

THE EFFECT OF GENDER ON THE BEHAVIORAL ECONOMICS OF  
CIGARETTE SMOKING

By

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## Introduction

This project is an extension of a previous study (Jennings, 2003) investigating demand characteristics of cigarette smoking and chewing gum. A commodity is assumed to serve as a substitute reinforcer for an alternative commodity when an increase in price of one commodity (the target) leads to an increase in consumption of an alternative commodity (the substitute) (Petry, 2001a,b). This concept is useful because it may help smokers by reducing the demand for cigarettes when the substitute commodity is available.

The literature on gender differences in smoking suggests that there are many factors which may lead to differences in smoking behavior between men and women. One of these which has received the most attention is type of dependence. It has been suggested that women experience greater behavioral dependence to smoking, while men tend to display a physiological dependence on nicotine (Butschky et al., 1995; Gross et al., 1997; Rose et al., 1985). In other words, women's dependence on cigarettes may be more influenced by the behaviors and sensations associated with smoking, such as mouth movements and the feel of smoke as it is inhaled (Eissenberg et al., 1999, Gritz et al., 1996). It is possible that gender differences in the type of reinforcement received from smoking cigarettes may affect the behavioral economics of smoking.

Another factor that some authors have suggested affects women's smoking behavior is menstrual cycle. There has been some inconsistent evidence that women may vary their smoking topography across the menstrual cycle, and that the probability of a



successful cessation attempt may vary by menstrual phase (Allen, Hatsukami & Christianson, 1995; Allen et al., 1999; Allen et al., 2000; Craig, Parrott & Coomber, 1992; DeBon, Klesges & Klesges, 1995; Frye, Ward, Bliss, & Garvey, 1992; O'Hara, Portser & Anderson, 1989; Pomerleau et al., 1992; Pomerleau et al., 1994). Due to this body of literature, a second phase was added to this research project to assess the presence of effects of menstrual cycle on the data collected.

To answer the question of whether or not gender differences exist in a hypothetical behavioral economics paradigm, the data from Jennings's 2003 study was reanalyzed for gender differences. These differences were specifically looked at in smoking and gum chewing behavior in the hypothetical paradigm. Gum chewing was chosen as a behavior of interest due to its potential to act as a substitute reinforcer for cigarette smoking, and because in Jennings's original study, it was the only one of the alternative commodities available in the hypothetical paradigm that acted as a substitute reinforcer for smoking. A second smaller sample of women was used to examine effects of menstrual cycle on behavior in the paradigm.

## Literature Review

Cigarette smoking is known to lead to many health problems including cancer, coronary heart disease, and stroke. Smoking is also associated with many deaths. In the United States alone, approximately 400,000 deaths annually are attributable to cigarette use. In comparison to the number of deaths that can be attributed to other drugs, this number is very high. For instance, the number of annual deaths attributable to alcohol is estimated at 125,000-150,000, heroin is estimated to cause 4,000 deaths annually, cocaine leads to 2,000-4,000 deaths, and annual deaths caused by marijuana is estimated at 75. This makes cigarette use the number one most preventable cause of death in the country (USDHS, 1990).

Smoking has historically been, and still is, more prevalent in men than in women. In 1998, 25% of men were smokers and about 21% of women reported being smokers. However, the gap between the genders is narrowing. The prevalence of smoking among men in 1964, at the time of the first surgeon general's report was 53% in men and 32% in women. The decline in smoking among men from 1965-1987 was 0.84%. In women, smoking declined only 0.21% in the same time span. In 1987, smoking-related diseases surpassed breast cancer as the leading cause of death among women.

The decline in smoking prevalence among women may have been attenuated by the increase in smoking among teenage girls, especially in the 1990's (Surgeon General's Report, 2001). Recent trends suggest that smoking rates are also rising among young women aged 18-24 (Surgeon General's Report, 2001). Another reason for the lack of a

large decline in women's smoking rates may be the greater difficulty that adult women have in maintaining smoking abstinence (USDHHS, 1989). Among adolescents, girls and boys have similar ages of initiation, but girls who begin smoking remain smokers for longer.

Several possible reasons for the gender differences in smoking and cessation rates have been investigated. Among these are differences in the experience of withdrawal. Several studies have provided evidence suggesting that women may experience different and more intense withdrawal symptoms (Fant et al., 1996; Perkins, 1996; Pogun, 2001). However, the validity of these findings has been questioned (Pomerleau et al., 1994; Pomerleau, 2000). In addition, women's menstrual cycles may affect the experience of withdrawal (e.g. Allen et al., 2000), although some evidence suggests that menstrual cycles have no effect on withdrawal symptoms (Allen, Hatsukami & Christianson, 1995; Pomerleau et al., 1994). Hormone cycles have also been thought to affect the experience of smoking (Allen et al., 1999; DeBon, Klesges & Klesges, 1995).

Differences in the sensory versus physiological effects of smoking may also play a role. Nicotine self-administration curves do not appear to be as robust for women as for men (Perkins, 1996). Women may also be less able to discriminate between different doses of nicotine, and less able to manage the doses they consume (Perkins, 1992). The sensory aspects of smoking increase subjective pleasure for both genders (Eissenberg et al., 1999; Gritz et al., 1996; Perkins, 1994; Perkins et al., 2001), but women appear to be affected by these aspects more than men are (Butschky et al., 1995; Gross et al., 1997; Rose et al., 1985). Differences in response to nicotine replacement therapy (NRT) may also be partially responsible for the differences in smoking and cessation rates. Women

generally have less success at cessation attempts using NRT (Perkins, 1996; Gritz, Nielsen & Brooks, 1996; Pomerleau, 1996). Some limited evidence even suggests that women's withdrawal symptoms could be exacerbated by the use of NRT (Wetter et al., 1999). Some researchers have suggested that hunger and weight control may also affect cessation. It is possible that women may fear increases in hunger and weight gain upon cessation more than men (Moolchan, Ernst & Henningfield, 2000; Perkins, 1993; Perkins et al., 1987; Pomerleau, 1996). It has also been noted that women tend to gain more weight upon cessation than male smokers (Perkins, 1993; Pomerleau, 1996). Each of these areas will be discussed in more detail below.

Based on the empirical evidence available, men and women appear to receive different benefits from smoking. They also appear to need different strategies for successful cessations. Due to these observations, a behavioral economics framework may be useful in understanding how cost and available alternatives affect smoking habits for men and women. This type of analysis could lead to a better understanding of what activities could serve as substitutes for smoking for each gender.

## Gender Differences in Nicotine Use

### *Gender Differences in Withdrawal Symptoms*

A difference in withdrawal symptoms has been proposed as one explanation for the gender differences in quit rates and successful abstinence. Previous research has indicated that women report more withdrawal symptoms, and more severity of withdrawal (Fant et al., 1996, Perkins, 1996, Pogun, 2001). However, this does not seem to be a likely explanation. More recent studies have suggested that the differences in

reported withdrawal symptoms may be due to the retrospective measures employed previously (Pomerleau et al, 1994, Pomerleau, 2000). When self-report measures of withdrawal are taken prospectively, men report symptoms in equal number and of equal severity to those reported by women. Thus, differences in withdrawal may simply be an artifact of the research methodology, and not a relapse concern specific to women. However, the symptoms experienced by women may still be somewhat different from those reported by men. Some researchers have found that men report more physiological symptoms during withdrawal, while women report more affective symptoms and greater levels of craving (Fant et al., 1996, Perkins, 1996, Pogun, 2001).

#### *Sensory versus Physiological Effects of Smoking*

Several factors suggest that smoking serves different purposes for men and women, and this may contribute to the differences in quit rates across gender. In particular, it appears that sensory and weight control factors are more important in maintaining smoking habits in women, while men may experience more physiological effects from nicotine. For instance, men and women may show differential physiological sensitivity to nicotine. Animal studies have suggested that in mice, nicotine is more potent in males. It has been argued that this may be due to blockage of nicotinic receptors by sex hormones (Damaj, 2001).

*Nicotine self-administration and dose discrimination.* Men appear to be more sensitive to the physiological effects of nicotine as demonstrated by gender differences in self-administration rates and the ability to discriminate between different doses of nicotine. For example, Perkins (1996) assigned smokers who were trying to quit smoking

to one week of either nicotine nasal spray or placebo. Men who were assigned to the nicotine condition used the nasal spray twice as much as those in the placebo condition. There was no difference in self-administration in women, suggesting that women are less able to discriminate between nicotine and placebo. Other physiological evidence suggests that men self-administer nicotine by nasal spray at higher rates than women when administering on an ad-lib basis (Perkins, 1996). The majority of animal research on self-administration of nicotine has used males exclusively. The paucity of research on female animals may be due to difficulty in achieving robust self-administration in female animals (Perkins, 1999).

In addition, it appears that women do not titrate their nicotine intake following preloading as well as men do. When participants are pretreated with varying doses of nicotine, and then allowed to smoke cigarettes ad lib for a set amount of time, titration of intake to achieve a desired dose can be observed. Men tend to titrate their nicotine intake to maintain plasma levels similar to those observed when smoking ad lib without nicotine preloading. On the other hand, women appear to inhale the same amount of nicotine regardless of preloading and dosage of pretreatment. These results suggest that women are less able to discriminate the amount of nicotine already taken in and regulate their own dosage (Perkins, 1992).

Even when asked to attempt to learn to discriminate nicotine dosages, women perform poorly. Women demonstrate greater difficulty in learning to discriminate doses of nicotine during a learning paradigm. In addition, even when they had been taught to discriminate doses adequately, women reported less confidence in their judgments than did men (Perkins, 1996).

*Other physiological evidence.* Recent research has been done on a small percentage of people who have a defective allele for which interferes with nicotine metabolism. One such study reported that men who have this allele smoke less in order to compensate for the higher plasma levels of nicotine that result from this defect (Tyndale, Pianezza & Sellers, 1996). Women who have the same genetic defect do not appear to compensate for their elevated plasma levels. Instead, they smoke at similar rates as women who do not have this allele (Tyndale, Pianezza & Sellers).

The differences found in men's and women's abilities to discriminate nicotine dosages may be explained by research that suggests that women are consistently less accurate than men at detecting any physiological changes (Roberts & Pennebaker, 1995). Additionally, women's performance at detecting these changes does not improve with feedback about the accuracy of their reports.

Interestingly, this effect is only found in the absence of contextual cues. Sex differences in perceptions of physiological changes are generally not found in the presence of a situational context, which can provide cues to the detection of changes (Roberts & Pennebaker, 1995). There is reason to believe that this may apply to changes due to nicotine intake, too. External cues may be important in determining the perception of physiological changes due to nicotine intake, especially for women.

*Sensory aspects of cigarette smoking.* Many women smoke at rates equal to men, and may even report higher levels of dependence. However, research suggests that physiological dependence on nicotine may not be a strong reinforcer of smoking in women. This would suggest that smoking has different effects in women. Sensory aspects of smoking may fill this role. Sensory aspects of cigarette smoking include things such as

holding the cigarette in the fingers, moving the lips and mouth, the smell of nicotine smoke, and the feel of the smoke in the back of the throat when it is inhaled. Women appear to respond more to these reinforcing aspects of smoking than to the nicotine itself (Eissenberg et al., 1999, Gritz et al., 1996).

External cues appear to increase the subjective pleasure obtained from smoking cigarettes for both men and women. For example, Rose et al. (1985) required male and female participants to gargle solutions that either contained the anesthetic lidocaine, or a saline solution. Participants also inhaled a mist of the same solution. Following this, participants sham smoked, or smoked real cigarettes. Cigarette smoke was found to significantly reduce subjective cravings. However, anesthetization of the airways blocked the immediate reduction in craving. When people are required to wear nose clips while smoking, olfactory cues associated with smoking can be almost completely blocked. Researchers have demonstrated that this blocking of olfactory cues can reduce puff volume, as well as reported taste and enjoyment of smoking in women. There were no men in this sample (Baldinger, Hasenfrazt & Battig, 1995). In both of the above studies, blocking sensory cues associated with smoking reduced the pleasure participants received from smoking.

Other evidence that the sensations felt when smoking help to maintain smoking behavior comes from studies in which participants are asked to rate different types of cigarettes. These studies have consistently found that subjective ratings such as 'liking' and 'satisfaction' increase with exposure to standard brand as well as de-nicotinized cigarettes. The de-nicotinized cigarettes decreased reported craving and withdrawal to the same extent as the nicotine cigarettes (Butschky et al., 1995, Gross et al., 1997). In some



previous studies, smokers who rated nicotine and de-nicotinized cigarettes similarly in 'liking' and 'satisfaction' tended to be more dependent than those who had more dissimilar ratings (Brauer et al., 2001).

Although sensory cues increase the subjective pleasure from smoking in both men and women, there is some evidence that the effect may be stronger in women. When men and women are administered comparable doses of nicotine by cigarette smoking and nasal spray, women report much greater increases in subjective measures such as feeling 'relaxed' and 'comfortable' when smoking cigarettes. This occurred even though the doses administered by the two routes were similar. Men did not show this same pattern of responding (Perkins, 1994).

Related to this, the effects of non-nicotine stimuli were investigated in a set of three studies. In the first two studies, participants wore swimming goggles and nose clips to block visual and olfactory stimuli. Self-administration and reported satisfaction were reduced when sensory stimuli were blocked. This effect was significant in women, but not in men. Interestingly, further analyses showed that the effect held for olfactory and taste stimuli, but visual stimuli did not appear to affect hedonic ratings or self-administration of nicotine. In the third study, the same procedure was applied to eating pizza. No gender differences were observed in this study, suggesting that the gender differences in subjective ratings may only apply to substances such as nicotine and not to all consumption (Perkins et al., 2001).

During quit attempts, women are also more likely to implement sensory substitutes such as nicotine inhalers or gum into their attempt (Perkins, 2001). It has also been suggested that women may consider 'hand-mouth activity' as more important in self-

administering nicotine gum during cessation attempts and in the use of cigarettes than men do (Parrott & Craig, 1995).

### *Nicotine Replacement Therapy*

Nicotine replacement therapies (NRT) are the main pharmacological treatment used to reduce nicotine withdrawal symptoms during cessation attempts (Fiore, Pierce, Remington, & Fiore, 1990; Hughes & Glaser, 1993). In several studies, nicotine replacement therapy (NRT) has been shown to be more effective than placebo for both men and women. However, the difference between the two conditions is generally higher among men than it is among women (Davis et al., 1994; Killen et al., 1990). In addition, some studies have reported that NRT is less effective at reducing withdrawal symptoms among women than men (Perkins, 1996; Gritz, Nielsen & Brooks, 1996; Pomerleau, 1996).

Sleep has also been used as a measure of response to NRT, because nicotine withdrawal leads to increased sleep fragmentation. It has been demonstrated that NRT alleviates sleep disturbance and reported withdrawal symptoms in men. However, use of NRT patch appears to exacerbate sleep disturbance in women. Women appear to show significant withdrawal symptoms when using NRT while men do not. It is not clear whether the exacerbated sleep disturbances seen in women during NRT use are associated with an increase in withdrawal symptoms (Wetter et al., 1999).

Men demonstrate higher abstinence rates than women when using NRT in the form of gum, patch or nasal spray. However, abstinence rates are higher among women when people use nicotine inhalers as NRT (West et al., 2001). This is an interesting

finding considering that gum and inhaler deliver nicotine by the same means, and at similar rates and dosages. A possible explanation for this finding is the additional sensory aspects of using an inhaler. The reduced efficacy of NRT in women may be evidence in favor of lessened physiological effects of nicotine in women.

However, the use of other non-nicotine medications is sometimes more effective in women than in men. These NRT medications include clonidine and antidepressants such as bupropion (Perkins, 1996). This offers even more support for the view that factors other than nicotine itself are important in maintaining smoking in women.

### *Hunger and Weight Control*

Since oral habits, such as chewing or moving the lips are considered to be sensory aspects of smoking, it is not surprising that people who quit smoking often eat more than when they were smoking and begin to gain weight. Many women are concerned about weight, and weight concerns are commonly cited by women as reasons to initiate and continue smoking (Moolchan, Ernst & Henningfield, 2000; Perkins, 1993; Perkins et al., 1987; Pomerleau, 1996). Most female smokers report being afraid of gaining weight following smoking cessation, while only one fourth of men report the same fears (Perkins, 1993). Weight gain following cessation is also a commonly reported reason for relapse (Perkins et al., 1987). Consistent with the view that sensory aspects of smoking may be more relevant to women, women tend to gain more weight following cessation than men do in the same time frame, and the difference in weight due to smoking status is greater in women than it is in men (Perkins, 1993; Pomerleau, 1996).

The commonly held idea that smoking reduces hunger may be misleading, however. By itself, nicotine does not appear to reduce reported hunger, even at higher doses (Perkins et al., 1992; Perkins et al., 1994). However, it has been found that consuming nicotine may reduce subjective feelings of hunger following caloric intake. In other words, some smokers report feeling fuller and more satiated than non-smokers after consuming the same number of calories. Therefore, the weight gain that many people experience following smoking cessation may be due in part to longer latencies to satiation in some situations, and in part to a desire to replace the sensory reinforcement obtained from smoking cigarettes. Gender differences are also apparent in food reinforcement. In behavioral experiments, such as those in which participants must press levers in order to receive reinforcement, it has been demonstrated that female smokers who are nicotine deprived work harder to obtain the food reinforcers than men in the same deprived state (Gritz et al., 1996).

### *Menstrual Cycle and Nicotine*

Nicotine is known to alter mood and performance. Menstrual phase is also known to exert changes on mood and performance. Consequently, it may seem reasonable that the effects of nicotine may vary across the menstrual cycle in response to hormonal changes. Several studies have found such effects, but the findings are inconsistent. Steinberg & Cherek (1989) measured women's smoking behavior during daily two-hour sessions. They completed the sessions across at least two menstrual cycles for each participant. The authors reported an increase in the mean number of puffs and puff duration during menses, as compared to pre- and postmenstrual phases.

When completing daily symptom checklists, women report increased rates of smoking during menses and late-luteal phase (DeBon, Klesges & Klesges, 1995). The results of many studies of menstrual phase and nicotine withdrawal are somewhat confounded by the high correlation between premenstrual symptoms and the symptoms reported by people in withdrawal, especially concerning affect (Allen et al., 2000). In one study, female smokers reported increases in urge to smoke during the late luteal phase, but objective measures of cotinine levels and expired CO did not vary across menstrual phases (Allen et al., 1999).

However, others have not found any evidence that smoking varies across the menstrual cycle (Allen, Hatsukami & Christianson, 1995; Pomerleau et al., 1994), except in women with Premenstrual Dysphoric Disorder (PDD) (Marks et al, 1994). Although these researchers found a modest difference in plasma nicotine levels across phase in earlier investigations (Pomerleau et al., 1992), the inability to replicate the effect casts doubt on the ability of menstrual phase to affect rates of smoking.

Menstrual phase may affect the ability of women to quit smoking. This can especially be seen in the increase in discomfort during the premenstrual period in women who are attempting to quit. This effect has been attributed to nicotine withdrawal, and more specifically, the combination of withdrawal and premenstrual symptomatology, which are very similar (O'Hara, Portser & Anderson, 1989).

For instance, Pomerleau et al. (1992) found that nicotine abstinence did not increase premenstrual discomfort in their sample. However, it did prevent the normal reduction in symptoms in the mid-to-late luteal phase. The women in this study also reported increased craving during the premenstrual phase.

There is some evidence that women who attempt to quit during the premenstrual phase experience more difficulty. It has been reported that women who attempt to abstain from smoking for two days during the premenstrual phase experience more difficulty than women in mid-cycle or men who are attempting to abstain for the same amount of time (Craig, Parrott & Coomber, 1992). Similar results were found by Allen et al. (2000). In their sample, women reported more severe withdrawal and premenstrual symptomatology in the late luteal phase than in other phases. In addition, women who attempted to abstain from smoking in the luteal phase in Perkins et al. (2000) study reported greater withdrawal and depressive symptoms than women who were in the follicular phase. Others have suggested that women are at greater risk of relapsing during their menses, regardless of quit date (Frye, Ward, Bliss, & Garvey, 1992). No other studies have looked at subsequent relapse.

### Behavioral Economics

Behavioral economics refers to the application of economic theory to the analysis of behavior, which has often been applied to substance abuse (Bickel et al., 1990, Bickel et al., 1991, Bickel et al., 1995, DeGrandpre et al., 1992, Kagel & Winkler, 1972).

Behavioral economics is an approach that grew out of consumer demand theory, and is used to examine the relationship between price and demand of a commodity.

Demand law is a fundamental concept in consumer demand theory, and thus it is fundamental in behavioral economics. The demand law states that when all else is held equal, consumption of a reinforcer or commodity goes down as price goes up (Allison, 1979). The nature of this law can be displayed graphically with consumption plotted as a

function of price. The resulting function is termed a demand curve (Allison, 1979). Demand curves have consistently been shown to be robust as measures of behavior across a variety of reinforcers and species, including humans (DeGrandpre et al., 1993, Hursh, 1991, Bickel et al., 1997, Bickel et al., 1998).

Several factors may influence the law of demand, including the availability of other reinforcers. A concept used to explain differences in consumption is elasticity of demand. Elasticity of demand refers to the degree to which consumption of a reinforcer decreases as its price increases (DeGrandpre et al., 1992).

When a unit change in price produces less than a unit change in consumption, demand for a reinforcer is considered inelastic. Demand for a reinforcer is considered to be elastic when a unit change in price produces greater than a unit change in consumption. For instance, when a 1% change in price produces a change in consumption which is larger than 1%, the demand would be seen as elastic (Vuchinich, 1999).

It is also possible to differentiate between types of elasticity. Petry (2001a,b) has identified own-price elasticity as the proportionate change in consumption as the price for that commodity increases. Different reinforcers may show different own-price elasticity. Cross-price elasticity refers to the effect on consumption of one reinforcer by changes in the price of another (Petry, 2001a,b). There are three possible relationships that can be found in cross-price elasticity. Increasing the price of one reinforcer (resulting in a decrease in consumption of the target reinforcer) can increase the consumption of an alternative reinforcer. In this relationship, the alternative reinforcer is labeled a substitute reinforcer. If consumption of an alternative reinforcer decreases as price for the target

reinforcer increases, the alternative is termed a complement reinforcer. Finally, consumption of the two reinforcers may be independent of each other.

This framework has been researched in many areas, and has been shown to be a useful framework for studying substance abuse, eating, and gambling (Madden, 2000). In fact, behavioral economics was developed as an alternative to the disease model of addiction.

### *Hypothetical Purchasing Task*

Petry (2001a,b) has used a Hypothetical Purchasing Task to study drug consumption in poly-drug users. In this paradigm, participants are asked to imagine that they are in a hypothetical situation, which the researcher outlines. Income and available options for spending out are written out for the participants on a piece of paper. They are told to try to act as much like they would in the real situation as is possible. The researcher can then manipulate prices of commodities across trials. In this way, data can be collected in a much shorter amount of time, and with much less cost than in a 'real world' situation. In these studies, choices concerning drug use made in the hypothetical situation tended to correlate with urinary analysis and self-reports of lifetime drug use (Petry, 2001a,b). This suggests that the Hypothetical Purchasing Task is useful as a model for behavior in the real world.

### *Behavioral Economics of Smoking*

Several studies have used a behavioral economics framework as a means of studying smoking behavior. For instance, Bickel et al. (1991) exposed participants to



several fixed ratio schedules in which they were required to pull a lever a fixed number of times in order to receive puffs on a cigarette. The researchers were able to demonstrate robust demand curves for cigarette smoking, demonstrating that consumption went down as unit price, or effort required, to gain the puffs increased. Other studies have also been able to establish these curves for cigarette smoking ( e.g. DeGrandpre et al., 1993).

In a similar study completed by Bickel et al. (1995), participants were required to pull a lever in order to receive puffs on a cigarette or a competing reinforcer, either money or recreation. Prices and amount of reinforcer were varied. Across conditions, it was found that introducing a competing reinforcer reduced nicotine intake. In other words, cross-price elasticity was demonstrated. Further, the greatest reductions in cigarette smoking occurred when unit price for smoking increased, and another reinforcer was available.

Behavioral economics has also been used to demonstrate that nicotine gum may serve as a substitute reinforcer for smoking. As price for smoking increases, consumption of nicotine gum increases, suggesting that it is a substitute for smoking (Shahan, Odum, & Bickel, 2000). As stated previously, nicotine gum as NRT has been shown to be effective, but less effective for women. In addition, external factors such as oral movement may be reinforcing aspects of smoking. Therefore, it may be possible that nicotine gum serves as a substitute reinforcer due to sensory factors as well as the nicotine it contains. However, none of the studies applying a behavioral economics framework to smoking thus far have used food or chewing gum as alternative reinforcers.

### *Chewing Gum as a Possible Substitute for Cigarette Smoking*

Chewing gum has been shown in several studies to reduce reported withdrawal. When nicotine-deprived participants in a study are asked to either chew gum or not have gum while watching a movie, self reported craving and withdrawal are found to be lower in participants who chew gum (Cohen et al., 1997). In another study, it was found that when gum was present in the laboratory setting, participants took fewer puffs and abstained for longer periods of time (Cohen et al., 1999). In addition, nonsmokers are more likely to chew gum than smokers (Britt et al., 1999). Other research has suggested that development of a regular gum-chewing habit during the first week of cessation may be associated with eventual success during that cessation attempt (Parrott & Craig, 1995).

The above findings suggest that there may be benefits to chewing gum during cessation attempts. This may be related to the idea that sensory reinforcement may be important in smoking. Thus, chewing gum may be able to serve as a substitute reinforcer for cigarettes for some people. Since the effects of sensory reinforcement appear to be stronger in women, and women appear to be less sensitive to the physiological effects of nicotine, we would expect price changes for smoking to have more of an effect on gum consumption in women than in men.

Recently, a study completed in our laboratory found that chewing gum was a substitute reinforcer for smoking (Jennings, 2003). Although various other activities were available, including meals, snacks, and leisure activities, none of the other activities were found to serve as substitutes for smoking. In this study, participants were not separated by gender, and so gender differences in chewing gum and smoking behavior were not determined. Specific influences, such as menstrual cycle in women were also not

examined. However, the results of this study lend support to the supposition that chewing non-nicotine gum may provide some of the same benefits as smoking cigarettes in situations in which cigarettes are made less available (Jennings).

### The Present Study

The current study is designed around a Hypothetical Purchasing Task based on the task developed by Petry & Bickel (1998). This Hypothetical Purchasing Task is designed to evaluate potential alternative reinforcers for cigarette smoking. Using a behavioral economics framework, participants will be assessed to determine the relationships of the possible alternative reinforcers to cigarette smoking.

The specific aims of this study were to examine the differences in cross-price elasticity of the possible alternative reinforcers between men and women, and to determine whether or not menstrual phase has an effect on the choices made by women in the hypothetical paradigm. The hypotheses of this study were as follows:

1. Women are more likely than men to choose chewing gum as a substitute reinforcer to cigarette smoking. As price for cigarettes increases, consumption of food and chewing gum increases in female participants more than in male participants.

2. Menstrual phase has no effect on the consumption choices made by women. It is expected that women's spending choices in the hypothetical paradigm will remain approximately the same across phases of the menstrual cycle.

## Methods

### *Study 1*

Data collected for a previous study (Jennings, 2003) were reanalyzed in order to test the hypothesis that different items or activities serve as a substitute reinforcers for smoking in men and women. The data from this study were collected in the following manner.

### *Participants*

Participants were selected from undergraduate psychology and marketing classes at Oklahoma State University. They either fulfilled an assignment for the class they had been selected from, or received extra credit for participation in the study. Potential participants were administered a screener in their classroom. They were selected based on smoking status. A total of 36 participants were collected. Of this number, 11 participants were excluded because they did not show demand elasticity. Therefore, 25 participants, 12 female and 13 male, were included in the final analysis. Participants were asked to smoke one cigarette within the hour before the experiment to control for withdrawal during participation.

### *Materials*

*Fagerström Test for Nicotine Dependence.* Participants completed the Fagerström Test for Nicotine Dependence (FTND), which is a paper and pencil measure to assess

nicotine dependence based on regular smoking habits. Scores may fall anywhere within a range of 0-11, with a score of 0 indicating minimum nicotine dependence and a score of 11 indicating maximum nicotine dependence (Fagerström, 1978). Participants also completed two Hypothetical Purchasing Tasks. Each participant was asked to complete two tasks to allow for assessment of consistency across the tasks. Before completing the Hypothetical Purchasing Tasks, each participant completed one practice situation in order to habituate him or her to the protocol. The data from this practice situation were discarded and was not used in any analyses.

*Hypothetical Purchasing Task.* This task is modeled after the task designed by Petry and Bickel (1998). In this task, participants were asked to imagine that they were spending 12 hours alone in a room in the research laboratory. Each participant was provided with \$60.00 in counterfeit money which could be spent throughout the day. Participants were informed at the beginning of the task that they would not receive any more money for they day, and no money could be saved and kept at the end of the day. Any unspent money was given back to the experimenter at the end of the day.

Participants were also handed a list of items available for purchase and their prices. They were informed that breakfast would be offered at 8:00 a.m. at a price of \$4.00, lunch would be offered at 12:00 p.m. at a price of \$6.00, and dinner would be made available at 5:00 p.m. for \$8.00. Otherwise, meals could be purchased a la cart at these three times for prices as listed. Meals were not available at any other time. Snacks were available for purchase throughout the day, including meal times, for various prices. Chewing gum was available for \$0.10 for each piece, and participants could buy various leisure activities for a flat fee of \$5.00 an hour. Options included watching DVD movies,

playing computer games, using the internet, listening to music, and reading books or magazines. Participants were told that sleeping while in the laboratory was not an option, and the experimenter would wake them up if they should fall asleep. The cost of cigarettes was varied in each situation. Cigarette costs that were encountered were \$0.10, \$0.20, \$0.50, and \$1.00 for each cigarette. They could only be purchased singly instead of in packs. There were visual representations of available items in order to assist the participant in making choices.

After the paradigm had been explained, the experimenter asked the participant to indicate what they would like to purchase during each hour of the day. Purchases were totaled for each hour, and the counterfeit money was exchanged to assist with keeping track of finances. The experimenter also periodically reviewed what had been done in the day. For example: "So far, you have eaten breakfast, watched a movie, and had 2 cigarettes. It is now 11:00. Lunch will be offered in one hour. What would you like to do now?" Participants were allowed to choose to do nothing for an hour. However, if they chose this option, they were required to spend five minutes of real time doing nothing, and then asked if they still thought they would like to do nothing for an hour. All purchases were recorded on a separate sheet of paper. Totals were generated for each day. Participants spent between 45 and 90 minutes completing the two trials of the Hypothetical Purchasing Task.

### *Study 2*

Participants for the second study included 10 female smokers. These participants were asked to partake in the same procedure used in the previous study. They were also

asked to complete an additional questionnaire concerning menstrual cycle. Each participant was assessed twice during the same one-month period. They appeared at the research laboratory once during the follicular phase of their menstrual cycle, and once during the late-luteal phase. These times were counterbalanced so that half of the sample had their first session during the follicular phase, and half the sample had their first session during the late-luteal phase. The data from these participants was analyzed to determine if any differences in choices exist across menstrual phase. One participant demonstrated inconsistencies in responding. These inconsistencies could reflect inadequate understanding of the task, or a failure to treat the task as a realistic situation. Due to this inconsistent pattern of responding, this participant was removed from the analyses presented below.

*Menstrual phase questionnaire.* Participants were also asked to complete a questionnaire concerning characteristics of their menstrual phase. Items include asking women to report the date of the first day of their last menstrual period, whether or not they take oral contraceptives or hormone therapy, and whether or not they are pregnant or nursing. This instrument was used to assess whether or not menstrual phase influences the decisions made on the hypothetical purchasing task. Questions were presented orally.

### *Procedure*

One participant was present at each experimental session. Each participant was asked to read and sign an informed consent form at the beginning of the session. Participants completed the FTND, and two Hypothetical Purchasing Tasks following the

consent. The experimenter provided a brief overview of the study and answered any questions before beginning the Hypothetical Purchasing Tasks.

As in study 1, participants were asked to imagine that they would be spending 12 hours alone in the room in which they were sitting. They were told to imagine that they would arrive at the research laboratory at 7:00 a.m. and remain in the laboratory until 7:00 p.m. Participants were then handed \$60.00 in counterfeit money. They were asked to imagine that this would be all the money they have for the entire 12-hour day. Participants were then told that everything they wanted to do during the day would have to be paid for with that money. No money could be saved for later use, as leftover money would be collected by the experimenter at the end of each day. Each participant was asked to complete the protocol on two separate occasions, coinciding with the follicular and late luteal phases of the menstrual cycle. Participants were also asked to complete a menstrual phase questionnaire following completion of both experimental sessions.

## Results

For all analyses, the total amount of money spent on each alternative commodity (meals, snacks, gum, and leisure activities) during each trial was used as a measure of consumption of alternative commodities. Since the cost of cigarettes varied across trials, number of cigarettes was used to measure consumption of cigarettes.

### *Study 1*

Data from a previous study completed in this research laboratory were reanalyzed to examine gender differences. The mean FTND scores for men and women were 3.85 and 4.5, respectively. This suggests that participants in this sample generally reported



moderate nicotine dependence. FTND scores for individual participants can be seen in Table 1 in Appendix A. In order to compare this sample with the sample of participants collected for study 2, demand elasticity was computed separately for men and women.

Demand elasticity was computed using an equation suggested by Allison (1983). Two types of demand elasticity can be computed, own-price and cross-price elasticity. Own-price elasticity refers to the proportionate change in consumption as the price for that commodity increases (Petry, 2001a,b). Different reinforcers may show different own-price elasticity. Cross-price elasticity refers to the effect on consumption of one reinforcer by changes in the price of another (Petry, 2001a,b). When computing own-price elasticity of cigarettes, Q is the quantity of cigarettes purchased at Price level (P) 1 and 2.

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

When consumption and price level are plotted on log-log coordinates, the slope represents  $E_{\text{own}}$ , own-price elasticity of cigarettes.

When computing cross-price elasticity of alternative commodities, the equation is stated as follows, where Q equals the quantity of commodity A purchased at Price level (P) 1 and 2.

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

When consumption and price level are plotted on log-log coordinates, the slope represents  $E_{\text{cross}}$ , the cross-price elasticity of commodity B across changing cigarette prices. In both of the above equations, slopes greater than 0.2 indicate that a commodity served as a substitute, slopes less than -0.2 indicate that a commodity served as a complement, and slopes in between -0.2 and 0.2 indicate that a consumption of a commodity was independent of manipulation of cigarette prices, based on conventions

obtained from Bickel (1995). Since logarithmic functions cannot be computed for values of 0, 0.3 was added to individual purchases consistent with previous research (e.g., DeGrandpe et al., 1993, Petry, 2001a,b). These elasticities computed using the formulas above, separated by gender, are reported in Table 2 in Appendix A. Elasticities for individual men and women can be seen in Tables 3 and 4, respectively, in Appendix A.

For women in this study, chewing gum served as a substitute reinforcer for cigarettes. Consumption of all other alternative commodities was independent of changes in cigarette price.

Gender differences in gum consumption between males and females were analyzed using a mixed-design ANOVA, with cigarette cost as the within-subjects factor, and gender as the between-subjects factor. The interaction between cost and gender was significant [ $F(3, 23) = 6.78, p = .02$ ]. Simple effects analysis revealed that women's consumption of chewing gum differed significantly across cigarette costs while men's chewing gum consumption did not [ $F(3, 69) = 6.48, p = .001$ ;  $F(3, 69) = .34, p = .796$ ], respectively. A visual representation of this interaction can be seen in Figure 1 in Appendix B.

### *Study 2*

The mean FTND score for participants in Study 2 was 3.0, indicating low nicotine dependence. FTND scores for individual participants can be seen in Table 5 in Appendix A. Reliability of choices between the two Hypothetical Purchasing Tasks within a single experimental session was evaluated by computing point-biserial correlations between consumption of the same commodity at the two trials at each of the four cigarette price

levels. Reliabilities at the follicular phase ranged from .16 to .97, with gum showing the least reliability across cigarette price levels. The reliabilities for consumption at the follicular phase can be seen in Table 6 in Appendix A. Reliabilities at the luteal phase ranged from .13 to 1.0, with gum again showing the least reliability. These reliabilities for the luteal phase can be seen in Table 7 in Appendix A.

Own-price and cross-price elasticities were computed using the same formulas presented earlier. They were computed separately for the follicular and luteal phase. Elasticities can be seen in Table 8 in Appendix A. Elasticities and Fagerstrom scores for individual participants in this sample can be seen in Table 9 in Appendix A.

During the follicular and luteal phases, cigarette purchases showed elasticities of -.89 and -.92, respectively. Using conventions developed by Bickel et al. (1995), these slopes were greater than  $-1$ , indicating that the decreases in cigarette purchases were less than the increases in prices, thus demand for cigarettes was inelastic.

During the follicular phase, snack purchases did not differ significantly across price levels, indicating that snack consumption was independent of cigarette prices. Meals appeared to be a complement commodity, leisure was independent, and gum was a substitute for smoking.

During the luteal phase, snack and leisure purchases were independent of cigarette prices, similar to the follicular phase. However, meal purchases and gum purchases were also independent of cigarette prices at the luteal time point. Figures 2, 3, and 4 in Appendix B illustrate changes in consumption across price levels during both time points.

Changes in consumption of gum and cigarettes between the follicular and luteal phase were analyzed by repeated measures t-tests, two-tailed. An alpha of 0.1 was chosen

a priori. This decision was made because the size of a menstrual phase effect, if one exists, was expected to be small. In addition, since null results were expected, it was decided that a less conservative alpha would be more appropriate. Consumption of cigarettes did not differ significantly across menstrual phase [ $t(8) = .52, p = .61$ ]. The effect size was small ( $d = .14$ ), and the 90% confidence interval ranged from  $-.114$  to  $.149$ . There was also no significant change in consumption of chewing gum across menstrual phase, although this statistic approached significance [ $t(8) = 1.205, p = .26$ ]. The effect size for chewing gum was estimated to be medium ( $d = .51$ ), and the 90% confidence interval ranged from  $-.314$  to  $.935$ .

## Discussion

The present study assessed smoking behavior through the use of a hypothetical paradigm. Participants were presented with a hypothetical situation in which they would be required to spend 12 hours in the research lab and have to pay for all food and activities. The cost of cigarettes was manipulated across trials. According to a behavioral economics framework, smoking behavior should decrease as cost of cigarettes increases. In addition, if a commodity serves as a substitute reinforcer for cigarettes, consumption of that commodity should increase as the cost of smoking increases (DeGrandpre et al., 1992).

Data from a previous study (Jennings, 2003) completed in this laboratory used this hypothetical paradigm to examine whether chewing gum could serve as a substitute reinforcer for smoking. Jennings found that people use chewing gum as a substitute for smoking, while snacking, meals and leisure activities are not effective as substitute

reinforcers for smoking. As part of the current study, the data from Jennings' 2003 study were reanalyzed to determine whether men and women differed in their use of chewing gum in the hypothetical paradigm.

The results of this reanalysis indicated that gender differences do exist in the behavioral economics of cigarette smoking in this hypothetical paradigm. Men and women both decreased their consumption of cigarettes as cost of cigarettes increased. However, consumption of chewing gum differed across gender. Specifically, women's consumption of chewing gum increased as the cost of cigarettes increased. This suggests that women may use chewing gum as a substitute reinforcer for smoking. In contrast, men's consumption of chewing gum did not differ significantly across costs of cigarettes, suggesting that men do not find chewing gum useful as a substitute reinforcer for smoking cigarettes.

The menstrual phase of the women in Jennings' (2003) study was not known and so it is unclear whether or not the gender differences observed in this sample were affected by the menstrual phase of these participants. Some previous research has found differences in smoking behavior or in reported craving and withdrawal across the menstrual phase (Allen et al., 2000; DeBon, Klesges & Klesges, 1995; Steinberg & Cherek, 1989). However, other researchers have reported that differences do not exist across the menstrual cycle (Allen, Hatsukami & Christianson, 1995; Pomerleau et al., 1994). Since the effects of menstrual cycle on smoking behavior and attempts at abstaining from smoking are unclear in the current literature, the possibility that participants' responding to the hypothetical paradigm could have been affected by menstrual phase seemed an important one to consider.

In order to answer questions about the effects of menstrual phase on women's reported behavior in the hypothetical paradigm, a small sample of women was asked to complete the hypothetical paradigm at two different points in their menstrual phase. Specifically, participants were asked to complete the hypothetical task during their follicular phase, approximately 11-16 days following the beginning of a menstrual period, and the late luteal phase, the week before a period is scheduled to begin. These times were chosen because previous research in which differences were found across the menstrual cycle used the same time points (Allen et al., 2000; Craig, Parrott & Coomber, 1992; Perkins et al., 2000; Pomerleau et al., 1992).

The results from this second sample of women supported the conclusions of Jennings' (2003) study. Chewing gum demonstrated elasticity curves consistent with it serving as a substitute reinforcer for cigarette use. Meals, snacks and leisure activities did not serve as substitutes for smoking in this study.

The results from this second sample did not lead to convincing conclusions about the role of menstrual phase. No significant differences were found in consumption of cigarettes or chewing gum across menstrual phase. However, the test for the effect of menstrual phase on consumption of chewing gum approached significance. It is possible that significant differences would be found in a larger sample.

In addition, the hypothetical paradigm used may not be powerful enough to detect real differences in behavior across menstrual phase. It should be noted that all of the participants were asked whether or not they felt their current menstrual phase affected their responding to the task. All participants reported that they did not feel menstrual

phase affected their responding, and further reported that they had not even thought of menstrual phase while completing the task.

The results of reanalysis of Jennings' (2003) data suggest that chewing gum served as a substitute reinforcer for cigarettes for women but not for men in the hypothetical purchasing task. Other available alternatives, including meals, snacks, and leisure activities, did not serve as substitute reinforcers for cigarettes for men or women. The current study supported the use of chewing gum in women as a substitute reinforcer for cigarettes. It remains unclear whether menstrual phase may explain the gender difference found in Jennings' data.

The difference between genders in the use of chewing gum as a substitute reinforcer for smoking supports previous research suggesting that behavioral or sensory cues may be a more important aspect of smoking for women than for men (Perkins, 1994, 2001; Parrott & Craig, 1995). Chewing gum may serve as a substitute for some women due to similarities between it and smoking, such as movement of the lips and mouth, which has been suggested as one of several sensory aspects of cigarette smoking that women respond to (e.g. Eissenberg et al., 1999, Gritz et al., 1996). It is possible that men do not find chewing gum to be an adequate substitute for smoking due to its lack of a pharmacological component. This would support previous research suggesting that men respond more to the pharmacological aspects, namely nicotine, of cigarette smoking more than to sensory or behavioral aspects (Perkins, 1996, 1999).

Taken as a whole, the present study supports the idea that men and women differ in their response to nicotine. Specifically, the data suggest that women may find substitutes such as chewing gum, which have sensory and behavioral components such as

taste and movement of mouth and lips, to be effective substitutes for cigarettes, while men may not respond as well to substitutes that lack a pharmacological component. Eating meals and snacks also result in taste sensations and oral movement. In addition, eating may have more 'hand-to mouth activity' than chewing gum. 'Hand-to-mouth activity' has been suggested to be an important behavioral aspect of smoking (Parrott & Craig, 1995). This makes it difficult to determine why chewing gum served as a substitute reinforcer for cigarettes while snacks and meals did not. Nonetheless, this is consistent with research by Perking (2001), in which eating pizza had no effect on ratings of satisfaction with nicotine intake, and other studies which have found that chewing gum may reduce reported withdrawal symptoms (Cohen et al., 1997, 1999; Britt et al., 1999; Parrott & Craig, 1995).

The present study has several limitations that may have made it more difficult to determine the effect of menstrual phase on consumption of cigarettes and chewing gum. The relatively small sample size, and possible influence of outliers in the data may have obscured an effect, if it exists. In addition, the methods used were unable to determine whether changing costs of cigarettes may have had a different effect on food intake without the presence of gum. This may be an important concern given women's reports of increased hunger and weight gain during cessation attempts (Perkins et al., 1987; Gritz et al., 1996).

Information on the possibility of chewing gum as a useful aid in cessation attempts may be helpful for smokers who are attempting to quit. In addition, the gender differences found in the current study may be relevant in developing cessation plans that will work for individual smokers. However, future research should be aimed at



elucidating the effects of menstrual phase on smoking, withdrawal, and possibly use of substitute reinforcers during quit attempts. In addition, it would be helpful to know why chewing gum appears to be a substitute reinforcer for female smokers while food is not. This is especially true given the lack of clarity on how chewing gum may substitute for sensory or behavioral aspects of smoking, and previous research on the role of eating during cessation attempts.

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## APPENDICES

APPENDIX A - TABLES

Table 1

*Fagerström Test for Nicotine Dependence Scores for Participants in Study 1 Separated by Gender*

---

<u>Men</u>	<u>Women</u>
0	3
0	2
5	5
2	6
5	4
2	5
7	5
4	6
5	4
6	2
6	6
5	6
3	

---

Table 2

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

*Purchased in Study 1*

---

<u>Gender</u>	<u>Own-Price</u>	<u>Cross-Price</u>			
	Cigarettes	Snacks	Meals	Leisure	Gum
Men	-.22	-.01	-.06	.04	.04
Women	-.17	-.10	-.004	-.04	1.09

---

Table 3

*Own-Price and Cross Price Elasticities for Purchases Made by Individual Male*

*Participants in Study 1*

---

<u>Own-Price</u>	<u>Cross-Price</u>			
Cigarettes	Snacks	Meals	Leisure	Gum
-0.18	.03	.00	.34	-.32
-.34	-.10	.00	-.03	.00
-.03	.10	.00	.00	.00
-.28	-.27	-.06	.05	.00
-.33	-.17	-.09	.01	-.17
-.08	.00	.01	-.11	.00
-.05	.14	-.26	-.13	.00
-.15	.00	.00	-.33	.84
-.36	-.08	-.04	-.07	.00
-.32	-.14	.00	-.09	.00
-.12	.21	-.13	-.09	.00
-.27	.12	-.19	-.05	.00
-.30	.05	-.05	.00	.20

---

Table 4

*Own-Price and Cross Price Elasticities for Purchases Made by Individual Female  
Participants in Study 1*

---

<u>Own-Price</u>	<u>Cross-Price</u>			
Cigarettes	Snacks	Meals	Leisure	Gum
-.02	.03	-.08	.02	.00
-.22	-.30	-.09	.01	2.93
-.09	.01	-.01	.01	-.42
-.04	-.94	.30	-.04	.00
-.14	-.07	-.05	-.02	.00
-.37	.15	.00	-.07	2.31
-.11	-.15	-.01	-.08	.00
-.11	.00	.02	-.07	.00
-.22	-.14	.00	-.03	2.83
-.34	-.12	.00	-.03	2.07
-.13	-.18	.00	-.16	3.15
-.29	.23	-.13	-.07	.21

---

Table 5

*Fagerström Test for Nicotine Dependence Scores for Participants in Study 2*

---

Participant	Fagerstrom <u>Score</u>
1	4
2	0
3	4
4*	3
5	1
6	6
7	5
8	2
9	3
10	2

---

*\* Participant removed from analyses reported in Results section*

Table 6

*Correlation of Each Trial for Each Commodity at the Four Different Levels of Cost for Cigarettes During Follicular Phase*

---

Cost Level	Commodity				
	Cigarettes	Snacks	Meals	Leisure	Gum
.10	.97	.59	.93	.83	.16
.20	.96	.30	.88	.77	.19
.50	.47	.31	.87	.70	.53
1.00	.68	.46	.75	.80	.70

---



Table 7

*Correlation of Each Trial for Each Commodity at the Four Different Levels of Cost for Cigarettes During Luteal Phase*

---

Cost Level	Commodity				
	Cigarettes	Snacks	Meals	Leisure	Gum
.10	.98	.80	.94	.88	1.0
.20	.93	.52	1.0	1.0	.13
.50	.93	.60	.83	.68	.23
1.00	.94	.70	.98	.80	.71

---

Table 8

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

*Purchased at Follicular and Luteal Phase*

---

<u>Phase</u>	<u>Own-Price</u>	<u>Cross-Price</u>			
	Cigarettes	Snacks	Meals	Leisure	Gum
Follicular	-.89	.04	-.31	-.17	.39
Luteal	-.92	-.01	-.16	-.26	.23

---

Table 9

*Own-Price and Cross Price Elasticities for Purchases Made by Individual Participants in Study 2*

---

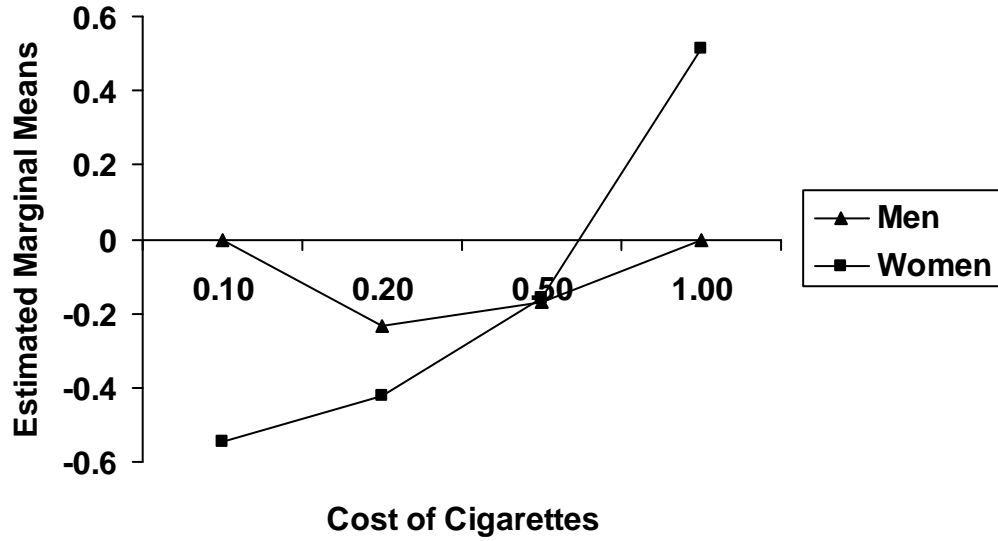
<u>No.</u>	<u>Phase</u>	<u>Own-Price</u>					<u>Cross-Price</u>				
		Cigarettes	Snacks	Meals	Leisure	Gum	Cigarettes	Snacks	Meals	Leisure	Gum
1	Follicular	-.87	-.18	.30	-.90	.76					
	Luteal	-.89	-.76	.00	.76	.00					
2	Follicular	-.98	-.15	-.92	-.93	.90					
	Luteal	-.94	.73	.30	-.92	.07					
3	Follicular	-.84	.93	.00	.00	.95					
	Luteal	-.98	.58	.00	-.92	.95					
4*	Follicular	-.94	.04	-.30	.30	.89					
	Luteal	-.90	.53	-.76	.76	-.78					
5	Follicular	-.95	-.94	.00	.00	.00					
	Luteal	-.98	-.84	.00	.00	.00					
6	Follicular	-.97	.14	-.70	.76	.30					
	Luteal	-.86	.30	-.76	.00	.00					

7	Follicular	-.79	-.35	-.47	.30	.59
	Luteal	-.96	-.02	-.25	.00	.75
8	Follicular	-.99	.88	-.81	-.76	.00
	Luteal	-.92	-.37	.13	-.95	.30
9	Follicular	-.75	.00	.71	.00	.00
	Luteal	-.98	.00	.00	.00	.00
10	Follicular	-.93	.00	-.87	.00	.00
	Luteal	-.76	.30	-.31	-.30	.00

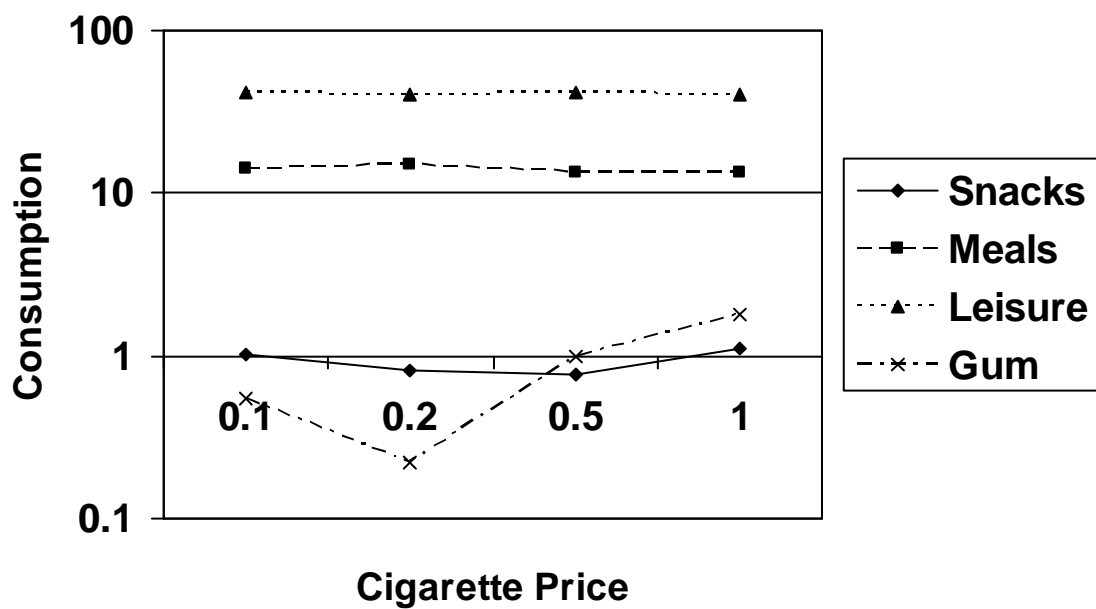
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*\* Participant removed from analyses reported in Results section*

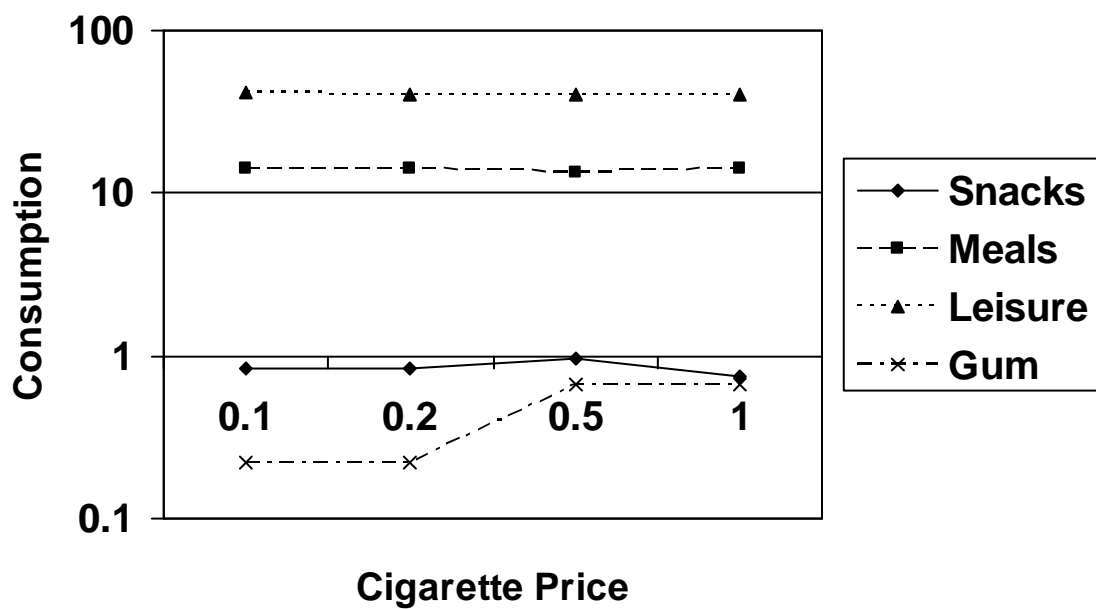
APPENDIX B - FIGURES



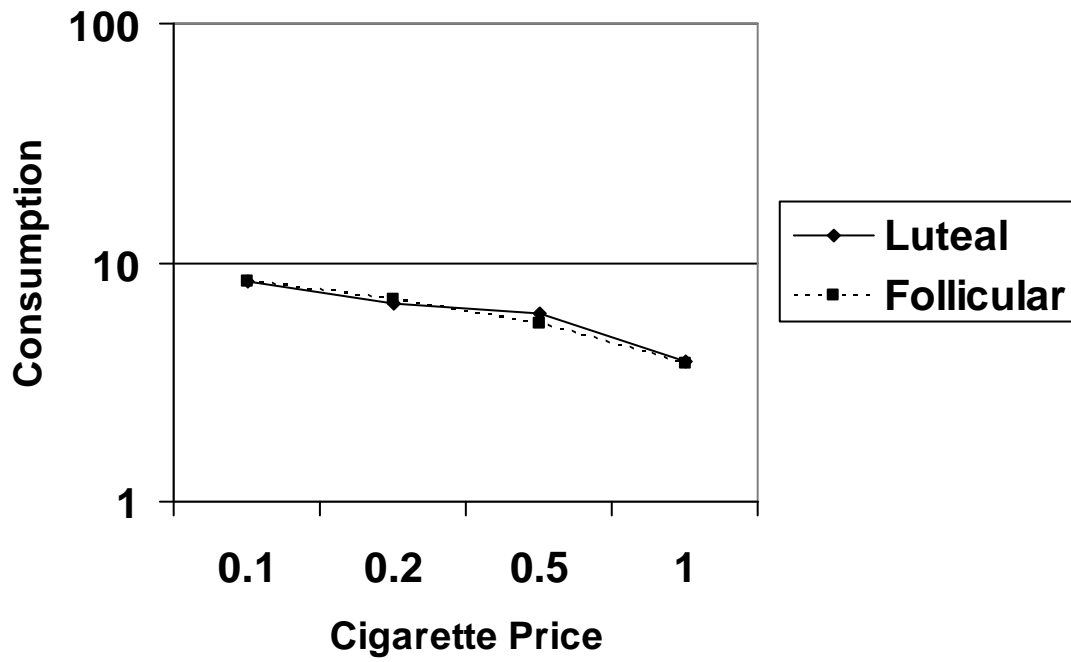
*Figure 1.* Gender by cost interaction. The estimated marginal means of the logarithmic functions of consumption of chewing gum have been plotted against the four cost levels of cigarettes. Women's consumption of chewing gum varied significantly across costs of cigarettes while men's did not.



*Figure 2.* Mean consumption of alternative commodities at varying cigarette prices during the follicular menstrual phase. Consumption has been plotted on a logarithmic scale.



*Figure 3.* Mean consumption of alternative commodities at varying cigarette prices during the luteal menstrual phase. Consumption has been plotted on a logarithmic scale.



*Figure 4.* Mean consumption of cigarettes at varying cigarette prices during the luteal and follicular menstrual phases. Data are plotted on a logarithmic scale.



## APPENDIX C - QUESTIONNAIRES AND FORMS

### Research Questionnaire

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

Name: \_\_\_\_\_ Age: \_\_\_\_\_ Sex M F email  
address: \_\_\_\_\_

Phone: ( ) \_\_\_\_\_ Best Time to  
Call: \_\_\_\_\_ Instructor: \_\_\_\_\_ Sec# \_\_\_\_\_

1. Do you have any medical conditions (e.g. heart problems)? If yes, please specify:  
\_\_\_\_\_
2. Do you currently use tobacco products? Y / N If yes, circle one of the following  
Cigarettes      Smokeless Tobacco      Both      Other: \_\_\_\_\_
3. Do you drink alcohol? Y / N If no skip Questions 4-6
4. On an average week, how many drinks (12 oz. Beer, 10 oz. Wine Cooler, or standard mixed drink) do you consume?  
\_\_\_\_\_
5. In the last six months, have you had more than 4 drinks in a single episode? Y / N
6. If yes to #5, how many drinks did you have on your heaviest episode in the last 6 months? \_\_\_\_\_

**IF YOU DO NOT USE TOBACCO, YOU DO NOT NEED TO COMPLETE THE REST OF THE FORM**

7. On average, how many cigarettes do you smoke daily? \_\_\_\_\_
8. Approximately, how many times a day do you use smokeless tobacco? \_\_\_\_\_
9. How long have you smoked or used smokeless tobacco? Smoke \_\_\_\_\_ mos./yrs.      Smokeless tobacco  
\_\_\_\_\_ mos./yrs.
10. Have you ever tried to quit? (Circle one) Smoking: Yes No      Smokeless: Yes No      Both: Yes No
11. If YES for #10, when was the last time your tried to quit? \_\_\_\_\_ (mo/yr)
12. Have you ever substituted one form of tobacco use for another? Y / N
13. Are you currently trying to quit smoking/ using smokeless tobacco or cut down?  
Smoking: Y / N      Smokeless: Y / N      Both: Y / N

## Script

Complete consent form and administer the Fagerstrom orally.

Explain the protocol:

*We are going to pretend that you have been asked to stay alone in this room for 12 hours, from 7 am until 7 pm. At the beginning of the day, you will receive \$60. You will have to pay for everything you do for the 12 hours you are here, and you can't take any extra money with you at the end of the day. If you fall asleep, someone will wake you up.*

Lay the first menu on the table. Continue the explanation:

*Here are the things that are available to you throughout the day. Meals are served at 8:00, noon, and 5:00. These are the only times meals are available. You may purchase a whole meal at this price (point at price) or choose a la carte items for the listed prices. The items in the bottom right corner are available throughout the day for the listed prices. Today, cigarettes are \$.10 each. You arrive this morning at 7:00 am. You have just woken up, and have not smoked a cigarette yet.*

Count out 1 \$20 bill, 2 \$10 bills, 5 \$5 bills, 4 \$1 bills, 3 quarters, 2 dimes, and 1 nickel. Hand play money to the participant:

*Here is your \$60 for today. Its 7:00 am, and breakfast will be served in one hour. What would you like to do until 8:00?*

Write the participant's purchases on the record sheet. Take the money she owes for the purchases and give her change, if needed. Record the amount spent on each choice in the columns on the right of the record sheet. Record the total spent in the upper half of the 'total' column. Record the amount of money the participant has left in the bottom half. Continue with the trial:

*Now it is 8:00. So far you have \_\_\_\_\_. You have \_\_\_\_\_ dollars remaining. Breakfast is available for \$4.00. What would you like to do from 8:00 until 9:00?*

Continue with the protocol in the same way. Try to summarize what the participant has done for the day every two hours. Be sure to include the number of cigarettes smoked so far.

At the end of the trial, staple the record sheet on top of the menu. Prepare to begin a new trial:

*This is another day, and you are back in this room at 7:00 am. Breakfast will be*

*served in one hour. What would you like to do until 8:00?*

Complete each trial the same as the practice trial.

When all of the trials have been completed, administer the menstrual phase questionnaire orally. Thank the participant, and remind her when her next appointment will be if this is her first time.

## Fagerström Test for Nicotine Dependence

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

<p style="text-align: center;"><b>Breakfast Menu - \$4.00</b> (Circle only one item from each category)</p> <p style="text-align: center;"><i>Free ice water available upon request</i></p> <p><b>1. Drinks (\$.50)</b> Coffee Hot Tea Milk Hot Chocolate</p> <p><b>2. Juice (\$.50)</b> Orange Apple Cranberry Grape Tomato Grapefruit</p> <p><b>3. Entrée: (\$2.50)</b> Continental Breakfast (assorted pastries) Bagel and Cream Cheese English Muffin and Jam Cold Cereal Instant Hot Cereal</p> <p><b>4. Dessert (\$.50)</b> Hostess Cakes Fruit (Apple, Orange, or Banana)</p>	<p style="text-align: center;"><b>Lunch Menu - \$6.00</b> (Circle only one item from each category)</p> <p style="text-align: center;"><i>Free ice water available upon request</i></p> <p><b>1. Drinks (\$.50)</b> Coke Dr. Pepper Iced Tea Sprite Lemonade</p> <p><b>2. Entrée: (\$5.00)</b> Beef, Chicken, or Vegetable Rice Bowl Tombstone Pizza (Pepperoni or Cheese) Assorted Hot Pockets Assorted Lunchables</p> <p><b>4. Dessert (\$.50)</b> Fruit (Apple, Orange, or Banana) Yogurt (Assorted Flavors) Cookies</p>												
<p style="text-align: center;"><b>Dinner Menu - \$8.00</b> (Circle only one item from each category)</p> <p style="text-align: center;"><i>Free ice water available upon request</i></p> <p><b>1. Drinks (\$.50)</b> Coke Dr. Pepper Iced Tea Sprite Lemonade</p> <p><b>2. Entrée: (\$7.00)</b> Healthy Choice Stuffed Pasta Shells Healthy Choice Chicken Terikayi Healthy Choice Turkey Gravy and Vegetables Stouffers Meatloaf Stouffers Veal Ptarmigan Stouffers Port and Roasted Potatoes Tombstone Pizza (Pepperoni or Cheese)</p> <p><b>4. Dessert (\$.50)</b> Ice Cream Sandwich/Bar Sara Lee Brownie Bites Cookies</p>	<p style="text-align: center;"><b>Snacks Available</b></p> <table style="width: 100%; border: none;"> <tbody> <tr> <td><b>1. Drinks</b></td> <td style="text-align: right;"><b>\$.50 per can</b></td> </tr> <tr> <td><b>2. Chewing gum</b></td> <td style="text-align: right;"><b>\$.05 per piece</b></td> </tr> <tr> <td><b>3. Snack Sized Candy Bars</b></td> <td style="text-align: right;"><b>\$.25 each</b></td> </tr> <tr> <td><b>4. Chips</b></td> <td style="text-align: right;"><b>\$.50 per bag</b></td> </tr> <tr> <td><b>5. Jello Pudding Cups</b></td> <td style="text-align: right;"><b>\$.50 per cup</b></td> </tr> <tr> <td><b>6. Del Monte Fruit Cups</b></td> <td style="text-align: right;"><b>\$.50 per cup</b></td> </tr> </tbody> </table> <p style="text-align: center;"><b>Entertainment and Leisure Activities</b> ((\$5.00 per hour))</p> <p><b>1. Movie Viewing</b> <b>2. Listening to CD's or the Radio</b> <b>3. Playing Computer Games</b> <b>4. Use of the Internet</b> <b>5. Leisure Reading</b> <b>6. Exercise</b></p> <p style="text-align: center;"><b>Cigarettes</b></p> <p style="text-align: center;"><b>\$.10 each (\$2.00 per pack)</b></p>	<b>1. Drinks</b>	<b>\$.50 per can</b>	<b>2. Chewing gum</b>	<b>\$.05 per piece</b>	<b>3. Snack Sized Candy Bars</b>	<b>\$.25 each</b>	<b>4. Chips</b>	<b>\$.50 per bag</b>	<b>5. Jello Pudding Cups</b>	<b>\$.50 per cup</b>	<b>6. Del Monte Fruit Cups</b>	<b>\$.50 per cup</b>
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<b>4. Chips</b>	<b>\$.50 per bag</b>												
<b>5. Jello Pudding Cups</b>	<b>\$.50 per cup</b>												
<b>6. Del Monte Fruit Cups</b>	<b>\$.50 per cup</b>												

<p style="text-align: center;"><b>Breakfast Menu - \$4.00</b> (Circle only one item from each category)</p> <p style="text-align: center;"><i>Free ice water available upon request</i></p> <p><b>1. Drinks (\$.50)</b> Coffee Hot Tea Milk Hot Chocolate</p> <p><b>2. Juice (\$.50)</b> Orange Apple Cranberry Grape Tomato Grapefruit</p> <p><b>3. Entrée: (\$2.50)</b> Continental Breakfast (assorted pastries) Bagel and Cream Cheese English Muffin and Jam Cold Cereal Instant Hot Cereal</p> <p><b>4. Dessert (\$.50)</b> Hostess Cakes Fruit (Apple, Orange, or Banana)</p>	<p style="text-align: center;"><b>Lunch Menu - \$6.00</b> (Circle only one item from each category)</p> <p style="text-align: center;"><i>Free ice water available upon request</i></p> <p><b>1. Drinks (\$.50)</b> Coke Dr. Pepper Iced Tea Sprite Lemonade</p> <p><b>2. Entrée: (\$5.00)</b> Beef, Chicken, or Vegetable Rice Bowl Tombstone Pizza (Pepperoni or Cheese) Assorted Hot Pockets Assorted Lunchables</p> <p><b>4. Dessert (\$.50)</b> Fruit (Apple, Orange, or Banana) Yogurt (Assorted Flavors) Cookies</p>
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<p style="text-align: center;"><b>Breakfast Menu - \$4.00</b> (Circle only one item from each category)</p> <p style="text-align: center;"><i>Free ice water available upon request</i></p> <p><b>1. Drinks (\$.50)</b> Coffee Hot Tea Milk Hot Chocolate</p> <p><b>2. Juice (\$.50)</b> Orange Apple Cranberry Grape Tomato Grapefruit</p> <p><b>3. Entrée: (\$2.50)</b> Continental Breakfast (assorted pastries) Bagel and Cream Cheese English Muffin and Jam Cold Cereal Instant Hot Cereal</p> <p><b>4. Dessert (\$.50)</b> Hostess Cakes Fruit (Apple, Orange, or Banana)</p>	<p style="text-align: center;"><b>Lunch Menu - \$6.00</b> (Circle only one item from each category)</p> <p style="text-align: center;"><i>Free ice water available upon request</i></p> <p><b>1. Drinks (\$.50)</b> Coke Dr. Pepper Iced Tea Sprite Lemonade</p> <p><b>2. Entrée: (\$5.00)</b> Beef, Chicken, or Vegetable Rice Bowl Tombstone Pizza (Pepperoni or Cheese) Assorted Hot Pockets Assorted Lunchables</p> <p><b>4. Dessert (\$.50)</b> Fruit (Apple, Orange, or Banana) Yogurt (Assorted Flavors) Cookies</p>												
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### Menstrual Phase Questionnaire

- 1) Do you use oral contraceptives or hormone treatments?      Yes    No
- 2) Are you nursing or pregnant?      Yes    No
- 3) Is your menstrual cycle regular?      Yes    No
- 4) What was the first day of your last menstrual period?      Date \_\_\_\_\_
- 5) Do you believe that your current menstrual phase influenced  
your responding to the task you just completed?      Yes    No
- 6) Please explain why or why not

Oklahoma State University  
Institutional Review Board

Protocol Expires: 12/10/2004

Date: Thursday, December 11, 2003

IRB Application No: AS0435

Proposal Title: Effect of Gender on the Behavioral Economics of Cigarette Smoking

Principal  
Investigator(s):

Frank L. Collins, Jr.  
215 N Murray  
Stillwater, OK 74078

Kimberly Haala ✓  
215 North Murray  
Stillwater, OK 74078

Reviewed and  
Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved

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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 me in 415 Whitehurst (phone: 405-744-5700, colson@okstate.edu).

Sincerely,



Carol Olson, Chair  
Institutional Review Board

VITA

Kimberly Haala

Candidate for the Degree of

Master of Science

Thesis: THE EFFECT OF GENDER ON THE BEHAVIORAL ECONOMICS OF  
CIGARETTE SMOKING

Major Field: Psychology

Personal Data: Born in Mankato, Minnesota October 7, 1979

Education: Received Bachelor of Science degree in Psychology from Minnesota State University, Mankato in December, 2000. Completed the requirements for the Master of Science degree with a major in Psychology at Oklahoma State University in May, 2005.

Experience: Employed at the Harry Meyering Center in Mankato, Minnesota from 2000-2001. Employed by Oklahoma State University as a graduate assistant from August 2001 to present.

Professional Memberships: American Psychological Association student affiliate, Society for Research on Nicotine and Tobacco