that they would soon be asked to give a three-minute speech but would first be allowed 10 minutes to prepare for it. They were instructed to prepared "mentally," and were not allowed paper and pencil. They were informed that the topic would be "What I dislike about my body and my physical

appearance," and that the speech would be videotaped and viewed by psychology graduate students who would evaluate the participant's speaking style for psychological factors such as openness and defensiveness. This activity was chosen because of its successful induction of anxiety and stress in other studies (cf., Glad & Adesso, 1976; Dobbs, Strickler, & Maxwell, 1981; Rose, Ananda, & Jarvik, 1984) and in which anxiety has been shown to be induced via speaking to a group of individuals who are somehow in positions of authority (Mulac & Sherman, 1975). Non-stress participants were informed that they would soon be asked to read magazines for 10 minutes. First, however, both groups completed the STAI-S Time 2 and the EAS Time 2 in order to gain a measure of the stress and anxiety experienced upon introduction of the stress-task and to compare that with stress experienced by the Non-Stress Groups. Smokers completed the QSU Time 2 and the NAS Time 2 in order to measure degree of urge and craving following introduction of the stress-task. Participants were then left for 10 minutes to either prepare for the speech or to read magazines. Following this 10 minute period, participants completed the STAI-S Time 3, EAS Time 3, and smokers also completed the QSU Time 3 and NAS Time 3, again for purposes of comparison of stress and craving levels. Participants were then asked to take the HMCT Time 2 in order to obtain a measure of discounting following introduction of the stress-task.

When finished with the HMCT Time 2, the investigator entered the testing room, turned the video camera on, and began recording. Participants in the Stress Groups were shown where to stand and were asked to begin the speech immediately after the experimenter left the room. Individuals in the Non-Stress Groups were asked to read magazines. Both groups were told they would be interrupted after three

minutes. After three minutes, participants were interrupted and the video camera was turned off. They were asked to complete the STAI-S Time 4, EAS Time 4, and smokers also completed the QSU Time 4 and NAS Time 4. Participants were then debriefed. In the debriefing, the goal of the study was explained, including the purpose of the instruments and the public speaking task. They were informed that, while they had been recorded, the experimenter was unable to hear them and that the tape would not be reviewed or rated and instead will be destroyed. They were given phone numbers to local mental health service organizations in case of distress caused by the stress-task and then excused. Their names were given to the appropriate psychology professors together with number of hours of participation for the purposes of extra-credit allotment.

Results

This study contained two objectives: Objective 1 was to determine whether stress increases the rate of temporal discounting in smokers and non-smokers. Objective 2 was to determine whether stress exacerbates cigarette craving in smokers; if so, what factors, including stress, best predict post-stress craving. There were two independent variables with two levels each: smoking status (smoker and non-smoker), and stress (stressed and non-stressed). Dependent variables were temporal discounting, anxiety, and craving, as measured by the HMCT, STAI-S, EAS, QSU, and NAS. The HMCT was measured at two assessment points, and the remaining instruments were measured at four assessment points.

To perform analyses necessary to evaluate each objective, participants with significant k-values were differentiated from those without significant k-values. The

procedure used to obtain k-values and the rationale for the use of only significant k-values in analyses will be discussed in the following pages. Information regarding the sample will then be presented, followed by presentation and interpretation of the data yielded in analyses of Objectives 1 and 2.

k-Values

In brief review of information discussed in the Literature Review, the hyperbolic model of temporal discounting assumes a decrease over time in a reinforcer's value. In the model, k indicates the degree of decrease in the reinforcer's value. Larger k-values indicate steeper rates of discounting, and smaller k-values indicate shallower rates of discounting. The HMCT presents choices between various amounts of money and various delays (see Appendix B for example), and these choices define ranges of discounting rates. Based upon participant pattern of choices across these discounting rates, k-values were derived that ultimately represent the point at which the participant switches to value the immediately-offered choice over the delayed choice. In other words, it defines the rate at which the value of delayed reinforces are discounted. Through nonlinear regression, it is possible to determine the degree to which the k-value fits the participants' raw data. If the fit is good, the k-value is considered significant, and if it fits poorly it is considered non-significant. In other words, having a significant k means that the slope estimated by nonlinear regression is sufficiently close to the participant's raw data. Data for participants with non-significant k-values was excluded from data analyses because the estimate of the slope from these data is unrepresentative of the participant's raw data.

Determination of k-value significance

Once the raw data from the HMCT was obtained, nonlinear regression analyses were used to estimate k-values for each participant, as noted above. The results of these analyses were submitted to independent samples t-tests, which revealed the adequacy, or significance, of k-values. In this study, participants with significant k-values accounted for 83.9% (n=52) of the sample, and those with non-significant k-values accounted for 16.1% (n=10). Reasons for non-significant k-values may have included participants intermittently choosing the immediate and the delayed amounts of money or otherwise responding randomly to the HMCT, possibly due to boredom, disinterest, or desire to finish quickly. Either style of responding may have resulted in failure to have one point at which the immediately-available money was preferred over delayed money, resulting in a non-significant, or non-fitting, k-value.

Sample Characteristics

Sixty eight participants were tested. Six of these were excluded from data analysis: all five pilot participants due to changes in the HMCT computer program after their data had been collected, and another participant because of failure to collect HMCT data due to computer problems. This left 31 smokers and 31 non-smokers for analysis of significant of k-values. Of these 62 participants, 10 were excluded from further analyses due to non-significant k-values. In order to determine whether results held true for all smokers regardless of degree of nicotine dependence, analyses were performed twice, once with smokers, regardless of FTND score and once with smokers with FTND scores of four or greater. Based upon scoring of the instrument, it is believed that scores of four or greater indicate a higher level of nicotine dependence,

though there are no formal, published cutoffs. Table 1 depicts the sample's demographic information for the following variables: sex, age, education, mean IDD and BAI scores, and mean number of cigarettes smoked per day, number of quit attempts during the last 12 months, and mean FTND score for smokers. Table 2 depicts the breakdown of participants by smoking status, stressed versus non-stressed, sex, significant k-value, and FTND score. With regard to the BAI and IDD data, two participants did not correctly complete the IDD and BAI, so their data could not be used. Finally, with regard to drug and alcohol use, no participant reported use of alcohol or drugs markedly exceeding that which other participants reported, as reported on the SAQ.

Smoker and Non-Smoker Differences: HMCT, Anxiety, and Depression

To determine whether smokers and non-smokers were different on baseline temporal discounting, smokers' Time 1 k-values were compared with non-smokers' Time 1 k-values using an independent samples t-test. Data were analyzed first using smokers regardless of FTND score and then again using only smokers with FTND scores of four or greater. When smokers with any FTND score were compared to non-smokers, there were no significant differences on Time 1 temporal discounting. However, when the sample was restricted to smokers whose FTND scores were four or greater, there was a significant difference between smokers and non-smokers, where smokers had higher k-values than non-smokers (t [40]= -1.949, p<.029; see Figure 1). This finding indicates that smokers who are more nicotine-dependent discount the value of delayed rewards more rapidly than non-smokers.

In order to determine whether one group had higher baseline levels of anxiety and/or depression, smokers and non-smokers were compared on BAI and IDD scores. This comparison was done using an independent samples t-test, and smokers were again evaluated according to FTND score. Regardless of FTND score, smokers were significantly higher in anxiety

(t [49]= -2.538, p<.015) and depression (t [49]= -2.513, p<.015) than non-smokers. In the restricted subject pool of smokers with FTND score of four or greater, depression was again significantly higher (t [39]= -2.577, p<.016), and anxiety near-significant (t [39]=-1.856, p<.076). Together, these findings indicate that smokers in general have significantly higher depression and anxiety than non-smokers. The second finding indicates that more highly addicted smokers have more depression than non-smokers but not higher anxiety than non-smokers, though there is less confidence in this last finding.

Higher initial levels of anxiety and/or depression in the Stress Group versus the Non-Stress Group could have potentially affected outcome on the stress task. To determine whether there were differences in baseline anxiety and/or depression in participants who were eventually stressed or not stressed, independent samples t-tests were again used. Results showed no significant differences between stressed and non-stressed participants on baseline anxiety or depression. This finding is consistent when all participants, including those with any FTND score are included, as well as when the pool is restricted to only those with FTND scores of four or greater.

Objectives 1 and 2

In order to evaluate Objectives 1 and 2, it was necessary to evaluate the manipulation check to determine whether the stress-task induced anxiety in participants to whom it was assigned. It is important to note that, in this study, stress and anxiety are referred to interchangeably. To evaluate Objective 1, the anxiety scales were submitted to a 2x2 repeated measures Analysis of Variance (ANOVA). These scales included the STAI-S and EAS (Surprise, Fear, and Anxiety Subscales). The ANOVAs were performed first for participants with any FTND score. On the STAI-S, there was a significant effect for Time x Stress (F [1, 43]=13.90, $p<.001$). Examination of the means indicated that over time, participants in the Stress Groups became significantly more anxious than those in the Non-Stress Groups. This finding suggests that the stress-task was successful in inducing anxiety in smokers and non-smokers in Stress Groups. In participants with FTND scores of four or greater, the findings are similar with regard to the STAI-S: there was a significant effect for Time x Stress (F [1, 34]=9.81, $p<.004$). Together, these findings indicate that, according to one measure of anxiety, smokers and non-smokers in the Stress Groups became significantly more anxious than those in Non-Stress Groups. These findings hold true for smokers with any level of nicotine dependence. Figures 2 and 3 depict these interactions, and Table 3 contains an ANOVA table summarizing these results.

According to the EAS subscales, results were more variable. On the Surprise subscale, there were no significant findings for participants with any FTND score. However on the Fear subscale, there was a significant effect for Time x Stress (F [1, 46]=11.38, $p<.002$), indicating that over time, participants in the Stress Group

experienced significantly more fear than those in the Non-Stress Group. On the Anxiety subscale, there was also a significant effect for Time x Stress (F [1, 46]=19.70, p<.000). For participants with FTND scores of four or greater, results are similar. There were again no significant findings on the EAS Surprise subscale. However, on the Fear subscale, there was a significant Time x Stress effect (F [1, 36]=8.52, p<.006), as there was on the EAS Anxiety subscale (F [1, 36]=13.26, p<.001). Together, findings from the EAS showed that, for smokers regardless of nicotine dependence and for non-smokers, those in the Stress Groups experienced significantly greater anxiety and fear, but not surprise, than those in the Non-Stress Groups. Figures 4, 5, 6, and 7 depict these four interactions, and Tables 4 and 5 contain ANOVA tables summarizing these results. The measures included in these analyses were those surrounding the introduction to and preparation for the stress-task (STAI-S and EAS Times 1, 2, and 3). We are able to conclude, therefore, that the stress-task was successful in inducing anxiety and fear in Stress Group participants.

Objective 1

The goal of Objective 1 was to determine whether stress increases the rate of temporal discounting in smokers and non-smokers. To evaluate this, a 2x2x2 repeated measures ANOVA was performed comparing participants' HMCT Time 1 and Time 2 values. Results indicated that the Time x Stress effect was non-significant, suggesting that temporal discounting was unaffected by stress. This finding holds true for analyses done with non-smokers and smokers with any FTND score (F [1, 39]=.150, p<.701), and with non-smokers and smokers with FTND scores of four or greater (F [1, 31]=.601, p<.444). Thus, while the stress task was successful in inducing anxiety and

fear in Stress Group participants, this anxiety and fear did not change the rate of temporal discounting in Stressed Smokers or Stressed Non-Smokers. Further, as expected, there was no change between pre-stress and pos-stress temporal discounting in either group of Non-Stressed participants. Table 6 contains an ANOVA table summarizing these results.

Objective 2

The goal of Objective 2 was to determine whether stress exacerbates craving in smokers, and if so, what factors including stress best predict that increased post-stress craving. Thus far, findings have indicated that: (a) smokers showed significantly greater overall anxiety and depression than non-smokers, according to the BAI and IDD; (b) participants in the Stress Group experienced significantly greater anxiety and fear than Non-Stress participants, according to the STAI-S and EAS subscales, and (c) regardless of this greater level of anxiety and fear, temporal discounting did not change in Stress Group participants as a result. Since it was shown that the stress-task was successful, we proceeded with evaluation of Objective 2. Prior to performing a multiple regression analysis to determine which factors best predicted post-stress craving, which we hypothesized would increase, we did a 3x2 repeated measures ANOVA in order to determine whether craving did indeed increase following the stress-task. Here, Times 1, 2, and 3 of each craving measure (QSU and NAS) were compared in Stressed and Non-Stressed Smokers. Analyses revealed a significant Time x Craving effect for each instrument. For smokers with any FTND score, there was a significant Time x Craving effect on the QSU

(F [1, 14]=33.38, p<.000), and on the NAS (F [1,24]=20.75, p<.000). For smokers with FTND scores of four or greater, results were similar for the QSU (F [1, 8]=22.14, p<.002) and the NAS (F [1, 14]=7.30, p<.17). However, there was no significant Time x Stress effect on either instrument, regardless of smokers' FTND scores. These results indicate that craving increased significantly for all smokers with time. However, Stressed Smokers did not experience significantly greater craving than Non-Stressed Smokers. In other words, participants showed significantly higher levels of craving with time, but this increase in craving was not affected by the stress-task. To further evaluate the relationship between stress and craving, correlation analyses were performed to determine whether Craving was significantly correlated with Stress, the variable used to denote whether participants were in the Stress or Non-Stress group. Findings indicated that Stress and Craving were uncorrelated. Since craving was shown to be unaffected by stress, analyses evaluating predictors of the hypothesized increase in post-stress craving were not performed. Table 7 contains an ANOVA table summarizing these results.

Discussion

This study was designed to answer two questions with regard to stress, temporal discounting, and smoking: (a) does stress increase the rate of temporal discounting in smokers and non-smokers, and (b) does stress exacerbate craving in smokers; if so, what factors including stress best predict that increased post-stress craving? To address these questions, participants were divided into four groups: Stressed Smokers, Stressed Non-Smokers, Non-Stressed Smokers, and Non-Stressed Non-Smokers. Analyses were done twice, once with non-smokers and smokers with any FTND score, and again with

non-smokers and smokers with FTND scores of four or greater. This was done to determine whether results generalized to individuals with any level of nicotine dependence. In the following pages, a review of the analyses and findings will be conducted, and interpretation of the findings will be presented. Discussion of temporal discounting as a state- or trait-driven phenomenon will be reviewed and discussed in light of the study's findings. Finally, limitations of the study will be presented and future directions for future research suggested.

Initial Findings

Before addressing the two objectives, baseline discounting rates in smokers and nonsmokers were evaluated, and findings indicated that smokers showed higher rates of discounting than non-smokers. Findings revealed significant differences in baseline temporal discounting between smokers with FTND scores of four or greater and non-smokers. These differences were not found in smokers with any FTND score. This suggests that only smokers who are relatively more nicotine-dependent have higher discounting rates compared to non-smokers. In other words, these individuals discount the value of delayed reinforcers at significantly higher rates than non-smokers. This finding is consistent with data from previous studies of both smokers (Bickel et al., 1999) and substance abusers in general (Kirby et al., 1999; Madden et al., 1997; Vuchinich & Simpson, 1998).

Examination of baseline anxiety and depression revealed significantly higher levels of anxiety and depression in smokers than in non-smokers, regardless of the degree of nicotine dependence. When the subject pool was restricted to smokers with higher nicotine dependence, the significant difference in depression remained, but the

difference in anxiety was only near-significant. It is unclear why this significant difference in anxiety would drop out in the restricted pool, since these participants had higher nicotine dependence and anxiety and depression have been shown to be higher in individuals with stronger nicotine dependence (Breslau et al., 1993; Glassman, 1993; Hughes & Hatsukami, 1986). However, if this restricted pool had been larger, the differences might have remained significant. Anxiety and depression in participants who were eventually in the Stress Groups with those who were in the Non-Stress Groups was also compared, since significantly higher baseline anxiety or depression in participants eventually to be stressed could impact anxiety scores surrounding the stress task. No significant differences were found.

Objective 1

The goal of Objective 1 was to determine whether smokers and non-smokers discounted the value of delayed reinforcers at higher rates during transient, environmentally-induced states of higher stress or anxiety. To evaluate the effect of stress, it was first necessary to do a manipulation check to determine whether the stress-task was successful in inducing stress or anxiety. Findings indicated that participant anxiety levels increased significantly following introduction of the stress-task regardless of smoking status or stress group status. Further, participants in the Stress Groups showed significantly higher anxiety and fear than participants in the Non-Stress Groups. These findings suggest that the stress-task was successful and hold true across levels of nicotine dependence. Interestingly, neither finding is true for the EAS Surprise subscale, perhaps indicating some expectation participants had that they would be asked to complete the stress-task regardless of whether it was actually assigned to them.

Since it was shown that the stress-task was successful in inducing anxiety, Objective 1 was addressed. Findings indicated that stress did not affect the rate of temporal discounting in any of the experimental groups. There was no significant change between Time 1 (pre-stress) and Time 2 (post-stress) discounting for non-smokers or smokers regardless of level of nicotine dependence. These results indicate that, though the stress task elicited anxiety and fear, discounting was not responsive to these emotional states. There could be several reasons for this finding. Though participants became significantly more anxious as a result of the stress-task, the anxiety may not have been strong enough to elicit changes in discounting. As students, participants may be adept at controlling their behavioral response to anxiety, maintaining functioning regardless of stressful conditions such as those induced by exams or other stressful school work. Perhaps, by virtue of being students, participants were less prone to discount the value of future reinforcers (e.g., the college degree) even under adverse conditions. The fourth explanation involves degree of nicotine dependence. The literature shows increases in discounting with substance abusers including smokers (Bickel et al., 1999; Kirby et al., 1999; Madden et al., 1997; Vuchinich & Simpson, 1998). Even though a portion of the smokers in this sample showed relatively high nicotine dependence, most showed moderate to low levels. The nicotine dependence in this sample may not have been strong enough to produce changes in discounting similar to those seen in the literature. Finally, some participants may have taken the HMCT with the goal of completing it quickly rather than accurately. Potential solutions to this problem are discussed below.

Objective 2

The goal of the second objective was to determine whether stress exacerbated craving in smokers, and if so, what factors best predicted the higher level of post-stress craving. Analyses were performed to determine whether stressed smokers did, in fact, show higher levels of craving than non-stressed smokers. Results indicated that, regardless of whether smokers were stressed and regardless of their degree of nicotine dependence, there was a significant effect for Time x Craving on both measures of craving. This indicated that all smokers experienced greater craving as the study progressed. This finding was to be expected, given that craving generally increases as time passes since last cigarette. However, no significant Time x Stress effect was found for either measure of craving, in either group of smokers. This indicates that the stressed smokers experienced craving no differently than the non-stressed smokers. Another way to evaluate this question was to perform correlations to determine whether either craving measure was correlated with either group (e.g., Stress Group or Non-Stress Group). Findings showed no significant correlation between these variables. Had craving been shown to increase as a result of stress, a multiple regression analysis would have been performed to determine the factors best predicting that higher level of post-stress craving. Specifically, Time 1 (pre-stress) craving, Time 1 (pre-stress) temporal discounting, and Group (Stress Group versus Non-Stress Group) would have been taken into account. However this analysis would have been irrelevant to our Objective without a stress-induced increase in craving.

There are two explanations for the failure for craving to increase following stress- induction. First, participants' nicotine dependence may not have been strong

enough to lead to increase in craving as a result of emotional states. Second, the delay between participants' last cigarette and the post-stress craving measure was approximately one hour. During this time, participants' craving increased, but the craving may not have increased to the extent that it was affected by stress. Again, as students, participants may have been accustomed to functioning at a consistent level despite discomfort. Finally, perhaps with a longer time delay between the last cigarette and Time 2 discounting measure, craving would have been more sensitive to anxiety. The delay was approximately one hour, but that may not have been sufficient to produce strong indications of craving.

Temporal Discounting as a State or a Trait

As discussed in the literature review, the temporal discounting literature is somewhat conflicted regarding its view of temporal discounting as a product of the environment or as an idiographic, trait-driven phenomenon. One of our tertiary goals was to shed light on this debate using the results obtained in this study. The state view of discounting, as discussed earlier, holds that the behavior of discounting the value of delayed reinforcers is the result of learning history and current environmental contingencies (Ainslie, 1975; Bickel et al., 1998; Kirby et al., 1999; Rachlin, 1995). According to this view, reinforcement is gained by choosing a more immediate reinforcer over a delayed one, and delayed reinforcers are discarded because their benefits are too far in the future. Contrary to the trait view, this perspective does not consider factors such as impulsivity, sensation-seeking, or extraversion to influence discounting. The trait-view, on the other hand, conceptualizes such factors as significant in discounting behavior. Specifically, impulsivity has been discussed as the

trait driving temporal discounting (Ostaszewski, 1996, 1997; Vuchinich & Simpson, 1998) and has been defined in a way nearly synonymous with temporal discounting: "the choice of less rewarding over more rewarding alternatives," and the choice of "poorer, smaller, or more disastrous of two alternative rewards" (Ainslie, 1975, pg. 463). There is an abundance of empirical support showing that drug abusers tend to have higher impulsivity than non-abusers (Green et al., 1997; Ostaszewski, 1996, 1997; Vuchinich & Simpson, 1998). Treatment of substance abuse, or any behavior involving discounting, would likely be influenced differently depending upon conceptualization of discounting as state-driven or trait-driven. To take steps toward this determination, further research is needed to address issues such as substance abusers' pre-morbid personality traits such as impulsivity and problem-solving style, other risk-taking behaviors, and physiological factors involved in constructs such as sensation-seeking (e.g., high threshold for physiological arousal). This study's failure to find a link between stress and discounting renders it difficult to comment on the state-view versus the trait-view based upon our findings. Finding that discounting had been increased as a result of stress would have lended support to a state-view. The absence of this finding could be construed as evidence for the trait-view, since discounting seemed to be unaffected by stress, however, we do not feel that simply the absence of this finding is sufficient to assert the trait-view.

Study Limitations

There are four primary limitations of this study. The first involves failure of stress to elicit changes in temporal discounting, and the second and third involve the smaller than optimal sample of smokers and their relatively low level of nicotine

addiction. Finally, the proportion of participants with significant k-values was also lower than optimal.

Possible explanations were presented earlier for the failure of stress to impact temporal discounting. In retrospect, there are several factors that may have increased the likelihood that stress impacted discounting. Administering the HMCT pre-stress, mid-stress, and post-stress would have allowed three instead of two measurements to compare. This still may not have led to significant findings, but it would have allowed for more easily identifying any change that was present. Further, administration of the HMCT by the experimenter may have minimized the likelihood that participants responded haphazardly, randomly, or too quickly. Though the anxiety measures used in this study are well-known and well-established, physiological measures of arousal used in addition may have added valuable information. Finally, requiring a stress-provoking activity that was designed to elicit an even stronger reaction, such as public speaking activity in front of others rather than videotaped, might have helped.

With regard to the sample of smokers, it has historically been difficult to recruit large numbers of smokers within the university setting, especially smokers who smoke more than 10 cigarettes per day. Recruiting outside this setting, however, would have presented challenges better addressed in a larger-scale, longer-term study with greater resources for participant compensation. Further, though the prevalence of smoking within a college population is likely lower than it is within the community, it is nevertheless an area that warrants understanding and attempts at intervention. Smokers in this sample generally had a lower level of nicotine dependence than what might be expected in the general population. Therefore, the results found in this study should be

generalized with caution. Further in a sample of smokers with higher nicotine dependence, stronger results and greater significance may have been found.

Though there is no known HMCT literature discussing the typical proportion of significant and non-significant k-values within any given sample, the proportion of participants with non-significant k-values was higher than we would have liked. If the sample had included more significant k-values, findings may have been stronger. As discussed earlier, reasons for non-significant k-values may have included random responding, boredom, or responding too rapidly in an effort to end the task quickly. Controls for these factors could include the paper-and-pencil administration of the HMCT or having an examiner present while either version of the HMCT is administered.

Future Directions

Temporal discounting is a relatively new area of research. The bulk of the literature in this area is theoretical, and much of the empirical literature addresses abuse of substances such as alcohol, cocaine and heroin. There remains an exceedingly small body of literature empirically addressing nicotine and temporal discounting. Future research might seek to increase this body by replicating work done on other substances, instead using nicotine. Issues addressed in this study which had not yet been addressed elsewhere are the impact of emotional states such as stress on temporal discounting and the effect of cigarette craving on discounting. These should continue to be addressed in future research

Other future research might address, or continue to address, the role of demographic variables such as age, sex, income, and education, on discounting. This

has been done to a limited extent with age and income variables (Green, Myerson, Lichtman, Rosen, & Fry, 1996; Green, Myerson, & Ostaszewski, 1999). Other emerging areas in discounting research are gambling (Chapman, 1996; Petry & Casarella, 1999; Rachlin, 1990), and health care including diet and exercise (Chapman, 1996; Epstein & Saelens, 2000; Green & Fisher, 2000; Hursh, 2000; Simpson & Vuchinich, 2000) and needle-sharing in drug abusers (Odum, Madden, Badger, & Bickel, 2000). With regard to healthcare, discounting research may provide especially valuable contributions. Issues to address in this area might be whether principles of temporal discounting and substance abuse are applicable to healthcare factors such as medication and other treatment regimen compliance, including compliance with physician visits. This may be particularly important in diseases such as high blood pressure, in which the effects of non-compliance are not immediately evident, and may also be important when serious negative outcomes are perceived by the patient as uncertain (e.g., heart disease as a result of long-term high blood pressure; lung cancer as a result of smoking). Other diseases to study in this regard may include obesity, diabetes, asthma, HIV, arthritis, and cancer. Research on quality of life in cancer patients is currently examining concepts similar to temporal discounting, involving quantity versus quality of life. For example, in cancer research questions are asked of patients such as "Would you choose to live a short time with good quality of life or a longer time with your current symptoms?" (Gafni, 1997; Glasziou, Cole, Gelber, Hilden, & Simes, 1998; Jalukar, Funk, Christensen, Karnell, & Moran, 1998).

In the area of diet and exercise, including obesity, the application of discounting principles may be useful, especially in the United States, where the obesity rate is

exceedingly high and nutrition exceptionally poor. Research should address the application of discounting principles similar to those used in substance abuse treatment, such that individuals are taught to place greater value on delayed reinforcers including health, value healthy non-food alternatives, and use healthier substitutes for unhealthy foods (e.g., food; Higgins et al., 1993, 1994; Vuchinich & Simpson, 1998; Vuchinich & Tucker, 1998).

Finally, in the area of psychotherapy and motivation for change, discounting research might explore the difficulties encountered in attempting to make fundamental changes in behaviors and cognition. In this area, discounting principles could be applied such that clients are taught to choose the delayed reinforcement derived from good mental health, adaptive behavior, and healthy relationships instead of the relative comfort and safety of maintaining the status quo maladaptive behavior patterns.

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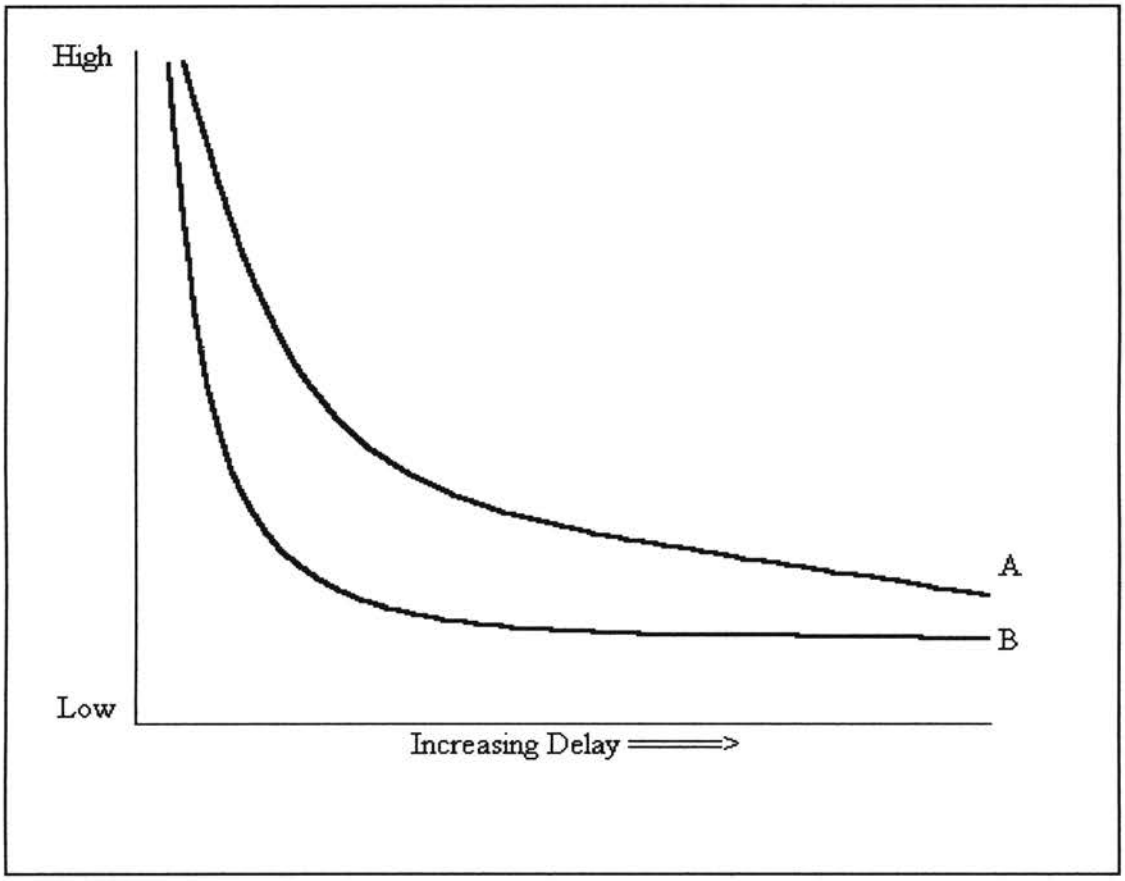
Appendix A

Slope (k) of Discounting Curves



High: High value of reinforcer

Low: Low value of reinforcer

k = rate at which value of reinforcer decreases

A: Smaller k; slow discounting

B: Larger k; rapid/steep discounting

Appendix B

Example of HMCT

Participants are asked to indicate a preference from each of the following pairs hypothetically available either immediately or after a delay. For example, they are asked to choose between $1,000 immediately and $1,000 in a week, followed by $990 immediately or $1,000 in a week. Though longer delays are incorporated into the real HMCT, they are not shown here.

Immediately	1 Week	Immediately	1 Month	Immediately	6 Months
$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
$990	$1,000	$990	$1,000	$990	$1,000
$980	$1,000	$980	$1,000	$980	$1,000
$960	$1,000	$960	$1,000	$960	$1,000
$940	$1,000	$940	$1,000	$940	$1,000
$920	$1,000	$920	$1,000	$920	$1,000
$900	$1,000	$900	$1,000	$900	$1,000
$850	$1,000	$850	$1,000	$850	$1,000
$800	$1,000	$800	$1,000	$800	$1,000
$750	$1,000	$750	$1,000	$750	$1,000
$700	$1,000	$700	$1,000	$700	$1,000
$650	$1,000	$650	$1,000	$650	$1,000
$600	$1,000	$600	$1,000	$600	$1,000
$550	$1,000	$550	$1,000	$550	$1,000
$500	$1,000	$500	$1,000	$500	$1,000
$450	$1,000	$450	$1,000	$450	$1,000
$400	$1,000	$400	$1,000	$400	$1,000
$350	$1,000	$350	$1,000	$350	$1,000
$300	$1,000	$300	$1,000	$300	$1,000
$250	$1,000	$250	$1,000	$250	$1,000
$200	$1,000	$200	$1,000	$200	$1,000
$150	$1,000	$150	$1,000	$150	$1,000
$100	$1,000	$100	$1,000	$100	$1,000
$80	$1,000	$80	$1,000	$80	$1,000
$60	$1,000	$60	$1,000	$60	$1,000
$40	$1,000	$40	$1,000	$40	$1,000
$20	$1,000	$20	$1,000	$20	$1,000
$10	$1,000	$10	$1,000	$10	$1,000
$5	$1,000	$5	$1,000	$5	$1,000
$1	$1,000	$1	$1,000	$1	$1,000

Appendix C

Study Procedure and Administration of Measures

The procedure for smokers and non-smokers within each group is identical except with regard to smoking. ***Procedures pertaining only to smokers are italicized & bolded.***

Stress Group	Non-Stress Group
(1) Participant Arrives Signs consent form ***Smokes one cigarette/***non-smokers given 10-minutes to relax Completes: Demographic Questionnaire SAQ BAI IDD STAI-S-1 EAS-1 ***FTND*** ***QSU-1*** ***NAS-1***	(1) Participant Arrives Signs consent form ***Smokes one cigarette/***non-smokers given 10 minutes to relax Completes: Demographic Questionnaire SAQ BAI IDD STAI-S1 EAS-1 ***FTND*** ***QSU-1*** ***NAS-1***
(2) HMCT explained to participant. Instructed to begin HMCT Time 1	(2) HMCT explained to participant. Instructed to begin HMCT Time 1
(3) Public speaking activity introduced & explained. Completes: STAI-S-2 EAS-2 ***QSU-2*** ***NAS-2***	(3) Participant told that he/she will be asked to relax periodically during study. Completes: STAI-S-2 EAS-2 ***QSU-2*** ***NAS-2***
(4) Participant told he/she will have 10 minutes to prepare for public speaking activity	(4) Participant instructed to relax/read magazines provided for 10 minutes
(5) After 10 minutes, participant completes: STAI-S-3 EAS-3 ***QSU-3*** ***NAS-3***	(5) After 10 minutes, participant completes: STAI-S-3 EAS-3 ***QSU-3*** ***NAS-3***
(6) HMCT Time 2	(6) HMCT Time 2

(7) Video camera turned on and participant instructed to begin public speaking activity. Informed that he/she will be stopped after three minutes.	(7) Video camera turned on and participant instructed to relax/read magazines provided. Informed that he/she will be interrupted after three minutes.
(8) After three minutes, participant stopped, camera turned off. Completes: STAI-S-4 EAS-4 ***QSU-4*** ***NAS-4***	(8) After three minutes, participant interrupted, camera turned off. Completes: STAI-S-4 EAS-4 ***QSU-4*** ***NAS-4***
(9) Participant debriefed & excused	(9) Participant debriefed and excused

APPENDIX D

Tables

Table 1

Demographic Information of the Sample

	Any FTND Score	**FTND Score ≥ 4**
Male	29 (55.8%)	23 (54.8%)
Female	23 (44.2%)	19 (45.2%)
Mean Age	21.7	21.9
Freshman	24 (46.2%)	21 (50.0%)
Sophomores	14 (26.9%)	12 (28.6%)
Juniors	7 (13.5%)	5 (11.9%)
Seniors	7 (13.5%)	4 (9.5%)
Mean number cigarettes per day (smokers)	20.09	22.0
Mean number quit attempts during last 12 months (smokers)	1.35	1.31
Mean BAI Score	9.54	8.93
Mean IDD Score	10.02	9.95
Mean FTND Score (smokers)	4.65	5.81

Table 2

Breakdown of Participants by Smoking Status, Stress, and Sex

1. All participants, regardless of K-values or FTND Score
   N=62

	MALE	**FEMALE**	*Total*
NON-STRESSED NON-SMOKERS	8	9	17
STRESSED NON-SMOKERS	7	7	14
NON-STRESSED SMOKERS	9	6	15
STRESSED SMOKERS	9	7	16
Total	*33*	*29*	*62*

2. Only participants with Significant K-values, regardless of FTND Score
   N=52

	MALE	**FEMALE**	*Total*
NON-STRESSED NON-SMOKERS	7	6	*13*
STRESSED NON-SMOKERS	7	6	*13*
NON-STRESSED SMOKERS	7	5	*12*
STRESSED SMOKERS	8	6	*14*
Total	*29*	*23*	*52*

3. Only participants with Significant K-values and FTND Scores ≥ 4
   N=42

	MALE	**FEMALE**	*Total*
NON-STRESSED NON-SMOKERS	7	6	*13*
STRESSED NON-SMOKERS	7	6	*13*
NON-STRESSED SMOKERS	2	4	*6*
STRESSED SMOKERS	7	3	*10*
Total	*23*	*19*	*42*

Table 3

ANOVA Summary Table: STAI-S

Smokers with all FTND Scores*

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	329.76	329.76	13.69	<.001	.24	.95
Time x Stress	1	334.80	334.80	13.90	<.001	.24	.95
Time x Smoker	1	11.93	11.93	.50	<.485	.01	.11
Time x Stress x Smoker	1	55.77	55.77	2.32	<.135	.05	.32
Error (TIME)	43	1035.78	24.09				

* For all tables: "Time" = Time 1, Time 2, and Time 3
"Stress" = Stress Groups vs. Non-Stress Groups
"Smoker" = Smoker vs. Non-Smoker

Smokers with FTND Scores ≥4

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	224.97	224.97	8.27	<.007	.20	.80
Time x Stress	1	267.11	267.11	9.81	<.004	.22	.86
Time x Smoker	1	4.53	4.53	.17	<.686	.01	.07
Time x Stress x Smoker	1	38.52	38.52	1.42	<.242	.04	.21
Error (TIME)	34	925.41	27.22				

Table 4

ANOVA Summary Table: EAS Fear Subscale

Smokers with all FTND Scores

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	9.13	9.13	3.9	<.054	.08	.49
Time x Stress	1	26.63	26.63	11.38	<.002	.20	.91
Time x Smoker	1	5.09	5.09	2.17	<.147	.05	.30
Time x Stress x Smoker	1	.90	.90	.38	<.539	.01	.09
Error (TIME)	46	107.65	2.34				

Smokers with FTND Scores ≥4

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	5.44	5.44	2.26	<.142	.06	.31
Time x Stress	1	20.55	2.055	8.52	<.006	.19	.81
Time x Smoker	1	2.80	2.80	1.16	<.289	.03	.18
Time x Stress x Smoker	1	.81	.81	.34	<.565	.01	.09
Error (TIME)	36	86.85	2.41				

Table 5

ANOVA Summary Table: EAS Anxiety Subscale

Smokers with all FTND Scores

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	2.20	2.20	.38	<.542	.01	.09
Time x Stress	1	114.67	114.67	19.70	<.000	.30	.99
Time x Smoker	1	.01	.01	.00	<.961	.00	.05
Time x Stress x Smoker	1	12.50	12.50	2.15	<.150	.05	.30
Error (TIME)	46	267.70	5.82				

Smokers with FTND Scores ≥4

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	.02	.02	.00	<.950	.00	.05
Time x Stress	1	77.76	77.76	13.26	<.001	.27	.94
Time x Smoker	1	1.50	1.50	.26	<.616	.01	.08
Time x Stress x Smoker	1	11.93	11.93	2.03	<.162	.05	.28
Error (TIME)	36	211.18	5.87				

Table 6

ANOVA Summary Table: Absence of Significant Effects for Objective 1

Smokers with all FTND Scores

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	.00	.00	.51	<.478	.01	.11
Time x Stress	1	.00	.00	.15	<.701	.00	.07
Time x Smoker	1	.00	.00	.07	<.797	.00	.06
Time x Stress x Smoker	1	.00	.00	.14	<.713	.00	.07
Error (TIME)	39	.00	.00				

Smokers with FTND Scores ≥4

Source	*DF*	*SS*	*MS*	*F*	*P*	*Effect Size*	*Power*
Time	1	.00	.00	.90	<.350	.03	.15
Time x Stress	1	.00	.00	.60	<.444	.02	.12
Time x Smoker	1	.00	.00	.02	<.881	.00	.05
Time x Stress x Smoker	1	.00	.00	.02	<.878	.00	.05
Error (TIME)	31	.00	.00				

Table 7

ANOVA Summary Table: Absence of Significant Effects for Objective 2

NAS and QSU for Smokers With all FTND Scores

NAS:

Source	*DF*	*SS*	*MS*	*F*	*P*	*Effect Size*	*Power*
Time	1	208.62	208.62	20.75	<.000	.46	.99
Time x Stress	1	7.62	7.62	.76	<.393	.03	.13
Error (TIME)	24	241.30	10.05				

QSU:

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	9146.28	9146.28	33.38	<.000	.71	1.00
Time x Stress	1	52.53	52.53	.192	<.668	.01	.07
Error (TIME)	14	3835.69	273.98				

NAS and QSU for Smokers With FTND Scores ≥4

NAS:

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	102.68	102.68	7.29	<.017	.34	.71
Time x Stress	1	.30	.30	.02	<.886	.00	.05
Error (TIME)	14	197.20	14.09				

QSU:

Source	*DF*	*SS*	*MS*	*F*	*p*	*Effect Size*	*Power*
Time	1	4773.94	4773.94	22.14	<.002	.74	.98
Time x Stress	1	77.14	77.14	.36	<.566	.04	.08
Error (TIME)	8	1724.86	215.61				

APPENDIX E

Figures

Figure 1

HMCT Time 1 when FTND is 4+

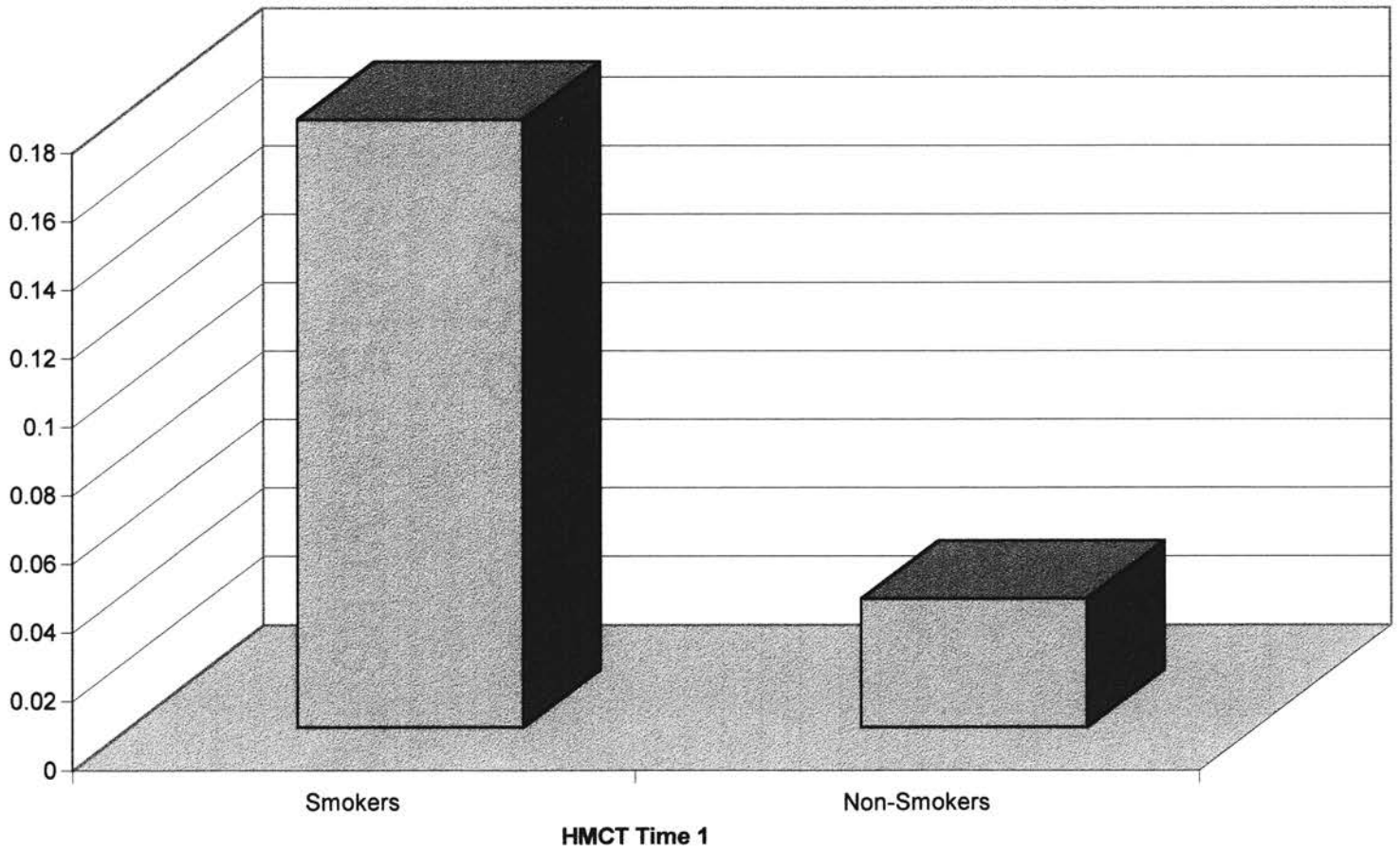


Figure 2

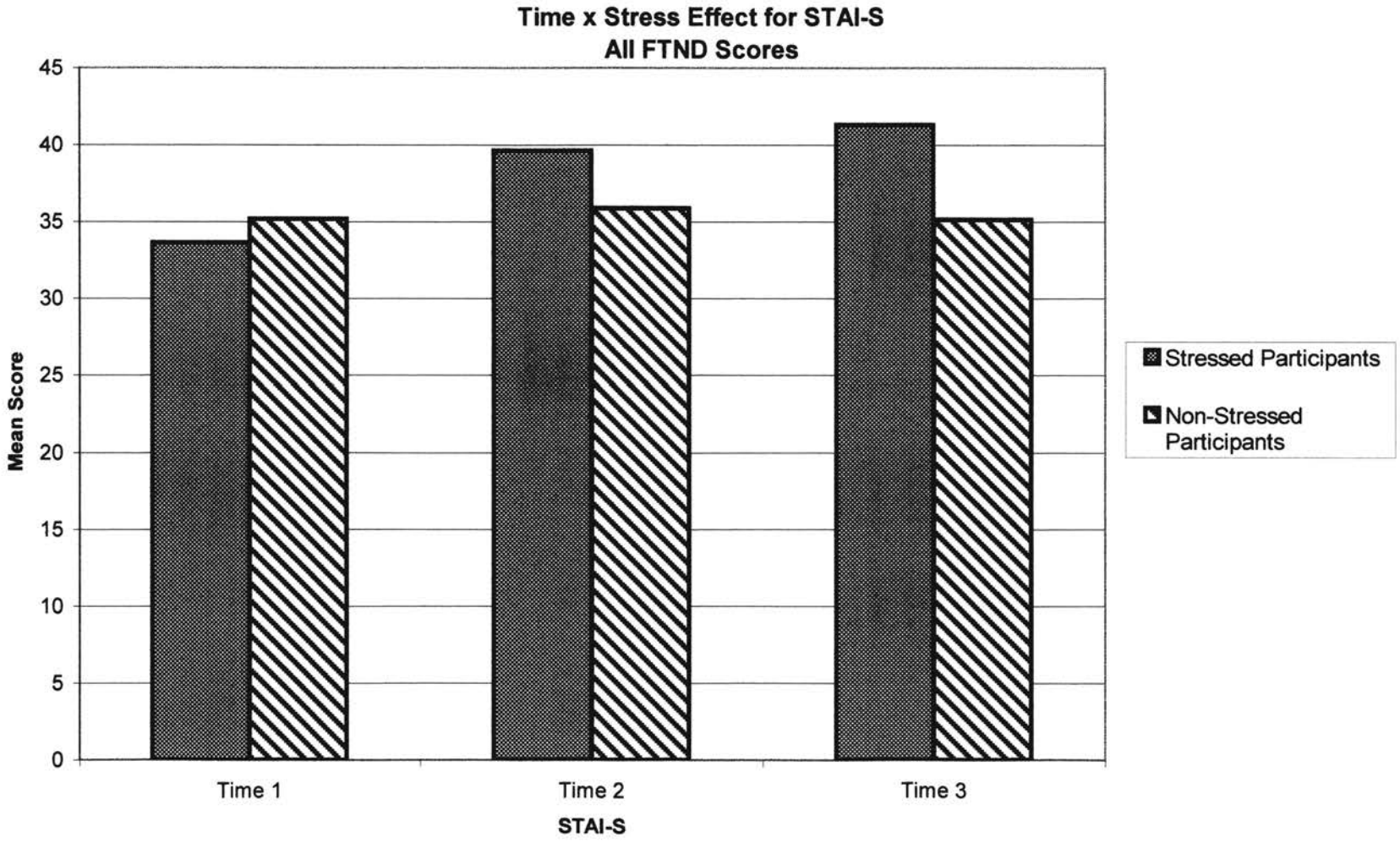

Time x Stress Effect for STAI-S
All FTND Scores
45
40
35
30
25
20
15
10
5
0
Mean Score
Time 1
Time 2
Time 3
STAI-S
Stressed Participants
Non-Stressed Participants

Figure 3

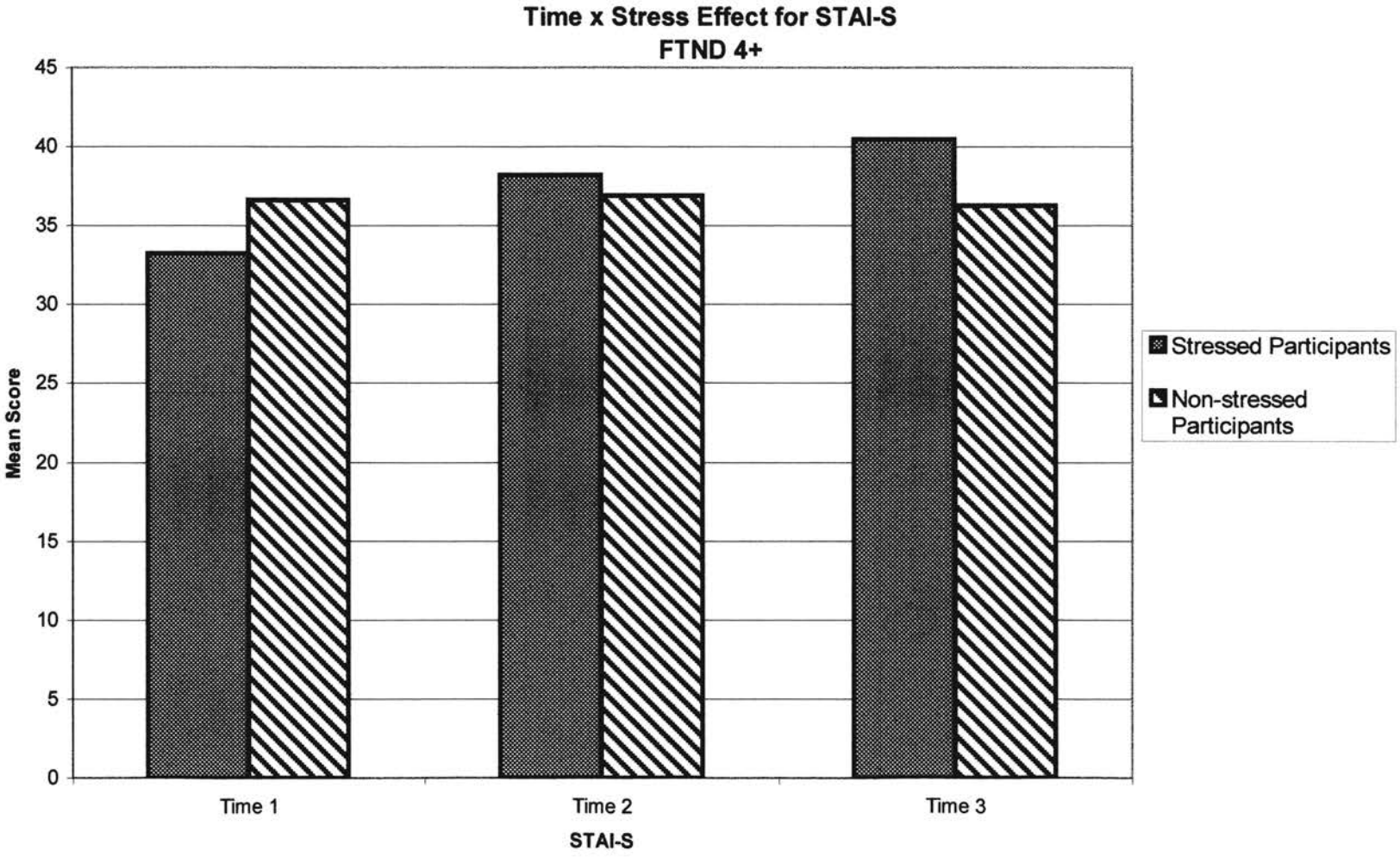

Time x Stress Effect for STAI-S
FTND 4+
Mean Score
45
40
35
30
25
20
15
10
5
0
Time 1
Time 2
Time 3
STAI-S
Stressed Participants
Non-stressed Participants

Figure 4

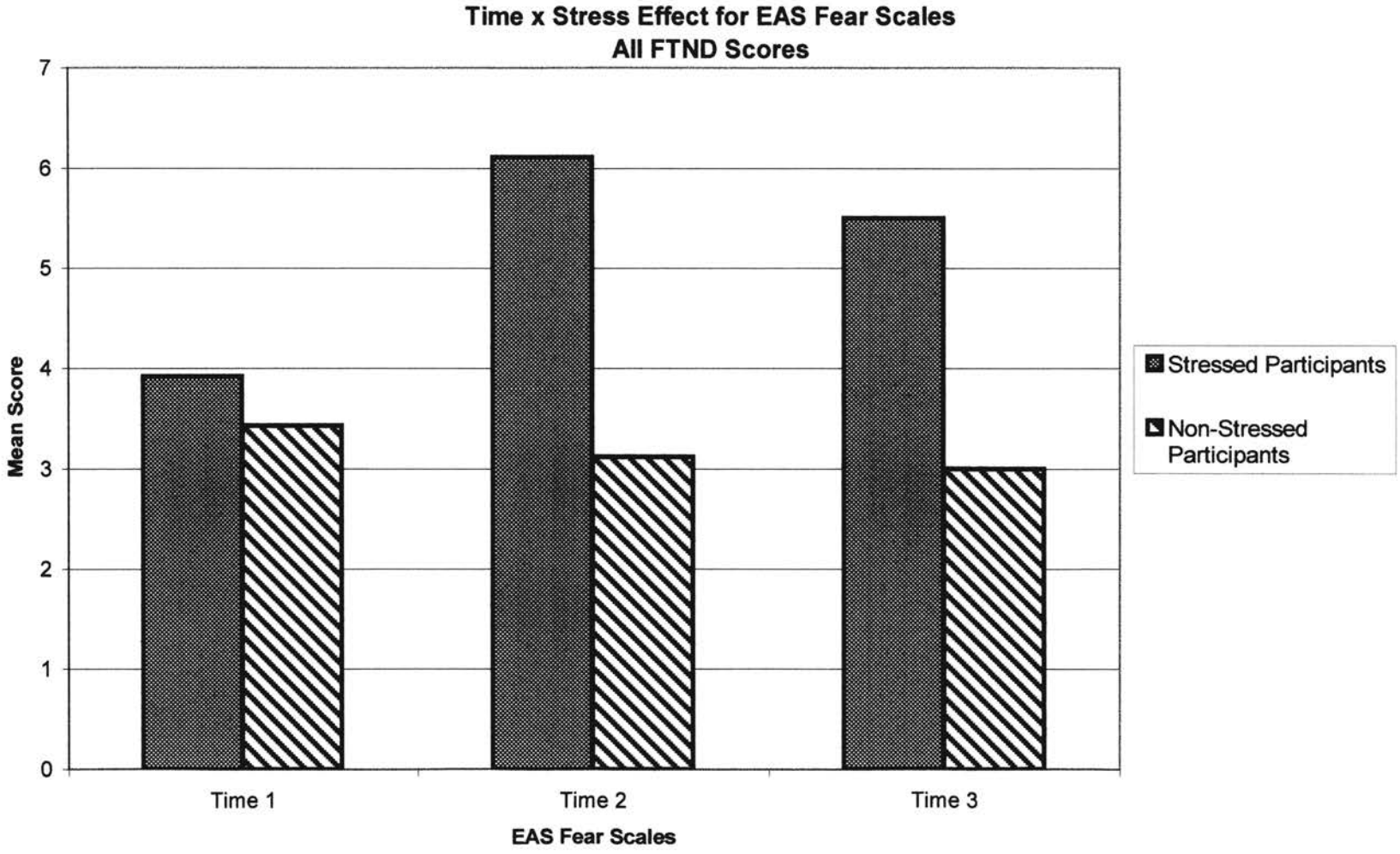

Time x Stress Effect for EAS Fear Scales
All FTND Scores
Mean Score
7
6
5
4
3
2
1
0
Time 1
Time 2
Time 3
EAS Fear Scales
Stressed Participants
Non-Stressed Participants

Figure 5

Time x Stress Effect for EAS Anxiety Scales
All FTND Scores

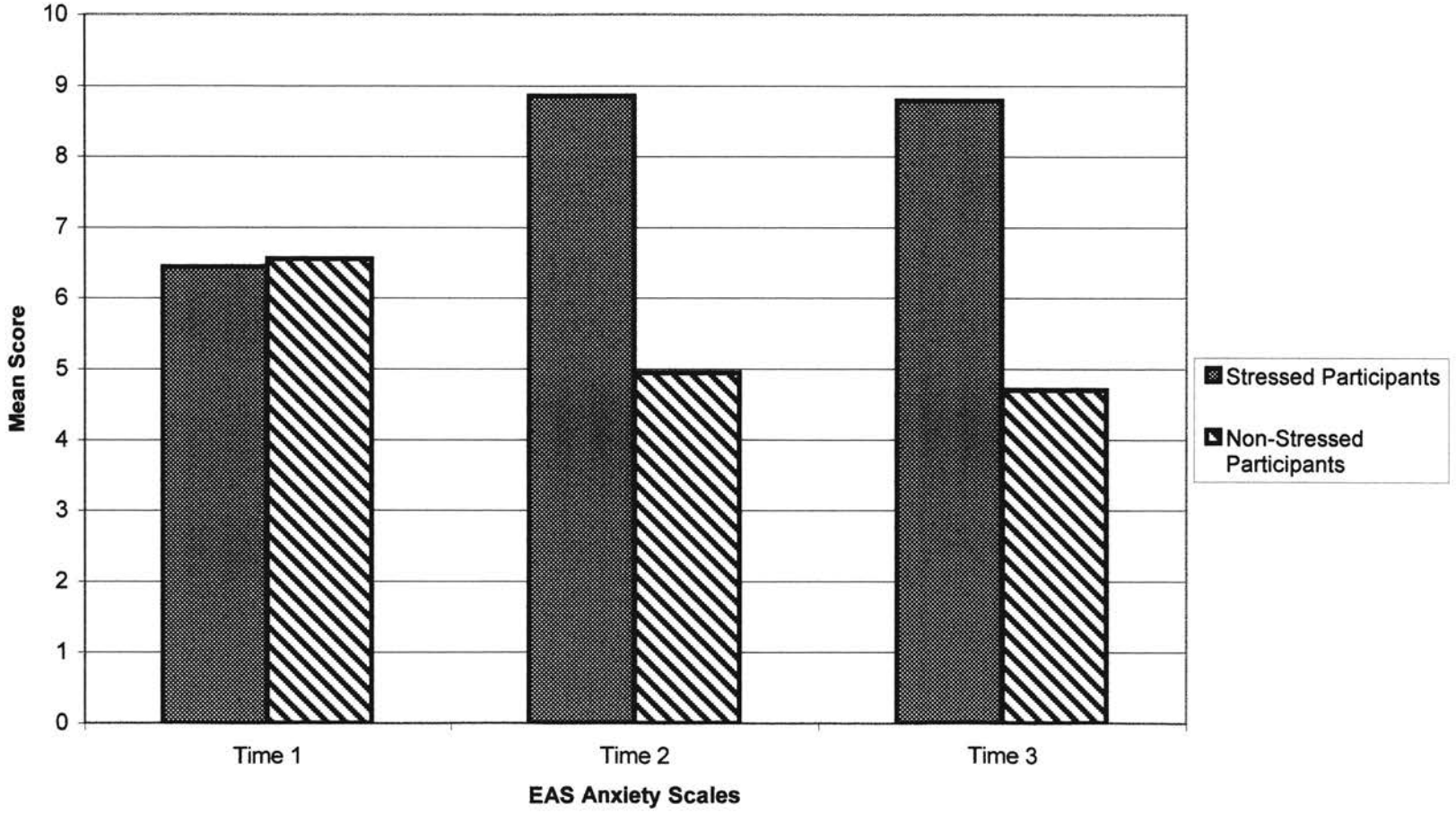


Figure 6

Time x Stress Effect for EAS Fear Scales
FTND 4+

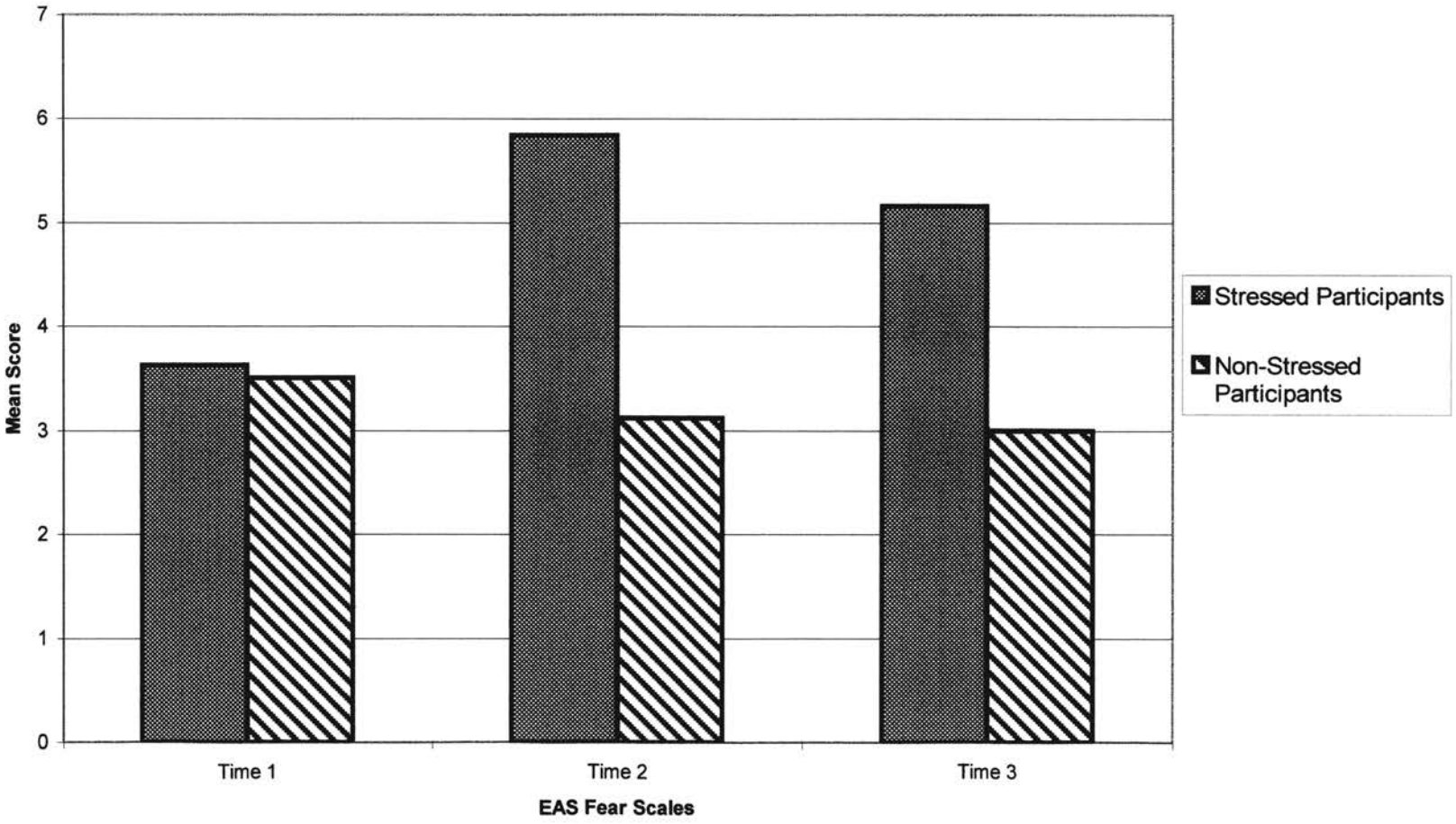
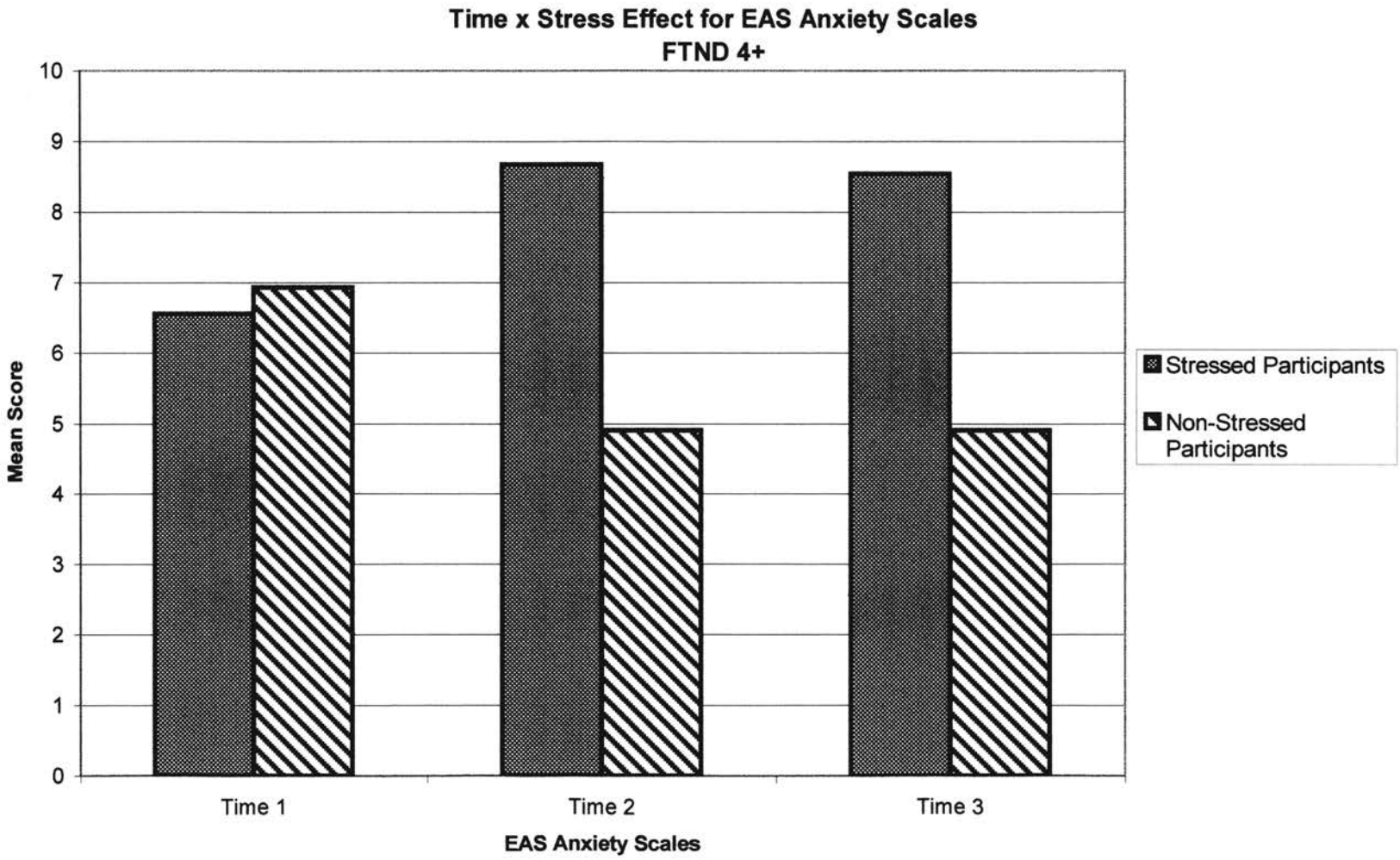


Figure 7


Time x Stress Effect for EAS Anxiety Scales
FTND 4+
Mean Score
10
9
8
7
6
5
4
3
2
1
0
Time 1
Time 2
Time 3
EAS Anxiety Scales
Stressed Participants
Non-Stressed Participants

Appendix F

IRB Form

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

Date:	September 29, 1999	IRB #:	AS-00-085
Proposal Title:	"RELATIONSHIP BETWEEN STRESS, CRAVING, AND TEMPORAL DISCOUNTING IN CIGARETTE SMOKERS"		
Principal Investigator(s):	Frank Collins, Jr. Laura Carter		
Reviewed and Processed as:	Expedited		

Approval Status Recommended by Reviewer(s): Approved

Signature: Carol Olson

Carol Olson, Director of University Research Compliance

September 29, 1999
Date

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

Laura C. Carter

Candidate for the Degree of

Doctor of Philosophy

Dissertation: TEMPORAL DISCOUNTING, STRESS, AND CRAVING IN CIGARETTE SMOKERS

Major Field: Psychology

Biographical:

Education: Graduated with a Bachelor of Arts in Psychology and French from Ripon College, Ripon, Wisconsin in May, 1994; Earned 36 graduate credit hours in Psychology from University of Memphis between August, 1994 and May, 1996. Completed the requirements for the Doctor of Philosophy Degree with a major in Psychology at Oklahoma State University in December, 2001.

Experience: Completed Pre-Doctoral Internship in Clinical Psychology at Milwaukee County Mental Health Division in August, 2001.

Professional Memberships: Association for the Advancement of Behavior Therapy, American Psychological Association, Wisconsin Psychological Association.