ASSESSING RESOURCE ALLOCATION IN COLLEGE STUDENTS

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CHAPTER I

Introduction

Cigarette smoking is the cause of many health-related problems, such as cancer and heart disease and has been linked to the deaths of many people. According to USDHHS (1998) figures, more than 400,000 deaths annually in the United States are attributed to cigarette smoking. In contrast the annual deaths from other drugs of abuse are much lower, including alcohol – 125,000-150,000, alcohol plus other drugs – 4,000, heroin – 4,000, cocaine – 2000 to 4000, and marijuana – 75. Despite evidence of clear relationship between smoking and later health concerns, many people find it difficult to quit smoking.

Smoking cessation programs typically have limited success; with reported 1 year abstinence rates less than 30% (Hajek, 1994). Improving cessation rates requires an understanding of the pharmacological and behavioral aspects of smoking. While research on nicotine replacement therapies has greatly increased our understanding of the pharmacological aspects of nicotine, these methods have not been successful in maintaining abstinence from smoking. Therefore more studies looking at other aspects of smoking cessation are needed, including nonpharmacological behavioral methods (Perkins, Hickcox, & Grobe, 2000).

Recent drug abuse treatment research supports the conclusion that for medication to achieve maximal efficacy, it may need to be combined with nonpharmacological treatment (Fiore et al., 1994; Bickel, DeGrandpre & Madden, 1997). For example, nicotine gum has been shown to be effective in decreasing withdrawal symptoms, however, there is a paucity of research about the essential elements required for optimal

intervention strategies that combine knowledge of biobehavioral mechanisms underlying smoking behavior (Abrams, Clark, & King, 1999). Behavioral economics provides a framework to study this phenomenon linking pharmacological and nonpharmacological treatment.

Behavioral economics grew out of consumer demand theory. Research in behavioral economics has been extended to many areas of study including smoking, eating, exercise, and gambling (Madden, 2000). Two major aspects of behavioral economics that apply to cigarette smoking include price of a reinforcer and the presence of alternative reinforcers. Behavioral economics seeks to describe the relationship of these components and their effects on drug taking behavior. The core ideas of the behavioral economic perspective have the potential to replace the disease model of addiction with a more scientifically credible and practical metaphor based on economic principles which describe choices made under specific conditions of environmental constraint (Vuchinich, 1999).

While measurement of consumption at various levels of cost is possible, real world measurement is very time consuming. Hypothetical decision making has been used by several laboratories to study aspects of behavioral choice. (Bickel, DeGrandpre, & Higgins, 1991; Hursh, 1980; Premack, 1965; Petry & Bickel, 1998). The present study will use a hypothetical paradigm to evaluate the effects of increased costs for cigarettes on the allocation of resources to various alternatives. The review of the literature focuses first on a historical overview of behavioral economics, followed by a discussion of behavioral economic concepts and the research that supports these specific concepts. In addition, the relevance of chewing gum as a substitute reinforcer is discussed. Also, the

hypothetical purchasing task of Petry and Bickel (1998) is discussed as the model for this study. Finally, the goals and hypotheses of the study are presented.

Behavioral Economics

Behavioral economics is an outgrowth of choice theory research where behavior is characterized as a "choice" among available activities (Vuchinich, 1999). This method is in part derived from the work of Premack (1965) and Hernstein (1970), both of whom demonstrated that the reinforcing value associated with an activity depends on knowledge of available alternative activities. This work was a major departure from the view of early behaviorists (Hull, 1943; Skinner, 1938) who analyzed reinforcers separate from the general context of their environment.

Kagel and Winkler (1972) discussed this emerging field as the synthesis of economic principles with procedures pioneered within the experimental analysis of behavior (e.g., token economics, use of animal subjects and schedules of reinforcement). The authors applied economic theory, which attempted to predict and control consumer behavior using mathematical-statistical analyses, with behavior analytic models that focused on behavior exhibited by subjects under specific reinforcement conditions. Using this combination of economic and behavioral analytic models appears to enhance predictions (Madden, 2000; Kagel & Winkler, 1972).

Application of this combined "behavioral economic" model was first applied to research measuring the impact of the environmental costs on choice of reinforcers in experiments with animals. For example, Hursh (1978) studied self-administration of food and water under different levels of effort (price) and found support for the economic principle, Law of Demand, wherein self-administration decreases as a function of price.

This early research laid the foundation for subsequent research, which generalized behavioral economic findings to humans and clinically relevant behaviors such as substance abuse (Madden, 2000).

As the literature on behavioral economics developed, the potential contributions of this model for understanding substance abuse were recognized. Vuchinich and Tucker (1988) used quantitative methods of choice to show the effects of price for alternative non-alcohol reinforcers on choice of alcohol or other alternatives. In general they found that while keeping the price of alcohol constant, as price for the alternative increased, participants were more likely to choose alcohol reinforcers, while as the price for the alternatives decreased, alcohol use decreased. Thus, behavioral economics could be used to account for patterns of substance abuse behaviors. This model provided important predictions about how substance abuse develops and changes over time and how changes in use patterns are related to the substance of abuse and the availability of opportunities unrelated to substance use (Vuchinich, 1999).

With such a quickly evolving and changing history, it is difficult to identify a single definition of behavioral economics that includes all aspects to be studied. Generally, it is the application of economic theory to the analysis of behavior as noted by many authors (Bickel, DeGrandpre, Higgins, Hughes, 1990; Bickel, DeGrandpre, Higgins & Badger, 1995; Kagel & Winkler, 1972). More specifically it is the study of variables (economic and noneconomic) affecting the behavior of consumers, including price and the availability of alternative reinforcers. In sum, it is the combination of microeconomic concepts, principles, and measures along with concepts, principles, and experimental methods developed by behavior analysts. Together these techniques and

principles are used to gain a more complete understanding of the interaction between behavior and the economic context in which it occurs (Madden, 2000). The value of behavioral economics derives from its ability to describe interactions qualitatively different reinforcers (Hursh, 1980; Bickel et al., 1992; DeGrandpre et al., 1994)

In studying drugs of abuse the behavioral economic model is helpful because it provides a functional approach to explaining drug dependence (Bickel et al., 1995). This model seeks to explain why reinforcers that were once of high value lose value in the presence of drugs of abuse. The recent application of behavioral economics to drug dependence helps explain how different environmental conditions might affect levels of drug consumption and drug seeking behavior. The concepts of consumer demand may be an effective axiom to organize factors relevant to drug dependence (Bickel et al., 1995), by explaining the relationships between drug prices and consumption (Petry, 2000). The application of behavioral economics to cigarette smoking is particularly relevant because researchers are interested in the specific conditions that reduce the consumption of cigarettes.

Law of Demand

Consumer demand theory focuses on the interaction between price and consumption. The law of demand describes the impact of unit price on the consumption of a reinforcer. Specifically, this law states that when all else is equal, as price goes up consumption of the reinforcer goes down (Pearce, 1986). Demand can be displayed graphically as a curve where consumption is plotted as a function of price (Bickel et al., 1997). Research has consistently supported the robustness of this concept in the experimental analysis of behavior (DeGrandpre et al., 1993; Hursh, 1991; Bickel et al.,

1990). Both prospective studies (Bickel & Madden, 1995; Bickel et al., 1997) and reanalysis of early behavioral economic studies support the wide generality of the positively decelerating demand curve (Bickel et al., 1998). It has been replicated with different reinforcers including cocaine, pentobarbital, food, and a variety of species including monkeys, rats, and humans in their natural environment and with a variety of cost manipulations (cf., Bickel et al., 1995; Hursh & Simon, 1988; Bickel et al., 1998).

There are many factors that influence the Law of Demand including the availability of another reinforcer. When the alternative reinforcer is present, it can accelerate the demand curve causing the consumption of the original reinforcer to go down more quickly at the same prices than when the alternative is not available. In some cases the presence of alternative reinforcers can change the overall consumption of the reinforcer by just being present at a reduced price. In the next section we will discuss these concepts in more detail including own-price and cross-price elasticity.

Elasticity of Demand

The rate of decrease in consumption (sensitivity to price) relative to the initial level of consumption is called price elasticity of demand (Madden, 2000). Commodities can be distinguished along the continuum of demand elasticities. Inelastic demand refers to little or no changes in consumption as price changes. When demand for a reinforcer is inelastic, a 1% price change in price produces less than a 1% change in consumption (Madden, 2001). Elastic demand refers to substantial changes in consumption as price changes (Vuchinich, 1999). Demand for a reinforcer is considered elastic if a 1% change in price produces greater than a 1% change in consumption. When plotted in log-log

coordinates, the slope of the function indicates the sensitivity of consumption to price change.

Own-price elasticity measures the proportional change in consumption across different price conditions. On log coordinates proportional change is equal to the slope of the line. Inelastic consumption is defined by elasticities greater than –1.0 (Hursh, 1980; DeGrandpre et al., 1994). Elastic consumption is defined by elasticities less than –1.0 (steeper slope). Reanalysis of 17 studies of human cigarette smoking (DeGrandpre, Hughes & Higgins, 1992), and an experiment with human cigarette smokers (Bickel, 1993) that explicitly employed a demand curve, have supported the inverse relationship between consumption and price.

Studies by Bickel (1993) and others support the positively decelerating function measured by own-price elasticity and suggest that it may be useful as an empirical tool for evaluating such problems as the process of drug dependence as well as the effects of pharmocotherapies on drug demand (DeGrandpre et al., 1994). Typically, commodities show mixed elasticity along ranges of price changes with demand being more inelastic at low prices and more elastic at high prices (Vuchinich, 1999). Behavioral economists are interested in identifying variables that affect price elasticity of demand. If we better understood how to make demand for problematic reinforcers more elastic, then we would render demand more sensitive to the host of variables that can affect the price of reinforcers (Madden, 2000).

Alternative Reinforcers

The availability of effective alternative reinforcers may affect own-price elasticity of the target commodity in several ways. Behavioral economics allows for the analysis

of commodity relationships that affect target commodity consumption. Specifically, it allows for the examination of the interaction between drug reinforcers and the availability of other reinforcers (Vuchinich & Tucker, 1988; Bickel et al., 1998). These relationships can be described as complement, independent and substitute relationships. Cross-price elasticity measures this relationship and quantifies how changing the price of a target commodity affects the consumption of alternative commodities at different prices. Technically, it is the slope of the function relating the consumption of a second commodity at different costs of the first "target" commodity. Positive slopes indicate commodity A is a substitute for a commodity B and negative slopes indicate commodity A is a complement of commodity B. Slopes near 0 indicate commodity of A is independent of commodity B (Hursh, 1980; Petry, 2001a).

A substitute relationship occurs when the unit price of one commodity increases (decreasing consumption) and the consumption of another commodity increases even though the price for the "substitute" remains constant. Substitutes compete with primary reinforcers, and when present are likely to decrease consumption of a target commodity (Bickel et al., 1998), however, identification of a substitute reinforcer requires observation of the consumption of a potential substitute at different levels of price for the target commodity. For example, if the price of Coca-Cola were to increase and the price of Pepsi remained constant, Pepsi consumption would increase as the price of Coca-Cola increases if Pepsi is a substitute reinforcer for Coca-Cola,. While studying alcoholics, Petry (2001a) found that hypothetically increasing the price of cocaine, thereby decreasing consumption, increased the consumption of alcohol, (Petry, 2001a).

A complement relationship occurs when the unit price of one commodity increases (decreasing consumption) and the consumption of another commodity decreases even though the price of the "complement" remains constant. For example, if the price of soup were to increases from $4.00 to $16.00 per bowl and the price of soup crackers remain constant at $.25 pack; if soup crackers are a complement reinforcer for soup, soup crackers consumption would decrease as the price of soup increases. Additionally, several studies have demonstrated the complementary relationship between cigarettes and alcohol. The results of an experiment conducted by Mello, Mendelson, Sellars, and Kuehnle (1980) indicated that when the price of alcohol was decreased and cigarettes remained at a fixed price, both alcohol and cigarette consumption increased. This complementary relationship is characterized by the increase in consumption in both the target commodity and the alternative when only the price of the target commodity is manipulated.

An independent relationship occurs when the unit price of one commodity increases (resulting in decreasing consumption) while both the consumption and the price of a second commodity remains constant. For instance, if the price of Coca-Cola increased (resulting in decreased consumption of the cola), it is unlikely that there will be any change in the consumption of soup crackers. Petry and Bickel (1998) found that hypothetically increasing the price of Valium decreased consumption of Valium, however, heroin consumption was unaffected for a group of heroin addicts. The introduction of the alternative had no effect on the consumption of the target commodity when the price remained constant for the alternative, even at high prices of the target commodity.

Recent studies have found that demand for a commodity will be more elastic when there is an alternative substitute reinforcer in the situation than when the alternative is a complement or an independent (Green & Freed, 1993; Bickel et al., 1998). Carroll (1995) demonstrated that the availability of an alternative competing reinforcer significantly decreased cigarette smoking relative to its absence. These findings support prior work by demonstrating that non-drug reinforcers can decrease drug use (Nader & Woolverton, 1991, 1992; Bickel et al., 1995). While the presence of substitute reinforcers clearly influences the elasticity of demand, consumption of the alternatives is also influenced when the price of the target changes.

The law of demand and the presence of alternative reinforcers work together to influence drug-taking behavior. Behavioral economics predicts that the price required to become involved in drug taking and the competing availability of other competing reinforcers are critical factors that render drug taking a highly preferred activity (Bickel et al., 1995). Introduction of alternative reinforcers may markedly reduce intake of some drugs in part depending on the unit price of the drug and the relationship of the alternative reinforcer (Carroll, 1999; Petry, 2001b). These economic relationships may be useful in describing drug use in natural situations. At times alternative reinforcers function as substitutes while at other times alternative reinforcers can function as complements. This interaction may contribute not only to issues of treatment; they may also be relevant for understanding the problem of polydrug abuse (Bickel et al., 1998). A goal for smoking cessation treatments would be to identify healthier nondrug reinforcers that substitute for cigarettes so that as the unit price of cigarettes increases, consumption could be shifted to the nondrug alternative commodity (Carroll & Campbell, 2000).

Chewing Gum as a Substitute Reinforcer

Most current theories of cigarette smoking point to nicotine as the primary reinforcing mechanism, however, it is clear that other aspects of smoking (e.g., taste, smell, social factors, etc.) may play an important role (Rose & Levin, 1991). Little research has been done on substitutes that reinforce the sensory aspects of smoking (Perkins et al., 2000). Recent studies have illustrated that chewing gum may serve to alleviate signs of craving of cigarettes as well as overall withdrawal when a nicotine dependent person cannot smoke (Cohen, Collins, & Britt, 1997; Cohen, Britt, Collins, Stott & Carter, 1999; Cohen, Britt, Collins, al Absi, & McChargue, 2001). Cohen and colleagues (1997) found reduced cigarette craving and withdrawal symptoms during brief abstinence in smokers given access to chewing gum, suggesting that chewing gum might serve as a substitute reinforcer. Since both chewing gum and cigarettes are administered orally, requiring movement of the jaw muscle and offering stimulant effects, it is clear that this type of relationship between the two commodities is possible.

In a follow-up study (Cohen et al., 1999), smokers were allowed free access to cigarettes but were rewarded for not smoking while watching a movie, and then asked to wait for a short period in an observation room. Participants were randomly assigned to a Gum or No Gum condition. Those in the Gum condition were asked to chew a piece of gum while those in the No Gum condition had only cigarettes available. Both groups were asked not to smoke and were rewarded for not smoking, with individuals smoking the least number of cigarettes receiving the highest rewards. Subjects were observed for

number of cigarettes smoked, number of puffs, and time before first cigarette. The participants in the Gum condition took fewer number of puffs and there was a longer time to the first cigarette and a fewer number of puffs taken on the first cigarette. These findings support the use of chewing gum as a useful technique for helping smokers who want to quit or reduce their smoking.

Cohen et al. (2001) then designed a study to evaluate the usefulness of chewing gum to reduce withdrawal, craving, and salivary cortisol in dependent smokers. It was hypothesized that when smokers were asked to chew gum during a period of brief nicotine deprivation they should show significantly fewer withdrawal and craving symptoms compared to a period of nicotine deprivation when they did not have access to gum. Upon entering the lab, participants were assigned to either a Gum or No Gum condition. Participants were asked to view a movie and remained in a room for a short period after. Measures of withdrawal were taken at 4 different times through out the experiment. As time progressed, the participants in the Gum condition showed lower levels of withdrawal symptoms compared to those in the No Gum condition. Withdrawal was clearly reported by the subjects who participated in this study, however, it was observed less acutely in subjects when they were instructed to chew gum. These findings suggest that behavioral alternatives, such as gum, can produce a significant reduction in a person's total withdrawal and ease the symptoms experienced while trying to stop smoking.

While previous research has examined the relationship between chewing gum and cigarette smoking, methods used are insufficient to show that chewing gum is a substitute reinforcer. In order to demonstrate that there is a substitute relationship between two

commodities, the price of one must be manipulated while the price for the second remains constant. The present study will manipulate the cost of cigarettes (the target commodity) while maintaining a constant cost for all alternatives using a hypothetical paradigm developed by Petry and Bickel (1998). Details of this paradigm will be reviewed in the next section.

Hypothetical Paradigm

Although it would be ideal to study the relationship between drug prices and consumption outside the laboratory, logistical issues exist. The amount of time needed would be substantial. It would be necessary to observe participants for long periods under different costs in order to determine consumption of both cigarettes and alternatives. We would estimate that it would require somewhere in the neighborhood of 12 hours of observation under each level of costs to get stable patterns of use.

An alternative to laboratory-based measurement has been developed and used with participants with a substance abuse history (cf., Petry and Bickel, 1998; Petry, 2000, 2001a, 2001b). This procedure involves the use of hypothetical behavioral experiments in which simulation of essential aspects of a situation are used to elicit the behavior in question (Epstein, 1986; Petry, 2000). The Petry and Bickel (1998) procedure used a Hypothetical Purchasing Task for assessing resource allocation with heroin abusers in which relationships between economic variables and drug preferences could be assessed with a variety of reinforcers (Petry & Bickel, 1998). Drugs and non-drug reinforcers were listed on a piece of paper. Income and price of the items were altered across a series of trials. Participants were asked to imagine a situation where they could buy drugs with no consequences. Changes in the price of heroin significantly altered the

purchase of heroin as well as other drugs. Cocaine consumption appeared to increase when heroin consumption increased (as price decreased) exhibiting a complementary relationship while Valium consumption was not affected as a result of heroin price increase (Petry, 2001a).

In a related study, Petry (2001a) evaluated the effects of alcohol, cocaine and Valium prices on polydrug use patterns in alcoholics. The Hypothetical Purchasing Task described above was used in this study. Again, changes in the price of the primary commodity alcohol brought about changes in the consumption of the other reinforcers. In this situation, cocaine was a complimentary reinforcer when the price of alcohol was lower, however at higher prices of alcohol, cocaine consumption decreased proportionately more than the price increase seen in alcohol.

To test whether drug use in real life was associated with purchases during the hypothetical situation in the experiment, comparisons were done to compare lifetime use for each drug with units of that drug purchased during the simulation. Drug choices in the Hypothetical Purchasing Task tended to correlate with self-reports of lifetime abuse and with urinalysis results. Drug choices in repeated exposures to the same condition were also correlated (Petry, 2001a).

In a similar study by Petry (2001b) using the Hypothetical Purchasing Task, participants were studied to determine the relationship between drug use and other activities (housing, food, and leisure activities). The price of housing was manipulated while income, the cost of drugs, and other activities remained constant. The price of housing affected consumption of some drugs including heroin, alcohol, and cocaine. As the price of housing decreased abusers increased the amount of resources allocated

proportionately more than the decrease in housing price. In some instances participants chose to go without housing. Willingness to go homeless was correlated with time spent homeless suggesting that those who hypothetically went homeless have also done so in real life (Petry, 2001b). Demand for leisure activities was found to be elastic, meaning that as the price of the target drug increased, leisure activities consumption increased disproportionately more than the change on the price of the drug.

The Present Study

The present study was designed around the Hypothetical Purchasing Task similar to the one developed by Petry and Bickel (1998) to evaluate five potential alternative reinforcers for cigarette smoking including snacks, chewing gum, leisure activities, leisure activities, and meals. Using a behavioral economic model, participants were assessed for each of the alternative reinforcer groups to determine the relationship of the reinforcer to cigarette smoking.

The specific aims of the study were to determine elasticity of demand by calculating the own-price elasticity of each commodity and the cross-price elasticity for cigarette smoking and (a) snacks, (b) chewing gum, (c) leisure activities, and (d) meals. The hypotheses included:

(a) The demand elasticity of cigarettes would become more elastic as the price of cigarettes increase and would increase the consumption of alternative reinforcers. Cigarette consumption would be inelastic at lower prices and become elastic as the price increases.

(b) The cross-price elasticity of snacks and chewing gum would indicate they are substitutes for cigarette smoking. As the price of cigarettes increased, the

consumption of these reinforcers would increase disproportionately to the increase in price of cigarettes.

(c) The cross-price elasticity of meals would be independent of cigarette smoking. As the price of cigarettes increase the consumption of meals would remain constant.

(d) No predictions about the cross-price elasticity of leisure activities were made, as there has not been sufficient data to suggest there is a relationship between these activities and cigarettes smoking.

CHAPTER II

METHOD

Participants

Participants were recruited using a screening instrument to ascertain the number of cigarettes smoked per day. All participants attended Oklahoma State University, taking either a Psychology or Marketing course. Approximately 600 students were screened for this project over two semesters, of those 10% reported smoking more than 11 cigarettes per day. Fifty-five students were contacted to participate in the study. All students who completed the experiment received extra credit or fulfilled a required assignment for the class in which they were enrolled. Thirty-seven participants met the criteria set for number of cigarettes reported and were run through the experiment, however; only 25 showed a decrease in the consumption of cigarettes as the price of cigarettes indicating demand for cigarettes. This is important, as the hypothetical task requires that participants respond to what they would likely do. Given the large amount of research showing that as cost increases, consumption decreases, participants who fail to show this pattern either cannot visualize the demands present in a hypothetical task or they are not responsive to the demand characteristics of the experimental procedure. Either way, studying the influence of demand for cigarettes on demand for other alternatives is not possible in these individuals.

This final sample of 25 participants (12 females; 13 males) was used in the final analyses to determine the relationship of each commodity as the price of cigarettes increased. The mean Fagerström Test for Nicotine Dependence (FTND) score for these

participants was 4.12 (SD=1.5). A score of four on this measure is indicative of moderate nicotine dependence.

Materials

All participants completed the Fagerström Test for Nicotine Dependence (FTND) and the Hypothetical Purchasing Task. The FTND is a 6-item, self-report measure 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. The FTND has been found to be a valid measure of nicotine dependence. It is a revised version of the Fagerström Tolerance Questionnaire (FTQ; Fagerström, 1978). The revised scale yields higher face and predictive validity than the FTQ (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Upon revision, the FTND internal consistency increased from .41 to .61, considered to be an acceptable level of internal consistency, and is closely related to salivary and CO readings obtained from dependent smokers (Heatherton, et al., 1991). The FTND has shown correlation with biochemical markers of heaviness of smoking. Scores range from on the FTND range from 0-10. A score of 0 is indicative of minimum nicotine dependence and a score of 10 is indicative of maximum nicotine dependence.

The Hypothetical Purchasing Task presents subjects with a hypothetical situation in which they were to imagine spending 12 hours alone in research laboratory. The subject was provided $60.00 in play money and a price list for meals, snacks, leisure activities, and cigarettes. They were instructed that no money could be saved and unspent money was given back to the research assistant at the end of the experiment.

Likewise, all items purchased must be used on the day they were purchased and could not be saved for a later day.

Subjects completed 9 hypothetical situations including one sample trial (where cigarettes were priced at $.10 each) and 8 experimental trials (where cigarettes were priced at $.10, $.20, $.50 or $1.00 with 2 sessions of each cigarette price) administered by a trained research assistant. For each trial, the subject started with $60 and was told that at the end of that day, all remaining money would be returned and could not be saved for the next day. Likewise, all commodities purchased must be used on that day. Trials were block randomized, so that each block contained all 4 cigarette prices.

Procedure

In order to control for possible nicotine deprivations, participants were asked to smoke a cigarette sometime during the hour prior to the start of the experiment. At the beginning of the session, all participants were asked to read and sign a consent from. The experimenter provided a brief overview of the study and answered any questions, then asked each participant to complete the Fagerström Test for Nicotine Dependence (FTND). The experimenter then described the Hypothetical Purchasing Task. During the session, samples of items on the menus were available including a basket of snacks, a list of movies, video games and music.

The specific instructions to the participants were:

> I want you to imagine that you have come into the lab to spend a day. You will arrive at 7:00 a.m. and leave at 7:00 p.m. First, here is a shopping list. It is broken down for you with your choices for breakfast which will be served at 8:00 a.m., lunch which will be served at Noon and dinner, which

will be served at 5:00 p.m. The rest of items include snacks, gum, and drinks. Here is the price list for each: a 4 ounce bag of chips, a small pudding snack, a 12-ounce juice, a 12-ounce cola, a small canned fruit snack, all for fifty cents. A snack size candy bar will cost twenty-five cents and a piece of gum will cost five cents. Assume there are as many as you want.

There are also entertainment activities available including video games, movies you can watch, reading, exercise, television, and listening to music. You pay five dollars for each hour of each activity. For example, if you watch a movie, they tend to be two hours long, so it will cost $10.00 if you watch the entire movie. The price for cigarettes is located at the bottom of the menu. In this particular case, the cost for cigarettes is ten cents each. You have $60.00 to spend each day. You do not have to spend it all; however, you will not be allowed to carryover any money or commodities into the next day.

At the beginning of each trial, the experimenter indicated the cost for cigarettes (.10, .20, .50, and 1.00 each) for that trial and asked the participant to indicate what they would purchase from the first hour in the lab until the last hour. Their purchases were summarized for them each hour and participants were told how much money remained. This continued hour by hour throughout the hypothetical day. Subjects could choose to do absolutely nothing for the hour, which resulted in the experimenter sitting for five minutes doing nothing to simulate what an hour would feel like. Participants were not allowed to sleep and could drink water at no cost if requested. The experimenter

recorded their choices on a separate sheet. The experiment lasted approximately 1 ½ hours.

CHAPTER III

RESULTS

Experimental Design

All analyses used a within-subject design where each subject served as his/her own control. Analyses were conducted for each of the dependent variables with the family-wise alpha level set at $p < .05$.

Data Analyses

Demand for each commodity was determined by adding the total amount of money spent on meals, snacks (excluding chewing gum), leisure activities, and chewing gum for each trial of the hypothetical-purchasing task. Since cost remained constant for these items over trials, money spent was a direct measure of consumption. For cigarettes, the number of cigarettes purchased was used to determine demand as cost for cigarettes increased.

Reliability of choices in the hypothetical task was evaluated by calculating point-biserial correlations between the two presentations of each commodity at each price of the 4 cigarette price levels. Test-Retest reliabilities were significant at the .05 level for the all commodities except gum (see Table 1). For these commodities reliabilities ranged from .40 - .97 with 62% of the reliabilities greater than .80. For gum, there was a great deal of variability and somewhat lower correlations, ranging from .12 to .77, with the highest reliability occurring when the cost of cigarettes was $ .50.

Insert Table 1

Demand elasticity was computed for each participant using the following equation from Allison (1983):

$$E_{own} = [\log (Q_{A2}) - \log (Q_{A1})] / [\log (P_{A2}) - \log (P_{A1})]$$

In which Q is the quantity of a commodity A purchased at price P1 and P2. When price and consumption data are converted to log-log coordinates, the slope between any two points represents E_{own}. Since the demand for some commodities was 0, and the log of 0 is undefined, 0.3 was added to all prices when analyzed. Previous research by Petry has indicated that the size of the number added does not influence demand estimates and we chose to use 0.3 to be consistent with previous research in this area.

Cross-price elasticities were calculated by an equation by Allison (1983):

$$E_{cross} = [\log (Q_{A2}) - \log (Q_{A1})] / [\log (P_{B2}) - \log (P_{B1})]$$

In which Q is the quantity of a commodity A purchased at price P1 and P2. When price and consumption data were plotted on log-log coordinates, the slope of the best fitting line for the 4 levels of cigarette price was computed for consumption of meals, leisure activities, snacking, and chewing gum for each participant. Positive slopes indicate that a commodity serves as a substitute; negative slopes indicate that a commodity serves as a complement; while slopes near 0 indicate that the commodity is independent (Green and Freed, 1993; Hursh, 1980; Petry, 2001a; Samuelson and Nordhaus, 1985).

After converting raw data to log-log coordinates, the mean units of consumption were compared to determine demand within each commodity using a repeated measures

ANOVA. Pairwise comparisons were run to identify significant differences among the means at different cigarette prices, correcting for multiple tests using a Bonferroni correction. A repeated measures ANOVA was then run to compare the slopes of each commodity to one another to determine significant differences in the overall change in consumption for each commodity. Pairwise comparisons were also run to determine specific differences among the slopes of each commodity, correcting for multiple tests using a Bonferroni correction.

Insert Table 2

Own-Price Elasticity

The slope of the best fitting line for the 4 levels of cigarette price was computed on cigarette consumption for each participant. Figure 1 shows cigarette purchases as a function of its price. Cigarette consumption differed significantly across the four price conditions, $F(3, 22) = 29.09, p \leq 0.001$, with purchases in each of three higher conditions differing significantly, ($p<.05$) from the .10 condition. Data are plotted on log-log coordinates such that the slope across conditions is equal to E_{own} shown in table 2. Using conventions developed by Bickel (1995) the slope of -.19 being greater than –1, decreases in cigarette purchases were proportionately less than increases in prices, thus demand for cigarettes was inelastic.

Insert Figure 1

Cross-Price Elasticity

The effects of cigarette prices on other drug purchases are shown in the figure 2. Using standards set by Bickel et al., slopes > 0.2 were considered substitutes, slopes < -0.2 were considered complements and slopes between 0.2 and –0.2 were considered independent.

Snack purchases did not differ significantly across the price conditions. The E_{cross} value for snacks was -.05 (Table 2), indicating that overall, snack consumption was independent of cigarette price increases.

Meal purchases differed significantly across the four price conditions, $F(3, 72) = 5.093$, $p <. 01$, with purchases of meals in the \$.10 and \$.20 conditions significantly higher than the purchase of meals in the \$1.00 condition, $p <. 05$. The E_{cross} value for meals was -.03 (Table 2) indicating that overall meal consumption was independent of cigarette prices.

Entertainment purchases differed statistically across the four price conditions, $F(3, 72) = 3.349$, $p < .05$. However, purchases did not differ significantly at a particular change in cost of cigarettes. No significant difference at cost of cigarettes was found. The E_{cross} value for entertainment was .04, indicating that overall entertainment consumption was independent of cigarette prices.

Gum purchases differed significantly across the four conditions, $F(3, 72) = 3.911$, $p < .01$. No significant difference at cost of cigarettes was found. The E_{cross} value for gum consumption for all participants was .56, indicating a substitute relationship between the purchases of gum and increase in cigarette price. Further analyses of only the

participants who chose to chew gum revealed a substitute relationship as well. The E_{cross} value for gum participants was 1.24, indicating a stronger substitute relationship between the purchase of gum and increase in cigarette price.

Pairwise comparisons of the change in consumption of each commodity as a function of cigarette price indicated significant differences between the slope of cigarette consumption and the slopes of meals, gum, and leisure activities.

Insert Table 3

Insert Figure 2

Insert Figure 3

CHAPTER IV

DISCUSSION

The present study adds to the literature in that it is an examination of cigarette smoking behavior in a realistic context. The results of the present study are consistent with other behavioral economic experiments that use effort as cost for smoking consumption, in that cigarette consumption remains inelastic at high costs of smoking. As early studies by Vuchinich and Tucker (1988) illustrated, demand for a commodity decreases as the price for the commodity increases. However, consumption remained inelastic for cigarettes, thus we did not see a point at which consumption became elastic as predicted. There may several reasons for the inelasticity seen in cigarette consumption in this study. When comparing the methodology of this study to similar studies using a hypothetical paradigm, many studies use effort as a measure of consumption, rather than play money (Bickel et al., 1993; DeGrandpre & Bickel, 1996). The effort required to receive a puff of cigarette was at times 100 times that of the smallest price. This manipulation in the current experiment would have made the session appear less realistic, as it would be hard for participants to envision a $1000.00 cigarette. However, it could be argued that the health problems associated with smoking could equal such high prices.

Additionally, this study examined the relationships between alternative reinforcers in the context of smoking. By introducing alternatives, a more realistic view of the smokers' dilemma is presented. As in similar studies by Petry, (2001a, 2001b) the consumption of meals was not affected by the price of cigarettes. Conversely, results from this study differ from those Petry (2001a, 2001b), as the consumption of leisure activities was not considered a complement shown in those studies. Several reasons

could account for this independent relationship. Participants may have had too much money, thus never having to sacrifice smoking and leisure activities at the same time. Additionally, given the moderate level of dependence indicated by the mean Fagerström score of 4.12, this study may not have assessed people who were highly nicotine dependent, making it hard for some to envision 12 hours sitting in a room and experiencing nicotine withdrawal.

Finally, the results of this study support the initial hypothesis that gum would be a substitute reinforcer, despite the large amount of variability within and between subjects. A study by Shahan, Odum, and Bickel (2000) produced similar results using nicotine gum, which was also shown to be a substitute; as the price of cigarettes increased, consumption of gum increased significantly. However, no studies to date have looked specifically at regular sugar-free gum as a substitute using a hypothetical paradigm. While these results are heartening, it is necessary to address the large amount of variability in those who did consume gum and characteristics of each participant. As related in the correlation table, there was very little consistency in the purchase of gum. Of the 25 participants, only 11 chewed gum and few chewed gum on a consistent basis. Further study of variables common to these participants would be helpful in understanding the substitute relationship between cigarette consumption and chewing gum consumption as the price of cigarettes increase.

Despite these findings, this study is not without limitations. First, the smokers who participated in this study are not indicative of the general smoker, with them being less responsive to the Hypothetical Purchasing Task and appearing less dependent on the FTND. Approximately one third (12) of those meeting criteria for the experiment (37)

did not show appropriate demand for cigarette consumption. Also, the average FTND score was 4.12 on a scale of 10. It is possible that more dependent smokers would respond more drastically to a price change in cigarettes. It has been shown that more dependent smokers tend to score higher on the FTND (Fagerström, 1991).

Second, although the hypothetical paradigm has been shown to be effective when researching poly-drug consumption with illicit drugs, many of the participants may have had a hard time envisioning the circumstances surrounding this model, including tobacco withdrawal, as tobacco is legal and relatively regularly available for their consumption. Future studies to address the variables influencing gum chewing including prompts and suggestions to chew gum when experiencing withdrawal may shed light on situations that gum is more likely to have a substitute relationship with smoking consumption. Another avenue to address is the difficulty of imagining going without smoking for a long period of time. This rarely occurs for most smokers; therefore it may have seemed unrealistic as Ultimately evaluating the correlation between the hypothetical situation and the real live enactment of the experiment may help with this problem, as the participant would possibly experience some nicotine withdrawal or the true feeling of doing absolutely nothing for an hour.

While there are several limitations to this study, using the hypothetical purchasing task warrants continued investigation. First, this paradigm offers a quantitative method to define relationships between a commodity and several different reinforcers, possibly finding alternatives not easily identified by others. It also allows one to study a phenomenon in the laboratory that follows similar laws in the real world. Realistically, when a person is choosing to smoke, there are a limited number of alternatives available

at different costs, which influence the cost of smoking. By studying specific alternatives and how much they decrease the likelihood that a person will choose to smoke, may allow one to tailor the environment to include those alternatives that the individual finds reinforcing.

In summary, this study demonstrates an inelastic demand for cigarettes and a substitute relationship between gum and cigarettes as the price of cigarettes increased. These results indicate that participants were resistant to change of price of cigarette smoking given at the four levels of cost and with the alternatives presented. However, it also indicated that some people may use chewing gum as a substitute as the price of cigarettes increase. As legislative bodies are lobbying for more restrictive laws on tobacco use, including tax increases, this study and others like it may aide in the provision of information to those providing smoking cessation to help individuals identify effective alternatives in their efforts to successfully quit smoking.

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APPENDIXES

APPENDIX A

TABLES

Table 1

Correlation of each trial for each commodity at the four different levels of cost for cigarettes

Cost Level	Commodity				
	Cigarettes	Meals	Gum	Snack	Leisure
.10	.96	.85	.12	.78	.95
.20	.97	.84	.22	.75	.79
.50	.96	.96	.77	.88	.81
1.00	.88	.44	.34	.40	.81

Table 2

Own-Price Elasticity for Cigarettes and Cross-Price Elasticity of Commodities Purchased

Own-Price	Cross-Price			
Cigarettes	Snacks	Meals	Leisure Activities	Gum
-.19	-.05	-.03 ***	-.04*	.56**

* p<.05, **p<.01, ***p<.001

Table 3

Means and Standard Deviations in log units for Cigarettes, Snacks, Meals, and Leisure Activities, Gum with All Participants, and Gum with Chewers

	Price Level of Cigarettes			
Commodity	.10	.20	.50	1.00
Cigarettes	1.36 (.30)	1.29 (.28)	1.25 (.29)	1.15 (.29)
Snacks	2.04 (1.16)	2.21 (.88)	1.89 (1.24)	1.95 (1.27)
Meals	3.42 (.13)	3.42 (.14)	3.39 (.17)	3.37 (.16)
Leisure Activities	3.79 (.20)	3.79 (.18)	3.79 (.13)	3.74 (.20)
Gum (With all)	-.33 (.91)	-.32 (.92)	-.16 (.82)	.24 (.90)
Gum (With Chewers)	-.08 (1.37)	-.07 (1.38)	.29 (1.11)	1.20 (.37)

APPENDIX B

FIGURES

Figure 1. Mean cigarette consumption charted as a function of cost on a log scale

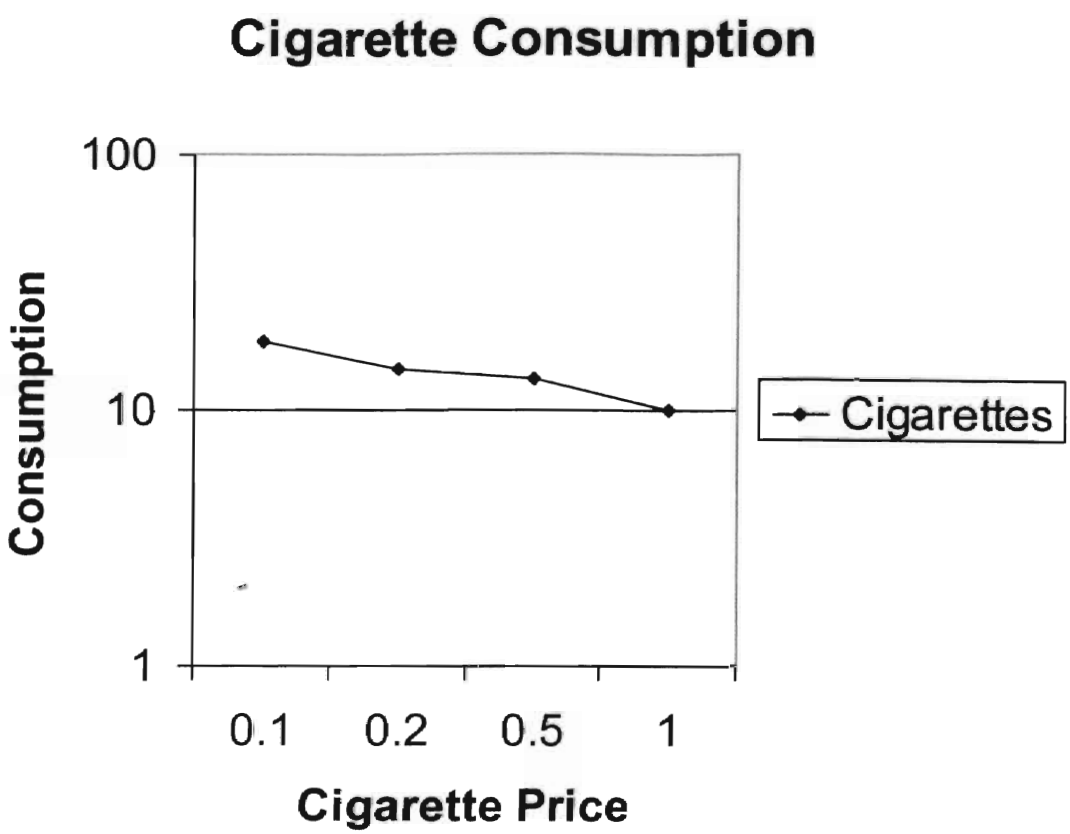


Figure 2. Snacks, Meals, Gum, and Leisure Activity Consumption Charted as a Function of Cost on a Log Scale

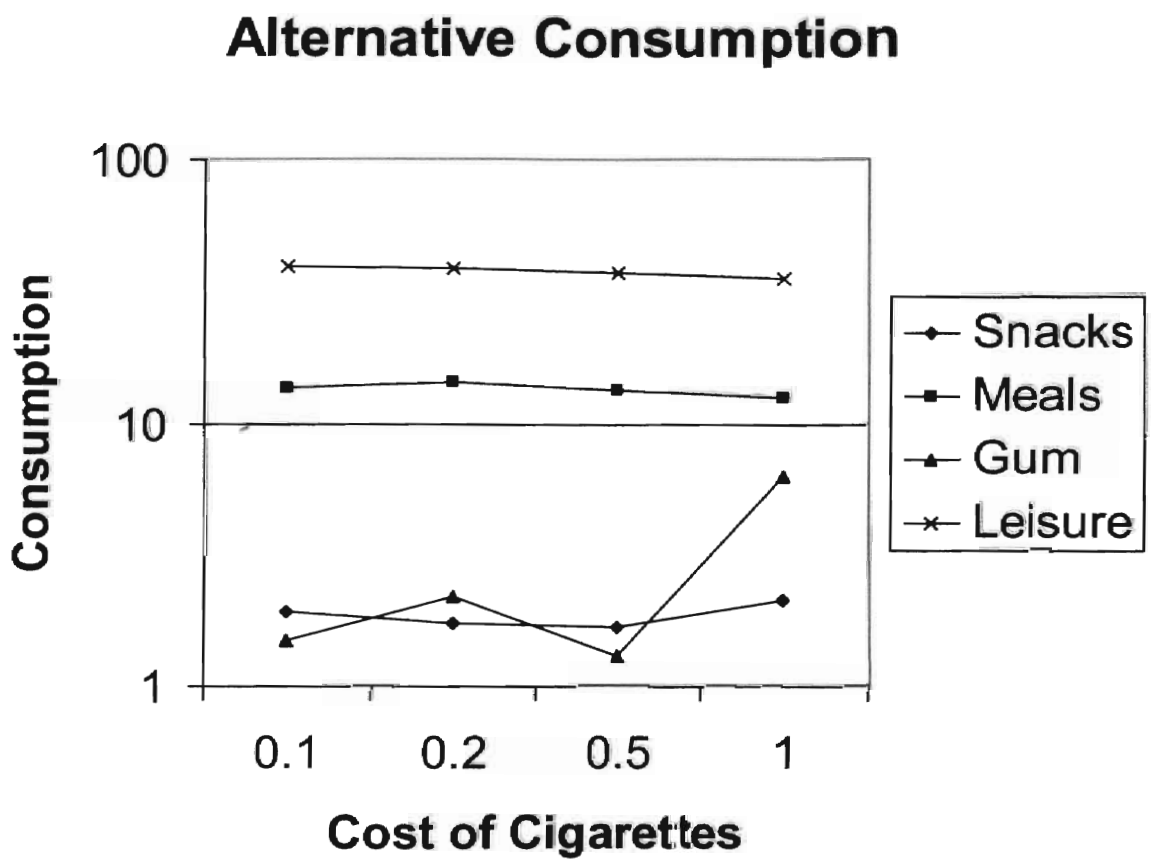
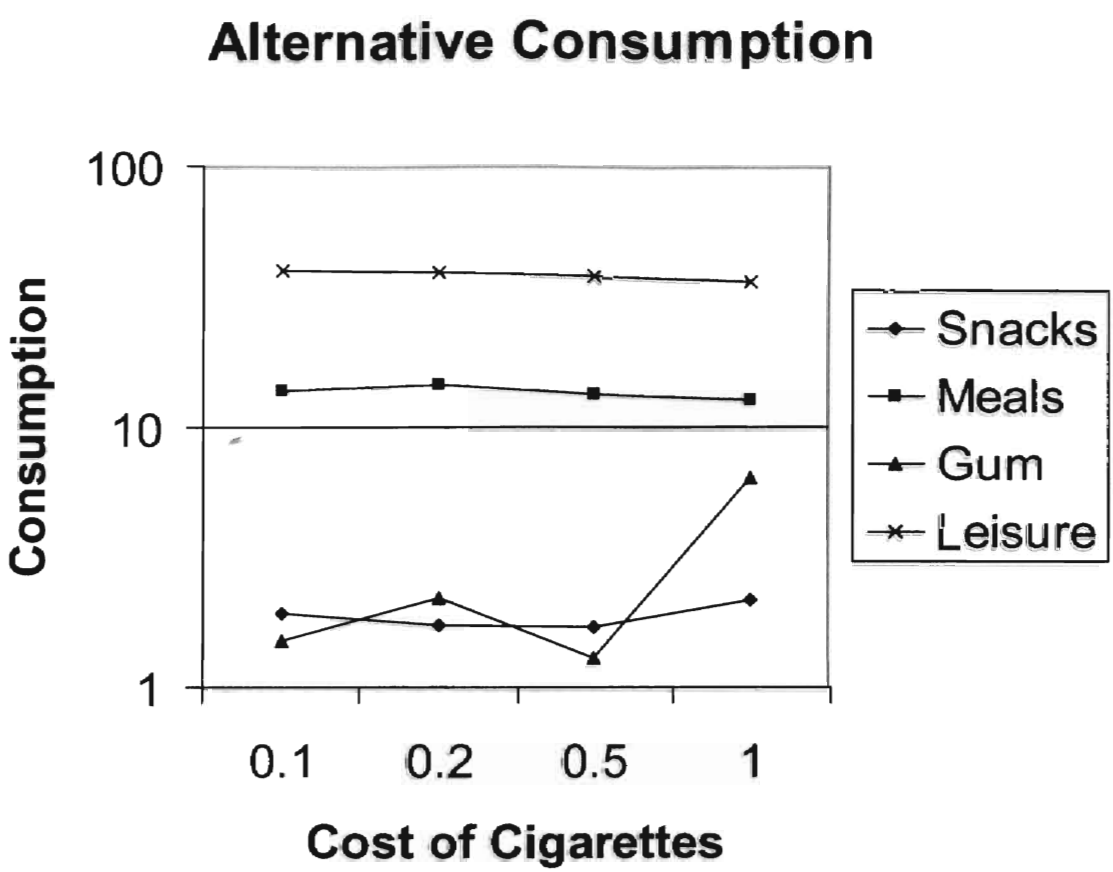


Figure 3. Snacks, Meals, Gum, and Leisure Activity Consumption Charted as a Function of Cost on a Log Scale with Gum Consumption of Participants Who Chose to Chew Any Gum.



APPENDIX C

INSTITUTIONAL REVIEW BOARD FORM

Oklahoma State University
Institutional Review Board

Protocol Expires: 4/3/03

Date: Thursday, April 04, 2002 IRB Application No AS0256

Proposal Title: ASSESSING HOW COLLEGE STUDENTS ALLOCATE RESOURCES, #2

Principal Investigator(s):

Frank Collins, Jr.
205 N Murray
Stillwater, OK 74078

Ernestine Green-Turner
309 N. Murray
Stillwater, OK 74078

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved

Dear PI :

Your IRB application referenced above has been approved for one calendar year. Please make note of the expiration date indicated above. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved projects are subject to monitoring by the IRB. If you have questions about the IRB procedures or need any assistance from the Board, please contact Sharon Bacher, the Executive Secretary to the IRB, in 203 Whitehurst (phone: 405-744-5700, sbacher@okstate.edu).

Sincerely,

Carol Olson

Carol Olson, Chair
Institutional Review Board

APPENDIX D

CONSENT FORM

Assessing How College Students Allocate Resources.

Consent Form

Behavioral Health Research Lab
Frank L. Collins, Ph.D.

I, _____hereby authorize or direct Dr. Frank Collins or associates or assistants of his choosing to perform the following procedure.

You are being asked to participant in a research study that will look at how people allocate resources under hypothetical situations.

During this study, you will be asked to complete several questionnaires related to resource allocation when the price of items and the amount of money you have to spend each vary.

The tasks should take approximately 2 hours to complete. As a student you will receive research credit for the amount of time spent in the experiment. If you have questions regarding the way the credit will be applied to your grade, please refer to the syllabus or speak with your instructor.

All information obtained during the study will remain confidential. All records will be coded by number and your name will not appear on any forms other than this consent form. All data will be kept in a locked filing cabinet in the researcher's lab. The only individual(s) who will have access to this data are Dr. Frank Collins and the research assistants conducting the project with you.

This is done as part of an investigation entitled Assessing How College Students Allocate Resources.

The purpose of this study is to determine which resources appear to serve as substitute reinforcers when costs for cigarettes are manipulated.

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

I may contact Dr. Frank Collins at (405) 744-6027 should I wish further information about the research. I may also contact: Sharon Bacher, IRB Executive Secretary, Oklahoma State University, 203 Whitehust, Stillwater, OK 74078.
Phone: (405) 744-5700

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

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

_____

Name (Print) Signature

I certify that I have personally explained all elements of this form to the subject or his/her representative before requesting the subject to sign it.

_____

Project Director or Authorized Representative

APPENDIX E

HYPOTHETICAL PURCHASING TASK MENU

Breakfast Menu -- $4.00
(Circle only one item from each category)

Free ice water available upon request

1. **Drinks:**
   Coffee Hot Tea Milk
   Hot Chocolate
2. **Juice:**
   Orange Apple Cranberry
   Grape Tomato Grapefruit
3. **Entrée:**
   Continental Breakfast (assorted pastries)
   Bagel and Cream Cheese
   English Muffin and Jam
   Cold Cereal
   Instant Hot Cereal
4. **Desert:**
   Hostess Cakes
   Fruit (Apple, Orange, or Banana)

Lunch Menu -- $6.00
(Circle only one item from each category)

Free ice water available upon request

1. **Drinks:**
   Coke Dr. Pepper Iced Tea
   Sprite Lemonade
   (Diet Options Available)
2. **Entrée:**
   Beef, Chicken, or Vegetable Rice Bowl
   Tombstone Pizza (Pepperioni or Cheese)
   Assorted Hot Pockets
   Assorted Lunchables
3. **Desert:**
   Fruit (Apple, Orange, or Banana)
   Yogurt (Assorted Flavors)
   Cookies

Dinner Menu -- $8.00
(Circle only one item from each category)

Free ice water available upon request

1. **Drinks:**
   Coke Dr. Pepper Iced Tea
   Sprite Lemonade
   (Diet Options Available)
2. **Entrée:**
   Healthy Choice Stuffed Pasta Shells
   Healthy Choice Chicken Teriyaki
   Healthy Choice Turkey, Gravy and Vegetables
   Stouffers Meatloaf
   Stouffers Veal Ptarmigan
   Stouffers Port and Roasted Potatoes
   Tombstone Pizza (Pepperoni or Cheese)
3. **Desert:**
   Ice Cream Sandwich/Bar
   Sara Lee Brownie Bites
   Cookies

Snacks Available

1.	**Drinks**	**$.50 per can**
2.	**Chewing gum**	**$.05 per piece**
3.	**Snack Sized Candy Bars**	**$.25 each**
4.	**Chips**	**$.50 per bag**
5.	**Jello Pudding Cups**	**$.50 per cup**
6.	**Del Monte Fruit Cups**	**$.50 per cup**

Entertainment and Leisure Activities
($5.00 per hour)

1. **Movie Viewing**
2. **Listening to CD's or the Radio**
3. **Playing Computer Games**
4. **Use of the Internet**
5. **Leisure Reading**

Cigarettes
(One of the following is listed)
$.10 each ($2.00 per pack)
$.20 each ($4.00 per pack)
$.50 each ($10.00 per pack)
$1.00 each ($20.00 per pack)

APPENDIX F

FAGERSTROM TEST FOR NICOTINE DEPENDENCE

CODE:_____

Fagerström Test for Nicotine Dependence (FTND)

Questions		Answers	Points
1.	How soon after you wake up do you smoke your first cigarette	Within 5 minutes	3
		6 – 30 minutes	2
		31 – 60 minutes	1
		After 60 minutes	0
2.	Do you find it difficult to refrain from smoking in places where it is forbidden e.g., in church, at the library, in cinema, etc.?	Yes	1
		No	0
3.	Which cigarette would you hate most to give up?	1st one in the morning	1
		All others	0
4.	How many cigarettes/day do you smoke?	10 or less	0
		11—20	1
		21 – 30	2
		31 or more	3
5.	Do you smoke more frequently during the first hours after waking than during the rest of the day	Yes	1
		No	0
6.	Do you smoke if you are so ill that you are in bed most of the day?	Yes	1
		No	0

Gender: Male Female

VITA

Ernestine Gnobia Jennings

Candidate for the Degree of

Master of Science

Thesis: ASSESSING RESOURCE ALLOCATION IN COLLEGE STUDENTS

Major Field: Psychology

Biographical:

Education: Graduated from Norman High School, Norman, Oklahoma in May 1992; received Bachelor of Science degree in Social Work from the University of Oklahoma, Norman, Oklahoma in May, 1997. Completed the requirements for the Master of Science degree with a major in Psychology at Oklahoma State University, in August 2003.

Experience: Research Assistant, Department of Psychology, Behavioral Sciences Laboratory; Oklahoma State University, Stillwater, OK, Supervisor: Frank L. Collins, Ph.D.

Professional Memberships: Association for the Advancement of Behavior Therapy, Society for Research on Nicotine and Tobacco, and Oklahoma Psychological Association.