

Chewing Gum and Reductions in Self-Reported Nicotine Withdrawal:  
Is it the flavor, chewing or both?

by

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## ABSTRACT

Cigarette smoking continues to be a major public health issue. While over 45 million adults in the U.S. report cigarette use, it is estimated that 70% of these individuals are interested in quitting. Indeed, many smokers try to quit each year (e.g., 42.5% report quitting for at least one day in the past year), however, only 4.7% were able to quit for 3 months or longer. One reason that smoking cessation is difficult is the withdrawal syndrome experienced. Behavioral economics provides researchers a theoretical framework to better understand how alternative reinforcers available in the environment may aid in cessation interventions by helping with the severity of nicotine withdrawal. One such alternative studied by Cohen, Britt and colleagues is confectionary chewing gum. Specifically, chewing gum has demonstrated the ability to lessen self-reported withdrawal symptoms during short-term abstinence. A question remaining in this line of research, however, is the determination of the active property of chewing gum that aids in the observed reductions. The purpose of the present study was to better understand how chewing gum affects the experience of nicotine withdrawal by teasing apart the actions of chewing, flavor, and the combination of the two. Gender differences across these properties were also examined. Results revealed the importance of the combination of both flavor and chewing over chewing on its own. Female participants consistently experienced more withdrawal than males. Clinical and research implications of these findings are discussed.

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## CHAPTER I

### INTRODUCTION

Cigarette smoking continues to be a major public health issue. The Substance Abuse and Mental Health Services Administration (SAMHSA) estimates that in 2004, 59.9 million individuals in the U.S. (24.9 % of the population) reported being current cigarette smokers (SAMHSA, 2005). This choice will result in the death or disability of approximately half of these individuals (Centers for Disease Control [CDC], 2006). As such, tobacco use continues to be the foremost preventable cause of death in the United States, claiming the lives of approximately 440,000 individuals each year (CDC, 2006). The CDC estimates that over the past four decades smoking has contributed to 12 million deaths including 4.1 million from cancer, 5.5 million from cardiovascular diseases, 2.1 million from respiratory diseases, and 94,000 infant deaths related to smoking during pregnancy (CDC, 2006). Cigarette smoking also contributes to a variety of other illnesses including, coronary heart disease, lung cancer, and peptic ulcer disease (Rose, 1996). While other types of tobacco products are also known to contribute to health problems, smoking cigarettes continues to be the most popular, most addictive, and most deadly form of tobacco use (Kozlowski, Henningfield, & Brigham, 2001).

By definition of nicotine dependence as defined by the American Psychological Association (APA), dependent smokers continue to use the substance despite the well-documented health risks associated with continuing this behavior (APA, 2000). In fact, it is estimated that 70% of all adult smokers in the United States are interested in quitting completely (CDC, 2005). Achieving this goal, however, is quite difficult and may be compounded by the age of the individual attempting to quit (SAMHSA, 2002). Among

U.S. tobacco users, college-aged adults (18 to 25 years) have been the most resistant to change and continue to report the highest rates (44.6%) of current tobacco use (SAMHSA, 2005). This finding demonstrates that this age group represents an important one to target if cessation rates are to continue to decline. Some issues to consider among this age group are their attitudes and beliefs about their susceptibility to the well-documented health risks and the ease of quitting. One study by Murphy-Hoefer, Alder, and Higbee (2004) found that college-aged smokers reported that they believed they would be able to stop their smoking habit at some point in the future. Additionally, there was an overall under appreciation of how they were compromising their health relative to their non-smoking peers. Participants tended to rationalize their use as falling below a threshold level of risk. These findings are not uncommon as young smokers appear to misjudge their own health status despite exhibiting respiratory problems such as wheezing, morning cough, and tightness in the chest (Prokhorov, et al., 2003). These findings highlight the fact that college-aged smokers have a sense of invulnerability to smoking and attitudes that conflict with quitting (e.g., quitting would produce minimal to no health benefit). Due to the fact that cigarette smokers in this age range appear most resistant to changing this unhealthy behavior, it may be particularly important to investigate novel treatment approaches for this age group.

One of the main reasons that smoking cessation is difficult for individuals wishing to quit is the withdrawal syndrome associated with reduced use of nicotine (al'Absi, Hatsukami, Davis, & Wittmers, 2004). Manifestations of withdrawal are mostly affective and include: irritability, depressed mood, difficulty concentrating, insomnia, anxiety, restlessness, anger, and increased appetite (APA, 2000; Seidman & Covey, 1999;

Stolerman & Jarvis, 1995; VandeCreek & Jackson, 1999). Withdrawal symptoms can begin as quickly as 6-12 hours after the last nicotine administration and last more than 4 weeks post cessation (Hughes, 1992). Complicating this picture even further is that individuals may experience different aspects of the withdrawal syndrome as being the most difficult. Since withdrawal appears to be a very individualized experience, optimally the treatment provided should also be tailored to the individual. Behavioral economic theory offers a useful framework in which to individualize available treatments.

### *Behavioral Economic Theory*

In the 1970's when the term behavioral economics was first used by Kagel and Winkler (Madden, 2000) it referred to economic research that focused on the prediction of human behavior. The authors argued that the fusion of economic principles with the procedures and methods of the analysis of behavior (e.g., schedules of reinforcement) would produce productive models of human behavior that could be used for predictive purposes. Hursh (1984) later described behavioral economic theory as a descriptive and general framework to aid in the analysis of relationships that could come about when investigating different reinforcers.

In terms of individual behavior, the theory of behavioral economics contributes methodology and techniques allowing psychologists to better analyze behavior. One economic term that has particular value in the analysis of behavior is *consumption*. Broadly applied, consumption may include a vast amount of activities (e.g., utilizing services, drinking, eating). More specifically, it can also be used as a measure of problem behaviors (e.g., drug use, overeating) and the success of treatment programs (Madden,

2000). A term very much related to the concept of consumption is *spending*. Spending can refer to an amount of money, labor, or time that an individual will give up in order to obtain a reinforcer (Madden). Analysis of an individual's spending can provide information regarding the value of a reinforcer by examining the amount of spending allocated for that reinforcer. Researchers are currently examining human behavior in terms of what is being used, the cost of consumption, and the choices made between different reinforcers available in the environment (Bickel, DeGrandpre, Higgins, Hughes, & Badger, 1995; Johnson & Bickel, 2003; Petry & Bickel, 1998; Shahan, Odum, & Bickel, 2000).

At a basic level these terms are straightforward and their application deceptively simple: an individual wants a consumer good, chooses that good over others and then spends a specific amount in order to obtain it. *Price*, therefore, is a concept that affects nearly all aspects of consumption, as well as choice, among particular goods. More specifically, when price is measured in terms of the amount of spending required in order to obtain one unit of the reinforcer (e.g., individual responses) it is referred to as the *unit price* (Bickel, DeGrandpre, & Higgins, 1993; Madden, 2000). Price in this respect is specifically, and parsimoniously, defined based on the amount of a reinforcer as well as the amount of the response requirement. Unit price can be impacted by either changing the cost of the reinforcer (response requirement) or by changing the reinforcing quality (dose) of the reinforcer (Rachlin, Green, Kagel, & Battalio, 1976; Madden, 2000; Carroll & Campbell, 2000). Unit price, therefore, is a cost-benefit ratio that can aid researchers in understanding and manipulating different costs (e.g. social, behavioral) that influence how a reinforcer is obtained. The impact of unit price is made clear when it's

manipulation creates change in the consumption of a good that was once considered essential and relatively resistant to change (e.g., cigarette smoking).

A study by Bickel, DeGrandpre, Hughes, and Higgins (1991) analyzing unit price in a sample of five community cigarette smokers found that the consumption of cigarettes decreased as unit price increased. These results illustrate the applicability and success of unit price within the study of drug use behavior. Thus, unit price is a crucial aspect of behavioral economics that allows researchers to test potential reinforcers, which may impact the elasticity of different behaviors. In addition to these factors, alternative reinforcers are typically available in the environment that may or may not be competing for an individual's resources (e.g., labor and money; Madden, 2000).

#### *The Role of Alternative Reinforcers*

Reinforcers available in the environment have differing relationships to one another and can be linked to each other in some common way (complements) or may be completely unrelated to one another (independents). A *substitute* is said to be a reinforcer that shares properties with another reinforcer (Madden, 2000) or is able to satisfy a similar need (Hursh & Bauman, 1987). That is, because the alternative reinforcer shares functional or structural properties, it can take the place of the old reinforcer. An imperfect example of this phenomenon includes the use of nicotine replacement products instead of cigarette smoking. Further, when the goal is to understand a particular behavior and the interaction of that behavior with other reinforcers, it is necessary to have them available to an individual in the same environment and study the interactions across reinforcers (Johnson & Bickel, 2003). It is only when there is an understanding of both the behavior and the interacting reinforcers that it is possible to predict and impact behavior.

Among the drugs of abuse studied under the framework of behavioral economics, cigarette smoking has been the most widely studied. Current research using behavioral economic theory in this field has led to the consideration that it may be as important to take into account the environment of change as it is to focus on terminating the drug behavior (Madden, 2000). As such, researchers have been shifting their thinking to include the consideration of variables present in the individual's environment that may be used to help improve upon current cessation interventions. In particular, it is believed that for those dependent on nicotine, substitute and complement reinforcers available in the environment can be targeted to help decrease smoking behavior.

A novel approach to the study of reinforcers is to consider the possibility of non-drug reinforcers that may have an impact on drug behavior. A study by Bickel, DeGrandpre, Higgins, Hughes, et al., (1995) demonstrated how a non-drug reinforcer, available in the environment of a cigarette smoker, could decrease the use of cigarettes. Specifically, the authors included money and recreational activities (e.g., VCR, video games, remote control car) as alternative reinforcers in the study of eight male participants. Results indicated that when an alternative reinforcer was present (either money or recreation) there was a significant drop in the consumption of cigarettes relative to when no alternatives were present. In addition, the authors concluded that the presence of the non-drug alternatives decreased drug-seeking behavior. Thus, the potential use of non-drug reinforcers in influencing drug use behavior has gained empirical support and has been theorized to impact drug use behavior on multiple levels.

There has been much discussion up to this point regarding reinforcers, but the issue of the type of reinforcement taking place has not yet been addressed. With respect

to the reinforcing properties of nicotine, there are various social and behavioral aspects to consider in addition to physiological reinforcement. As a result, when researchers consider potential substitutable alternatives for nicotine, thought about what products may be able to take the place of the interoceptive effects as well as the various social and behavioral effects must be considered. As a result, the identification of a substitute reinforcer that can adequately alleviate (or at least significantly lessen) all costs of quitting is difficult. Thus, it is important to develop a better understanding of how individual alternatives affect the behavior in order to anticipate impact on response cost.

According to behavioral economic theory, an alternative to smoking that can produce the same reinforcement should be able to compete with the original behavior. Theoretically, the more similarities that are shared between an original reinforcer and the alternative, the more likely that alternative reinforcer will be successful in replacing the old reinforcer. One cost that smokers experience when they quit smoking is a lack of oral stimulation (Perkins, Hickcox, & Grobe, 2000). Alternative oral stimuli such as cinnamon sticks and plastic straws can be considered simple distractions, however, their value as behavioral substitutes can also be explained within a behavioral economic framework. For cigarette smokers, oral stimulation has become part of the ritual of smoking and has likely become a conditioned reinforcer due to the repeated pairings with the drug effects of nicotine. Thus, the identification of an alternative that can serve to reduce the demand for oral stimulation may help smokers wishing to quit remain abstinent.

### *Chewing Gum as an Alternative*

One healthy alternative to smoking that has received perhaps the most empirical attention is the use of confectionary chewing gum. Cohen, Collins, and Britt (1997) investigated the potential benefits of chewing gum on the effects of nicotine withdrawal and craving. This study examined 20 cigarette smokers who were asked to abstain from smoking in the laboratory for approximately three hours. Half of the participants were asked to chew gum during the abstinence period, while the other half were not given access to gum. Results indicated that chewing gum reduced self-reported craving and withdrawal symptoms during abstinence. Encouraged by these findings, Cohen, Britt, Collins, Stott, and Carter (1999) expanded upon their previous work by examining the effects of chewing gum when participants were able to smoke. Similar methods were used as in the previous study except that participants in both groups (gum and no gum) were encouraged not to smoke and were rewarded for not smoking during the experimental session. Results revealed that the presence of chewing gum was related to a significant decrease in the number of cigarette puffs taken and significantly increased the length of time until the first cigarette was smoked. Chewing gum was again shown to help manage nicotine withdrawal symptoms when compared to a control condition in a research study using a within subjects design (Britt, Cohen, Collins, & Cohen, 2001). Together, these studies suggest that chewing gum may be useful in helping smokers who wish to quit.

### *The Impact of Flavor*

Chewing gum, therefore, appears to help with the symptoms of nicotine withdrawal, but to date it is unclear what aspect of chewing gum may be most helpful to

smokers. In order to better understand why chewing gum may serve as a behavioral substitute to cigarette smoking, the present study will examine the main components thought to be reinforcing in gum chewing (i.e., flavor and chewing). Prior research has examined the individual impact of chewing and flavor although they have not been investigated together within a population of smokers. Some studies examining the impact of flavor have used brain activity and imagery. Specifically, Yagyu et al. (1997) compared blood flow to different areas of the brain when participants were given flavored gum and hard candy. Based on results from this study, it was concluded that there was no distinct difference in brain response in the gum or candy conditions. It was also noted that smell and taste properties appear to influence the brain more than chewing. Based on these findings it was concluded that chewing, in and of itself, was less important than the taste and olfactory properties of chewing gum.

Flavor, especially sweet flavor, has been associated with abstinence from smoking as well as craving for nicotine. Specifically, Perkins, Epstein, Sexton, and Pastor (1990), examined female smokers who were asked to abstain from smoking for one week. During this week it was observed that participants increased their consumption of sweets. When participants resumed their smoking the following week, the consumption of sweets decreased. The authors concluded that eating sweets during the period of abstinence might have served as a substitute for smoking. Another study, examining brief cessation in both males and females, demonstrated that simply providing sugar (dextrose) tablets was enough to cause a reduction in subjective craving ratings compared to placebo (West, Hajek, & Burrows, 1990). This study provides further evidence supporting the notion that sweet flavoring may be a useful temporary substitute for smoking. Consistent with

findings from the above two studies, some researchers are of the opinion that the flavor of a substitute may, on its own, provide craving reduction (Levin, Behm, & Rose, 1990).

### *The Impact of Chewing*

Another aspect of chewing gum that may be relevant to smokers wishing to quit is the act of chewing. One of the primary reasons reported by smokers for the continuation of this unhealthy behavior is that it relieves stress (Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996). Chewing has long been shown to provide several benefits such as relief from tension, boredom, loneliness, and even be an outlet for anger (Hendrickson, 1976). Further, in terms of the subjective experience of relaxation, chewing gum has been investigated for its calming effect. Specifically, Hollingworth (1939) conducted an investigation in which individuals were followed at work under three different conditions: chewing flavored gum, having a flavored wafer dissolve in their mouth, or having nothing present in their mouth. At various periods during their workday, participants rated their subjective experience of strain or relaxation. Results indicated that workers reported feeling more relaxed when chewing gum compared to either of the other two conditions. Therefore, it appears that chewing flavored products has an impact on the subjective experience of relaxation. In a follow-up study (Hollingworth, 1939), muscular tension was measured (at the elbow joint) utilizing the same three experimental conditions. Consistent with the prior study, results indicated that the chewing condition produced the largest decrease in tension. Hence, the act of chewing a flavored piece of gum affects not only subjective ratings of relaxation but also muscular tension.

Thus far, the two major components of chewing gum have been discussed: chewing and flavor. Both of these components have been shown, either directly or

indirectly, to target two of the primary reasons that individuals report smoking cigarettes (i.e., to help deal with cravings for nicotine and the reduction of tension/stress). The first of these components is clearly related to success in smoking cessation, however, it is important to consider the second as well. Specifically, as discussed earlier, many of the symptoms associated with nicotine withdrawal overlap with feelings of tension (e.g., anxiety, irritability, and restlessness). Thus, there is a clear rationale suggesting that the act of chewing could help individuals experiencing nicotine withdrawal by producing a more relaxed state.

### *Gender Issues*

With respect to chewing and flavor the importance of gender should also be considered. One study investigating chewing gum among children noted differences in the responses of boys and girls in terms of the act of chewing gum as well as preferred flavor (Lewkowski, et al., 2003). Specifically, this study examined the separate and joint impact that the action of chewing and sweet taste had on children's ratings of pain. Interestingly, among boys, sweet taste combined with chewing increased pain ratings whereas the opposite was observed among girls (i.e., sweet taste with chewing decreased pain ratings). Interestingly, sweet taste on its own (e.g., without chewing behavior) increased pain ratings among girls. Taking these gender differences into account, it is feasible that there may be gender differences observed among individuals who smoke cigarettes with regard to their experience of relaxation/tension and craving. Hence a controlled investigation of the properties of chewing gum across genders may provide valuable information that could inform treatment. This is particularly important given recent findings that women have less success than their male counterparts in quitting

smoking and may be at greater risk for smoking-related illnesses (Perkins, 2001). In regards to withdrawal symptoms, men appear to smoke at higher rates compared to females (Bjornson et al., 1995) and typically experience more intense nicotine withdrawal (Pomerleau, 1996).

### *The Current Study*

The preceding literature review lends support to the notion that confectionary chewing gum may serve as a healthy alternative to cigarette smoking. Previous research clearly indicates that chewing gum can significantly lessen self-reported symptoms of nicotine withdrawal (Cohen et al., 1997; Britt et al, 2001). There is also evidence to suggest that the act of chewing (via the reduction of tension/stress) and sweet flavor (via its ability to lessen cravings for nicotine) may aid smokers wishing to quit this unhealthy habit. Further, ancillary evidence exists in support of the notion that gender differences may exist in the ability of chewing gum to exert an influence on nicotine withdrawal and craving. The purpose of this study, therefore, was to investigate which component(s) of confectionary chewing gum are responsible for the previously reported decreases in self-reported nicotine withdrawal across genders. This study utilized a within subjects design, where each participant experienced three experimental conditions in random order (e.g., flavored chewing gum, flavorless gum base, and flavor strips) as well as a no product control while being deprived from nicotine for 24 hours. The conditions were counterbalanced (using an incomplete counterbalancing technique) across participants in order to minimize order effects. Men and women were counterbalanced separately in order to ensure that both groups were equally randomized. This design allowed for an

evaluation of the properties of chewing gum (individually and in combination) that may account for the previously reported reductions in nicotine withdrawal.

*Statement of Hypotheses*

*Hypothesis 1: Reduction in Self-reported Withdrawal after 24-hour abstinence.*

After 24 hours of abstinence (Time 6), less self-reported nicotine withdrawal (i.e., total score on WSC at Time 6) would be observed among the experimental groups compared to the control group. More specifically, the flavored gum group would experience significantly less self-reported withdrawal compared to the other three groups. The gum base and flavor strip groups would experience statistically significant lower scores on self-reported withdrawal symptoms compared to the control group but would not differ significantly from each other.

*Hypothesis 2: Reduction in Self-reported Withdrawal averaged across the*

*abstinence day.* It was hypothesized that the flavored gum group would again demonstrate significantly lower self-reported withdrawal when withdrawal was defined as the average score collapsed across all time points during the abstinence period (Times 1-6). The flavored gum group would report less self-reported withdrawal compared to the other three groups. Both the gum base and flavor strip groups would show significantly lower scores in self-reported withdrawal compared to the control group.

*Hypothesis 3: Gender effects after 24-hour abstinence.* Female participants, after

24 hours of abstinence (Time 6), would report significantly lower self-reported withdrawal in the gum and gum base groups compared to the flavor and control groups due to the relaxing nature of the chewing process. Similarly, male participants would experience significantly lower self-reported withdrawal within the gum and gum base

groups compared to the flavor and control groups. Overall, males would experience significantly greater levels of withdrawal than females.

*Hypothesis 4: Gender effects after the abstinence day.* Similar gender effects would be witnessed when self-reported withdrawal scores are averaged across the abstinence day (Time 1-6). Female participants would report significantly lower self-reported withdrawal in the gum and gum base groups compared to the flavor and control groups. Male participants would also report significantly lower self-reported withdrawal within the gum and gum base groups compared to the flavor and control groups. Again there would be significant gender differences observed with female participants reporting lower self-reported withdrawal than male participants.

## CHAPTER II

### METHOD

#### *Participants*

Twenty-four college-aged participants who reported using 16 or more cigarettes per day for the past 6 months and who were at least 18 years of age were eligible to participate in the present study. Exclusionary criteria included: (1) a recent (within the past 6 months) attempt to quit or a decrease in cigarette use, (2) current dental problems and/or a history of jaw pain (including TMJ pain) that may preclude the use of chewing gum, (3) those refusing to chew gum, or (4) current use of psychoactive medication. Participants recruited through Introductory Psychology courses (N = 19) received course credit in exchange for taking part in the study.

Given the stringent exclusionary criteria and the difficult nature of the protocol (e.g., abstinent from smoking for 24 hours), undergraduate students and community members of college age meeting the criteria noted above were recruited via fliers. Participants who were recruited via fliers (N = 5) were informed that their name would be entered in a raffle for one first place prize (\$75.00) and two second place prizes (\$50.00) as compensation for participation. These five participants did not significantly differ from the 19 participants who received course credit with respect to age, smoking rate, or level of nicotine dependence (as assessed by the Fagerström Test for Nicotine Dependence). However, participants from both recruitment groups did significantly differ with regard to race and gender (see Table 2).

## *Measures*

General Habits Questionnaire (GHQ). The GHQ was designed specifically for this study in order to obtain demographic data and information regarding number of cigarettes smoked and chewing gum habits (e.g., reasons for using, time of day, amount).

### *Nicotine Measures.*

Fagerström Test for Nicotine Dependence (FTND); Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). The FTND is a 6-item self-report measure designed to assess physical dependence to nicotine. Questions focus on various aspects of individuals' smoking practices (e.g., How many cigarettes per day do you smoke?). Total scores range from 0-10, where higher scores are indicative of greater physical dependence. A five-level categorization has been developed to identify dependence levels: very low (0-2), low (3-4), medium (5), high (6-7), and very high (8-10) (Fagerström, Heatherton, & Kozlowski, 1990). The FTND has a test-retest reliability of .882 and a Cronbach's alpha of .64 among a non-clinical sample of smokers (Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994).

Withdrawal Symptom Checklist (WSC); Hughes & Hatsukami, 1986). The WSC is a 12-item self-report measure designed to assess the presence of tobacco withdrawal symptoms as well as the severity of each symptom. A 4-point Likert scale, ranging from 0 (not present) to 3 (severe) is used to assess the severity rating. The instrument has been shown to be valid and reliable.

CO Measures (Vitalograph, Lenexa, KS., USA) Carbon Monoxide (CO) measures provide a biological marker to validate smoking status as well as to corroborate self-reported smoking abstinence. According to the guidelines set forth by the Society for

Research on Nicotine and Tobacco's Subcommittee on Biochemical Verification (2002) abstinent participants must have CO levels below 10 parts per million (ppm). Due to the fact that some participants had very high levels at baseline, a second criterion for the verification of abstinence was utilized. Individuals with initial CO levels above 20 ppm were required to have a drop in CO level by at least 50%. This criterion has been used in other studies (Bickel et al., 1991; Tidey, Higgins, Bickel, & Steingard, 1999).

Participants CO level was also used to determine eligibility to complete the study.

According to the Subcommittee on Biochemical Verification the optimal cut-off CO level to distinguish a tobacco user from a nonuser is between 8-10 ppm. This study used a cut-off CO level of 10 ppm in an attempt to insure that only regular smokers completed the study.

#### *Experimental Product Measures*

Product Monitoring Form. A monitoring form was also developed specifically for this study in order to help participants accurately keep track of their use of the products, the amount of the products used, as well as the duration of use.

#### *Procedure*

*Recruitment.* Potential participants were screened via a mass survey administered to all introductory psychology students to identify individuals who reported current use of 16 or more cigarettes per day or were recruited via fliers. Identified heavy smokers from the mass survey were called and invited to participate in a study examining the use of chewing gum by cigarette smokers. Those recruited via fliers were instructed to call the laboratory for more information. Interested participants were screened over the phone to determine if they met study criteria, and if so, were scheduled for their initial visit.

Participants were asked to smoke cigarettes at their usual rate on the day of their initial baseline visit and were scheduled to attend a 30-minute baseline appointment.

*Baseline Session.* This session began with a review of the informed consent form. Participants then completed the demographic and baseline (BL) measurements (i.e., FTND, WSC, and CO). Smoking status for each participant was biochemically validated using the carbon monoxide (CO) monitor (Vitalograph, Lenexa, KS., USA) to ensure that each participant was a regular smoker. All participants were required to demonstrate a baseline CO reading greater than or equal to 10 parts per million to be considered eligible for further participation. Participants were informed that they would be asked to provide a CO measure each day that they participated in the study and it was explained that the information would be used to biologically confirm their self-reported abstinence.

Participants were then scheduled for the four experimental sessions (one each week lasting approximately 15 minutes each) in which they abstained from using any tobacco products for the previous 24 hours. Participants were scheduled on a weekly basis in order to minimize the adverse effects of long-term nicotine abstinence.

*Experimental sessions.* Participants came to the laboratory just prior to their 24-hour abstinence period in order to retrieve the appropriate product and were reminded of their abstinence from tobacco use. The specific product provided to each participant each week was randomized to control for potential order effects. During the 24-hour period the participants were instructed not to use any other type of gum, mint, or chewing candy besides the product provided for them that week. Lastly, participants were asked to refrain from consuming alcohol during each 24-hour abstinence period so as to avoid any interference with their ability to remain abstinent from smoking. For each of the four

experimental sessions, participants returned to the laboratory having abstained from cigarette smoking for 24 hours.

During each 24-hour period of abstinence, participants were asked to use their assigned product at six specific times during the day (i.e., at waking, after each meal, and at bedtime). An attempt was made to standardize these times for each participant across the experimental and control sessions. At each of these time points, participants completed the WSC and product monitoring form after consuming the product (see Figure 1). During the control condition participants completed the WSC at each of the six time points but were not given a product monitoring form, as they were not consuming any product. Participants were informed that they could use additional product at any time throughout the 24-hour abstinence but were required to use their assigned product at each of the six specific time points. If participants used the product at additional times they were not required to fill out the WSC but were asked to list the use in the appropriate section of the product monitoring form. Participants were provided an adequate amount of the product for each abstinence period but were also given contact information in case they required more. Additionally, participants were required to re-schedule their experimental days if they were not able to maintain smoking abstinence for the full 24-hour period.

The only variation in procedure across experimental sessions was the product that the participants were asked to use for each session (i.e., chewing gum with flavor [Gum], gum without flavor [Gum base], flavor strip [Flavor], or nothing [Control]). In the Gum condition participants were asked to chew peppermint flavored Wrigley's Extra sugar-free chewing gum. Peppermint (mint) was chosen due to its widespread use in the

empirical literature (Houtsmuller, Fant, Eissenberg, Henningfield, & Stitzer, 2002; Morinushi, Masumoto, Kawasaki, & Takigawa, 2000; Yagyu, et al., 1997; Yagyu, et al., 1998) as well as the ability to match the gum flavor with a flavor strip. Use of these products was counterbalanced (using an incomplete counterbalancing technique) across participants in order to minimize order effects. Men and women were counterbalanced separately in order to ensure that both groups were equally randomized.

When participants arrived to the lab following each of the experimental abstinence days they were immediately asked if they had been able to abstain from tobacco products and a CO measure was taken to corroborate their self-report. Participants who did not meet the cutoff for abstinence noted earlier were not run and were scheduled to repeat the experimental condition. Participants who were able to abstain were administered the final experimental measurement (i.e., WSC).

## CHAPTER III

### RESULTS

#### *Preliminary Results*

Due to the fact that the current study utilized a within-subjects design, each participant served as his or her own control. Each participant took part in all four conditions with each condition coinciding with one of the products used (i.e., chewing gum with flavor [Gum], gum without flavor [Gum base], flavor strip [Flavor], or nothing [Control]). The four conditions were counterbalanced using an incomplete counterbalancing technique in an attempt to decrease the impact of order effects. As a manipulation check, a repeated measures analysis of variance (ANOVA) was conducted with self-reported withdrawal (Time 6) as the within-subjects variable and the order of the conditions as the between subjects variable. As expected, the order that the participants received the conditions was not found to be significant,  $F(9, 60) = 1.16, ns$ ; therefore, we collapsed across the order of conditions for the remaining analyses. Further, given that the focus of the present study was to examine changes in withdrawal severity across conditions and not the amount of product used each week, pieces consumed for each product was not standardized across participants. In order to be sure that the quantity of product used was not responsible for our findings we again ran a repeated measures ANOVA as a manipulation check with total number of each product used as the within subjects variable. Once more, as expected, it was found that there was no significant dosage effects,  $F(2, 46) = .70, ns$  with participants using roughly the same amount of each product. All repeated measures ANOVAs conducted for this study were reported using the Greenhouse-Geisser adjustment for violation of sphericity.

### *Hypotheses 1 and 2: Reduction in Self-Reported Withdrawal*

In order to investigate how each condition impacted self-reported withdrawal two separate ANOVA's were conducted. For Hypothesis 1, self-reported withdrawal was defined as the amount of withdrawal experienced after 24 hours of abstinence (Time 6). For Hypothesis 2 self-reported withdrawal was defined as the amount of withdrawal experienced across the entire 24-hour abstinence period (the average of Times 1-6). It was hypothesized that after 24 hours of abstinence as well as during the entire abstinence period, the Gum condition would result in the least amount of self-reported withdrawal. It was further hypothesized that the Gum base and Flavor conditions would not differ significantly from each other but would result in less withdrawal among participants compared to the Control condition. Hypothesis 1 was not supported as there was no significant difference between the conditions defining withdrawal at Time 6,  $F(3, 69) = 1.46, ns$ .

In order to examine Hypothesis 2, a second repeated measures ANOVA was conducted with average withdrawal scores (Times 1-6) as the within-subjects variable. This hypothesis was partially supported as a significant difference in withdrawal severity reported by participants across conditions was observed during the 24-hour abstinence period,  $F(3, 69) = 3.38, p < .05$  (see Figure 2). The multiple-comparison procedure used to further investigate this significant finding was the studentized range statistic. This procedure was used in order to control the familywise error rate at the value of .05 (Toothaker, 1992) while conducting all pairwise comparisons. Six pairwise comparisons were conducted on the self-reported withdrawal scores in order to examine each of the possible pairs across the four conditions. The average withdrawal between the Gum and

Gum base conditions was the only significant pairwise comparison with the Gum condition producing lower withdrawal scores (see Table 3).

*Hypotheses 3 and 4: Gender Effects and Reduction in Self-Reported Withdrawal*

As with the previous hypotheses, self-reported withdrawal was defined first as the amount of withdrawal experienced after 24 hours of withdrawal (Hypothesis 3) and then as the amount experienced across the 24-hour abstinence period (Hypothesis 4). In addition to the reduction of self-reported withdrawal these two hypotheses investigated any gender differences that may exist. It was hypothesized that no matter how withdrawal was defined (e.g., Time 6 or an average of Times 1-6), male participants would experience significantly greater self-reported withdrawal than females. It was further hypothesized that both males and females would experience less withdrawal in the Gum and Gum base conditions when compared to the Flavor and Control conditions.

As shown in Figure 3, a repeated measures ANOVA was used to test the main effect of gender in Hypothesis 3 and found that females experienced significantly more self-reported withdrawal at Time 6 across all conditions,  $F(1, 22) = 9.62, p < .01$  (see Figure 3). However, there was no interaction effect observed between gender and condition,  $F(3, 66) = .51, ns$ . Another repeated measures ANOVA was used to test Hypothesis 4. Females again were found to experience significantly greater withdrawal compared to their male counterparts when withdrawal was defined as an average score,  $F(1, 22) = 5.11, p < .05$  (see Figure 4). Similar to what was observed in Hypothesis 3, there was no interaction effect between gender and condition,  $F(3, 66) = .62, ns$ .

## CHAPTER IV

### DISCUSSION

The current study is an extension of past research (Cohen et al., 1997; Britt et al, 2001) investigating the utility of confectionary chewing gum on self-reported withdrawal from nicotine. Chewing gum has thus far demonstrated its ability to lessen withdrawal symptoms during short periods of abstinence as well as decrease smoking behavior when smoking is permitted. For this investigation, chewing gum was divided into what was believed to be its active properties, chewing and flavor, in order to better understand how it influences the experience of nicotine withdrawal. Given the well-documented gender differences noted in the literature regarding nicotine withdrawal, successful cessation, and response to chewing gum properties, gender was included as a variable of interest. The goal of this study, therefore, was to gain a better understanding of what about chewing gum (e.g., chewing, flavor, or a combination of the two) has worked to decrease subjective reports of nicotine withdrawal in previous studies while considering the influence of gender.

Nicotine withdrawal was operationally defined in two ways for the purpose of this study: (1) The total score on the Withdrawal Symptom Checklist (WSC) at Time 6 (24 hours of nicotine abstinence) and (2) The average total score of the WSC across the entire abstinence period (Times 1-6). The four study conditions included: (1) gum with flavor (chewing plus flavor), (2) gum without flavor (chewing only), (3) flavor strips (flavor only), and (4) a no-product control (no chewing or flavor). The flavor used in the gum plus flavor and the flavor strips conditions were matched as closely as possible. Hypothesis 1 defined withdrawal at Time 6 and investigated any differences across the

four conditions while Hypothesis 2 investigated the same differences but used average withdrawal scores across the abstinence period. It was hypothesized, for both Hypothesis 1 and 2, that the self-reported withdrawal experience would differ depending on the condition. Specifically, it was hypothesized that the gum plus flavor condition would reveal the strongest effects (e.g., largest reductions in nicotine withdrawal), while the no-product control would reveal the highest levels of withdrawal. Results did not support this hypothesis as no significant differences across conditions were observed at 24-hour withdrawal (Hypothesis 1). These results indicated that participants' self-reported withdrawal at the end of the 24-hour abstinence period did not differ as a result of the product to which they were exposed.

Defining withdrawal across the abstinence period (Hypothesis 2), however, revealed an overall significant difference in self reported withdrawal across conditions. A closer inspection of the data revealed that only the Gum and Gum base conditions significantly differed in self-reported withdrawal. Specifically, the chewing plus flavor condition was associated with the lowest reported levels of withdrawal while the chewing only condition was associated with the highest levels. The flavor only and control conditions were associated with more intense symptoms of withdrawal compared to the chewing plus flavor condition but less intense symptoms compared to the chewing only condition. Therefore, it would appear that both active properties of chewing gum are necessary to produce significant reductions in self-reported withdrawal. It is important to note that upon closer inspection of the data, this finding only held up in the chewing plus flavor and chewing only comparison. Thus, results from this study only reflect the importance of both chewing and flavor over chewing alone. However, examination of the

data revealed that the flavor only condition closely followed the chewing plus flavor condition in terms of withdrawal severity. While statistical significance was not reached, it appears that flavor alone may be more important than chewing alone. This finding may be due to the enjoyment level of the product used. Specifically, perhaps chewing in and of itself is only useful when it is perceived as something pleasant. That is, in the chewing only condition where participants were asked to chew flavorless gum base, perhaps this product led to greater subjective nicotine withdrawal given the novel and perhaps aversive nature of the product. Clearly, when people chew gum with flavor, it is typically removed or replaced once the flavor has been depleted. Additionally, it is well established in the literature that negative affective states can prompt smoking behavior among established smokers (Hall, Muñoz, Reus, & Sees, 1993). Perhaps chewing something with no taste can elicit such emotions.

Gender effects were investigated in Hypotheses 3 and 4 again defining withdrawal at the 24-hour abstinence time point or as an average score across the abstinence period, respectively. Results for Hypothesis 3 and 4 revealed an opposite finding with females experiencing significantly more self-reported withdrawal compared to men. This finding, however, was not statistically significant due to the product being used, as male and female withdrawal patterns did not differ as a result of the experimental conditions. These results highlight gender differences with respect to the overall experience of nicotine withdrawal. Specifically, prior research has found that women have poorer cessation outcomes compared to men (Perkins, 2001) but it is not clear why women have a harder time quitting than men. What is known from past studies is that compared to male smokers, female smokers do not smoke at greater rates (Bjornson et

al., 1995) they are not less motivated to quit (Zhu, Melcer, Sun, Rosbrook, & Peirce, 2000), and they do not experience more intense symptoms of nicotine withdrawal (Pomerleau, 1996) (a finding inconsistent with the current study). In fact, compared to their male counterparts, female smokers are more likely to seek assistance in their quit attempts (Zhu et al., 2000) and report greater social pressure to quit (Royce, Corbett, Sorensen, & Ockene, 1997). Given that no significant gender differences were observed across conditions in the present study, males and females appear to experience the properties of chewing gum in a similar manner.

This study utilized the theory of behavioral economics in order to better understand the utility of chewing gum in relation to how it may aid smokers wishing to quit. It is theorized that chewing gum may satisfy similar needs as cigarettes and thus, successfully serve as a partial substitute for cigarettes. In an attempt to expand upon past research and better understand what similarities chewing gum shares with smoking, the active properties of chewing gum (i.e., chewing and flavor) were investigated separately. Results indicated that the combination of both chewing and flavor produced the lowest levels of nicotine withdrawal, suggesting that both properties may be necessary for chewing gum to aid smokers experiencing withdrawal. However, the flavor component in and of itself was not significantly different from the Gum condition, suggesting that flavor may be more important than the act of chewing in isolation. Clinically there are a number of implications as there are numerous reinforcers readily available in the environment that can address one or both of these needs (e.g., gum, flavor strips, hard candy, and mints).

The significant difference between the Gum and Gum base conditions was only observed when withdrawal scores were averaged across the 24-hour abstinence period rather than at the completion of the abstinence period. Clinically this is relevant as it points to the importance of looking at withdrawal as a process rather than at a set time point. Far too often, clinical research and practice focus too much attention at milestones such as 24 hours of abstinence, 48 hours of abstinence, or one year of abstinence. This finding illustrated that there is much to be understood about the withdrawal experience over time and treatments may need to consider and account for variability of symptoms across this construct.

Results of this study also revealed that the female participants experienced more self-reported withdrawal than males across conditions. Men were predicted to experience higher levels of withdrawal due to past research indicating that men smoke at higher rates compared to females (Bjornson et al., 1995) and that men typically experience more intense nicotine withdrawal (Pomerleau, 1996). It should be noted that the sample of females in this study smoked more cigarettes per day than males and obtained slightly higher FTND scores than males (see Table 1), which may account for our disparate findings. Overall it is clear that chewing gum (with flavor) was useful for female as well as male smokers in lessening the impact of nicotine withdrawal. However, because of the significantly higher withdrawal intensity observed among female participants in this study compared to males, it may be that chewing gum is not as effective among women. Perhaps females experience significantly different costs than males when abstaining from cigarettes and chewing gum is not able to effectively replace cigarettes.

Although significant attention was given to developing a methodologically sound study, results should be interpreted in light of some limitations. Study participants were mostly Caucasian individuals early in their smoking history (e.g., college students). Further, the data collected for this study was primarily self-report (with the lone exception being the CO measurements). Participants were asked to respond to measures on their own, at six different time points, over a 24-hour period across four different conditions. Due to the nature of self-report data and the number of separate, time-sensitive data points needed, the reliability of participant responses could be questioned. Another limitation of the present study is that recruited participants were not attempting to quit smoking but rather they were asked to abstain from smoking on four different 24-hour periods. For this reason study conclusions cannot be easily applied to smokers who are attempting to quit smoking permanently and are using chewing gum to manage withdrawal symptoms during the cessation period. Future research should examine the possible difference between those wishing to manage withdrawal symptoms temporarily (e.g., movie theatres, workplace) versus those attempting to quit smoking permanently.

Results from this study contribute further to the research literature examining gender differences with regard to nicotine withdrawal and smoking behavior in general. Additionally, men and women appear to differ in their response to chewing gum while abstaining from smoking. Future research should continue to investigate these differences in order to better understand the differing utility of chewing gum among males and females. Thinking more broadly, this study highlights the importance of further research investigating the relationship between gender, smoking behavior, nicotine withdrawal, and smoking cessation interventions.

The application of behavioral economic theory among individuals suffering from substance use disorders appears to be a valuable undertaking. Specifically, a thorough investigation of an individual's environment to assess what is readily available that may help the cessation process may lead to creative interventions that improve upon existing treatment options. Clearly, cigarette smoking has a number of reinforcing properties including, social, behavioral, and physiological. Chewing gum should be investigated in future studies along with other interventions (i.e., nicotine replacement therapies, cognitive behavioral therapy) in order to determine its utility in conjunction with other, more traditional cessation tools. More research is also needed examining the utility of chewing gum in its own right and developing a better understanding of why it may be a practical cessation tool. Breaking down this relatively simplistic behavior into its primary components will enable researchers to gain a better understanding about what components are the most useful during various stages of abstinence from nicotine.

In conclusion, chewing gum continues to demonstrate its ability to decrease self-reported withdrawal among regular smokers who are temporarily abstaining from cigarettes. Chewing gum is a possible cessation tool that would be easily accessible, low in cost, and simple to administer. Due to the well-documented risk of smoking and the difficulty smokers face during the cessation process, such a behavioral substitute that may positively influence the negative aspects related to smoking cessation may be quite useful. This study is the first step in systematically examining the active properties of chewing gum in an attempt to better understand why gum is potentially useful as an aid in smoking cessation.

Table 1. Participant characteristics (n = 24) by gender

Characteristic	Male (n=12)	Female (n=12)
Age (years)	20.3	22.1
Race (Percentage White)	83.3%	91.7%
Smoking rate (Cigarettes/day)	16.5	18.3
Minimum #	10	12
Maximum #	20	23
FTND Score (Range 0-10)	3.7	4.3

Table 2. Participant characteristics (n = 24) by incentive to participate in this study

Characteristic	Raffle (n=5)	Course Credit (n=19)
Age (years)*	25.2	20.2
Smoking rate* (Cigarettes/day)	17.6	17.3 4.3
FTND Score* (Range 0-10)	3.4	4.1
Race † (Percentage White)	80.0%	89.5%
Gender † (Percentage Male)	60.0%	47.4%

\* T-tests were not significant between groups at  $p < .05$

† Chi square tests were not significant at  $p < .05$

Table 3. All pairwise comparisons investigating mean differences between conditions.

Condition	Gum	Gum base	Flavor	Control
Mean	48	57	49	55
		t score	Q statistic	Significance
Gum vs. Gum base		-2.67	-3.78	.05*
Gum vs. Flavor		-.30	-.42	<i>ns</i>
Gum vs. Control		2.08	2.94	<i>ns</i>
Gum base vs. Flavor		2.37	3.36	<i>ns</i>
Gum vase vs. Control		.59	.84	<i>ns</i>
Flavor vs. Control		-1.78	-2.52	<i>ns</i>

\* Critical value of the Studentized Range Statistic according to Keppel 1991 is 3.74 where  $k = 4$  and  $df_{error} = 60$ .

## Figure Captions

*Figure 1.* Example schedule of an experimental 24-hour abstinence period with each time point and measurements to be completed in parentheses.

*Figure 2.* Participants' self-reported withdrawal, defined as average withdrawal across the 24-hour abstinence period, was significantly different depending on the experimental condition. Post-hoc analyses demonstrated significance only between the Gum and Gum base conditions.

*Figure 3.* Female participants experienced significantly more withdrawal, measured at Time 6, than males across all conditions. The interaction between experimental condition and gender was not significant.

*Figure 4.* Female participants experienced significantly more withdrawal, average score across 24-hour abstinence period, than males across all conditions. The interaction between experimental condition and gender was not significant.

Figure 1. Example schedule of 24-hour abstinence period

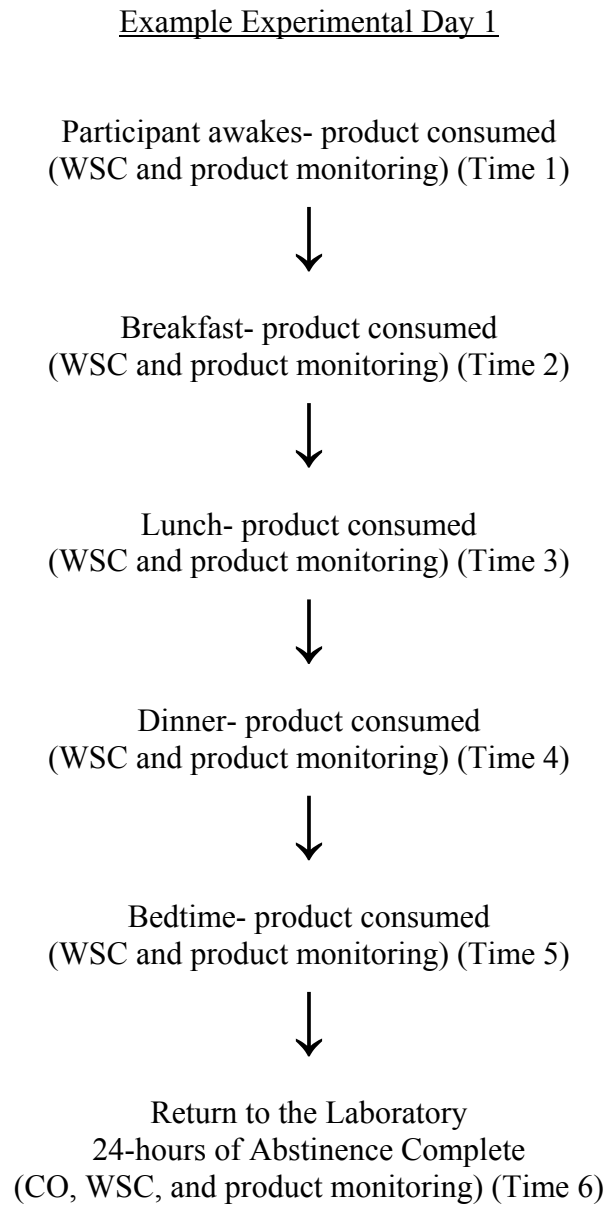


Figure 2. Average withdrawal scores by experimental condition

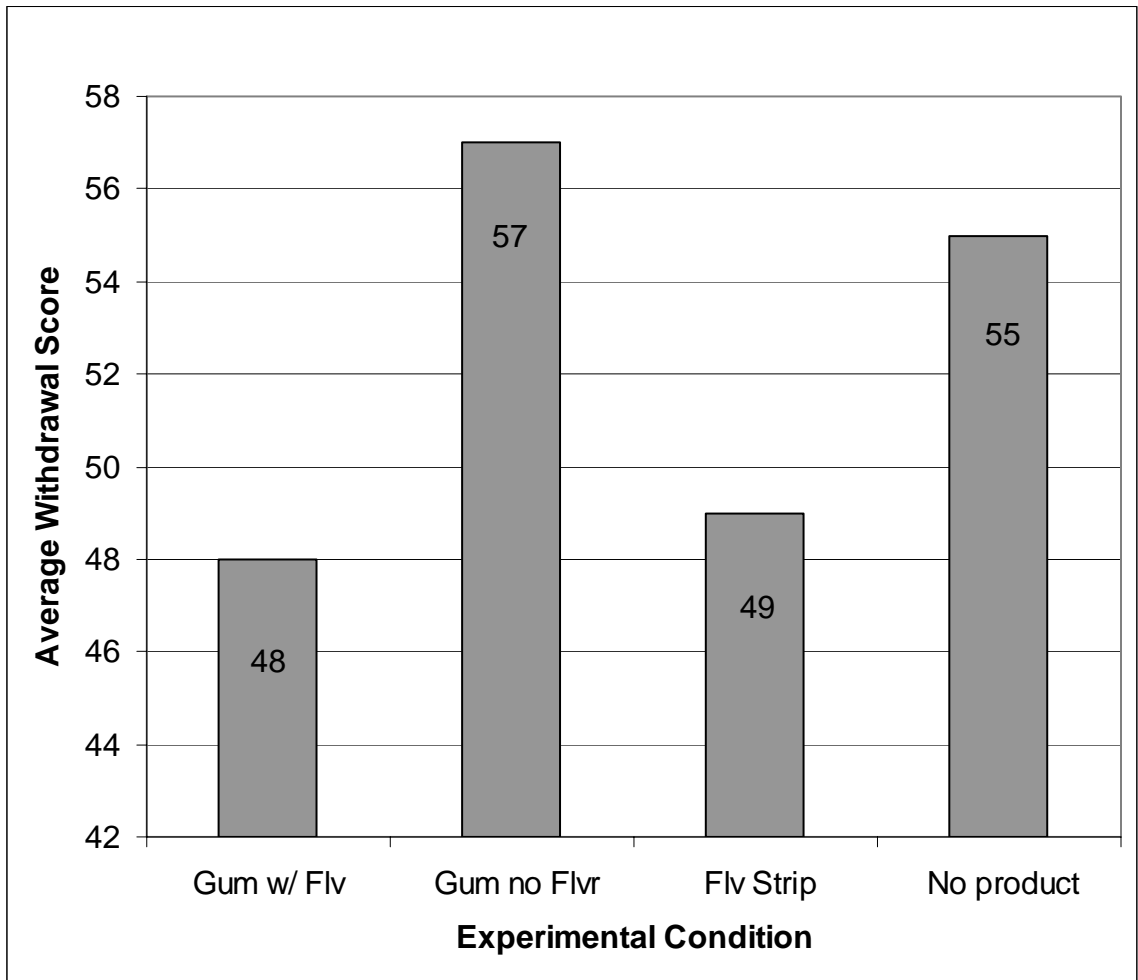


Figure 3. Withdrawal scores after 24 hours of abstinence illustrated by gender and condition

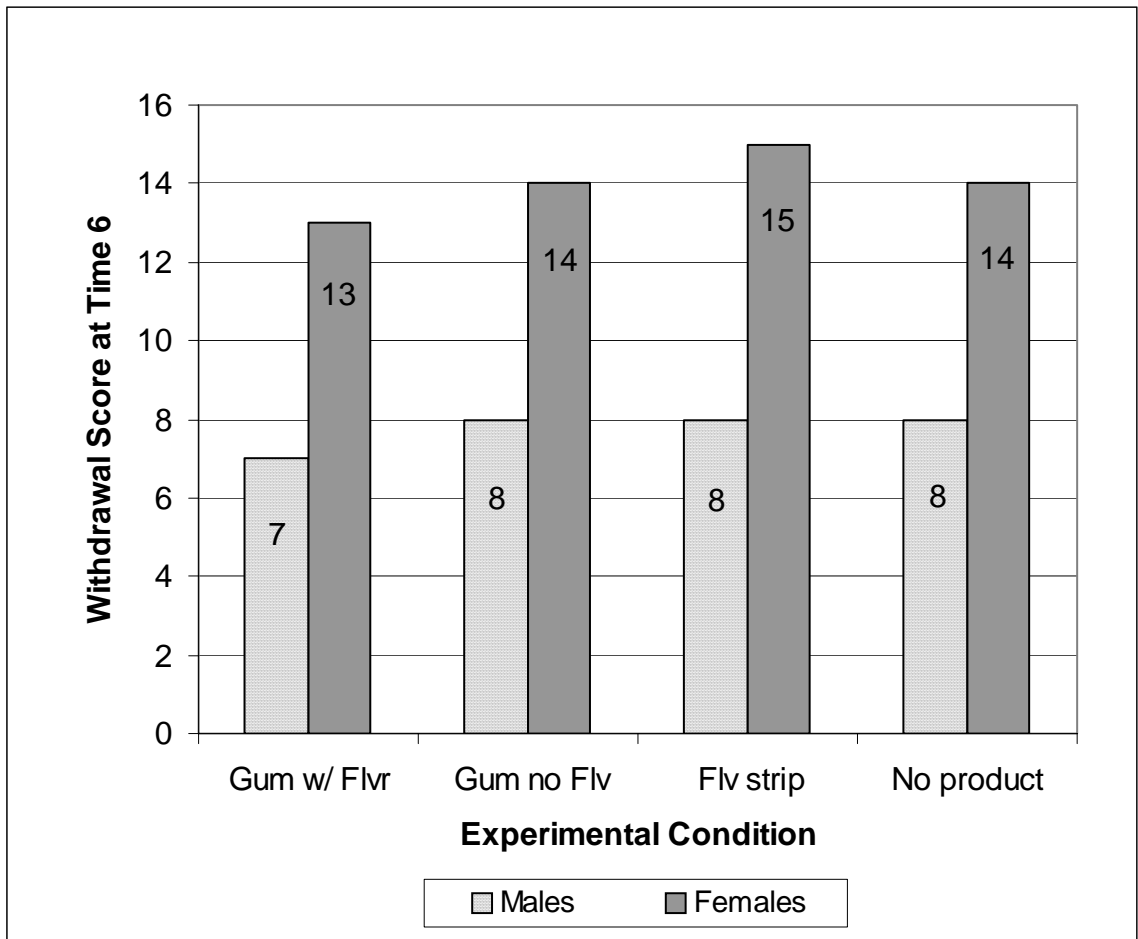
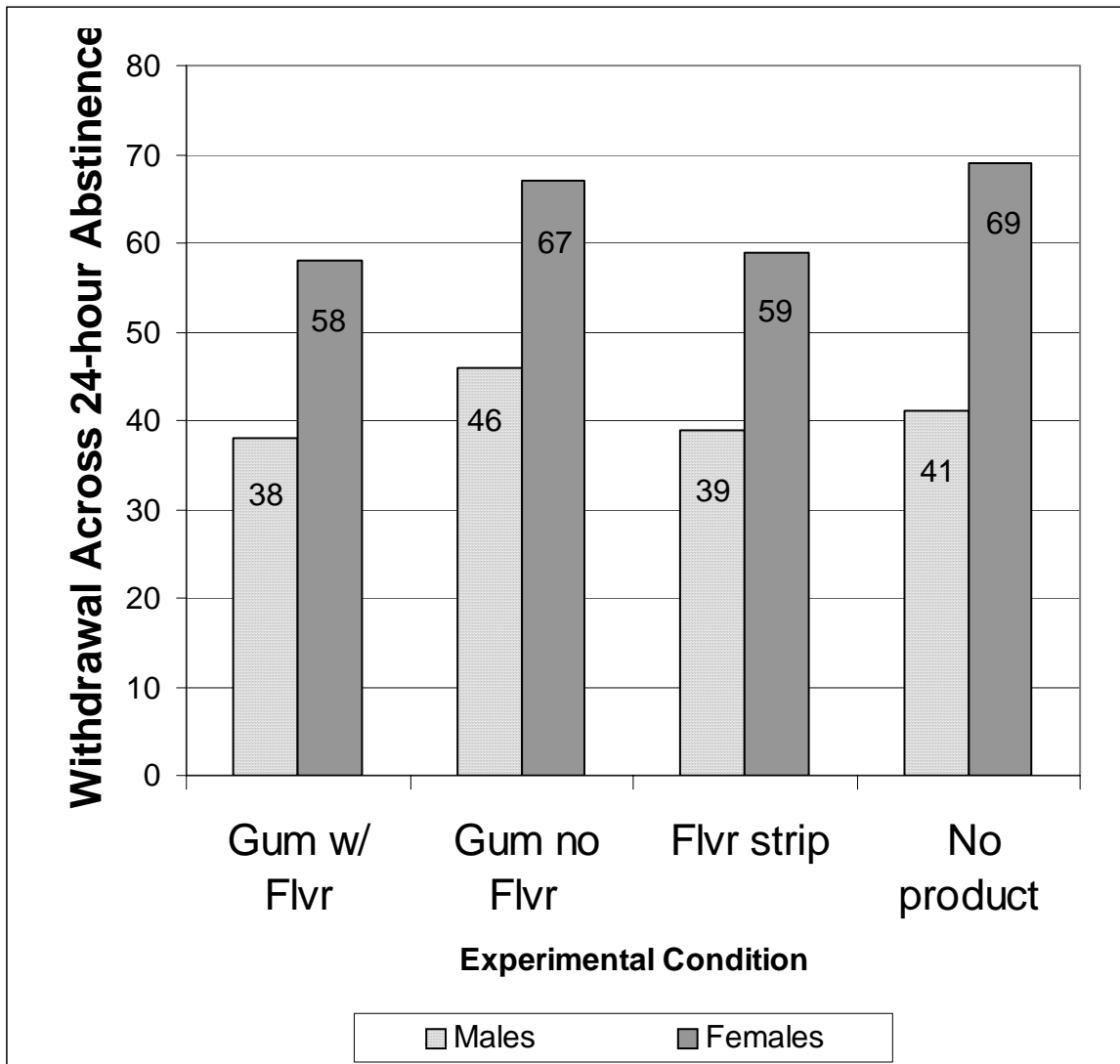


Figure 4. Average withdrawal scores illustrated by gender and condition



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## APPENDIX A

### Extended Literature Review

#### *Nicotine Dependence/Withdrawal*

##### *As a Major Concern*

Cigarette smoking continues to be a major public health issue. The Substance Abuse and Mental Health Services Administration (SAMHSA) estimates that in 2000, 65.5 million Americans reported using a tobacco product. Sixty four percent of smokers (35.9 million) reported smoking every day in the past 30 days (SAMHSA, 2002). This choice will result in the death or disability for approximately half of these regular tobacco smokers (CDC, 2002). Tobacco use continues to be the foremost preventable cause of death in the United States and claims the lives of 430,000 individuals each year. This number exceeds that of individuals killed by AIDS, murders, drug abuse, alcohol, car crashes, fires, and suicides combined (CDC, 2002). Tobacco smoking also contributes to variety of illnesses including coronary heart disease, lung cancer, and peptic ulcer disease (Rose, 1996). In addition, smoking-related illnesses alone accumulate upwards of \$100 billion each year for the United States (CDC, 2002). Smokeless tobacco, in particular, increases the risk of oral and pharyngeal cancer. Many other illnesses such as gingival recession, necrosis, and leukoplakia result as a consequence of a reduction in gingival blood flow (Miller & Coccores, 1991). The public at large is now informed that the health consequences of cigarettes impact more than simply the smokers themselves. Evidence for significant risks due to environmental tobacco smoke is now beginning to be noted and the negative impact of smoking is increasing.

Despite the overwhelming concern for all individuals using any type of tobacco product, cigarettes remain the most popular and well advertised. This emphasis may at first appear excessive; however, cigarettes continue to remain the most popular, most addictive, and most deadly form of tobacco use (Kozlowski, Henningfield, & Brigham, 2001). When an individual inhales the drug the effects reach the brain within seven seconds. This time is more than twice as rapid as heroin reaching the brain after an injection in the arm (Miller & Cocores, 1991). Other, less popular, inhalation forms of nicotine use are through a pipe, cigar smoking, and snuff. Centuries ago snuff was a very popular form of nicotine delivery. In this case, tobacco was in the form of finely ground powder, two fingers were inserted in the powder and then sniffed through the nostrils. In regards to smokeless tobacco, the two basic types are dipping and chewing. Dipping involves the placement of tobacco, in moist or dry form, between the cheek and gum area where it can be worked like a lozenge. Chewing of tobacco involves a wad of tobacco leaves that is masticated in the cheek area.

It is clear that tobacco has been used for many centuries and in many different forms. The issue that is to be discussed in this review is when this use becomes excessive and out of the control of the individual. For many years it was debated whether nicotine is addictive, and can in fact cause the effects of withdrawal and tolerance, as is the case for other drugs of abuse. It was postulated that nicotine was merely habit-forming, but the enormous degree of compulsion to obtain and use this drug has convinced many otherwise (Stolerman & Jarvis, 1995). It was not until 1988 that the surgeon general, in a special report, declared that nicotine was indeed addictive (United States Department of Health and Human Services, 1988). It is now a majority standing that nicotine is not only

addictive, but the compulsion involved is comparable to that of illicit substances such as heroin and cocaine.

The manifestation of compulsive use that is observed with all addictive drugs can be observed as a variety of patterns including intermittent and daily use. Cigarette smokers, in particular, rarely go more than one day without nicotine (Lynch & Bonnie, 1994). Most users of addictive drugs engage in patterns of occasional or low-level use. This model of behavior is rarely seen with tobacco users due to the excessive amount of self-administration of this drug (Kozlowski et al., 2001). In addition to the pattern of use, a distinct difference between nicotine use and other addictive substances are the sensations produced by nicotine or cigarette smoking. These sensations cannot truly be described as highly enjoyable, as they many times are for other drugs. The most significant intoxicating effects of nicotine involve alertness, irritability, muscle relaxation, attention, and a decrease in appetite (Miller & Cocores, 1991). After individuals become accustomed to these sensations produced by nicotine, they are reinforced to turn to the substance to produce these effects.

Individuals dependent on nicotine continue to use the substance despite its detriment to their health. The health consequences that are known to be an effect of smoking are widely publicized leaving smokers fully aware of the repercussions of this maladaptive behavior. Despite the fact that many smokers have a continuing desire to exert control over their use, there are usually many unsuccessful efforts at ending their pattern of nicotine use. It is estimated that 68 percent of the approximately 47 million smokers in the United States state that they are interested in quitting their habit (CDC, 1997). Research is beginning to educate us that there are behavioral and social

reinforcements such as peer approval and mood modulation involved in the continuation of smoking (Hirschman, Leventhal, & Glynn, 1984; Tarter et al., 1998). These new areas of study may provide a clue as to why cessation is such an illusive goal. This difficult goal appears to be compounded by age differences in those that are successful at quitting. Among American tobacco users, young adults between the ages of 18 and 25 have been the most resistant to change and continue to report the highest rates (45.3%) of current tobacco use (SAMHSA, 2002). Depending on the properties that are most reinforcing for a particular individual, some smokers may benefit from a purely nicotine replacement treatment while others may be in need of a behavioral component in addition to or as an alternative treatment approach.

#### *Diagnostic Criteria*

Before it is possible to begin the planning of treatment and the most efficient approach to this process it is necessary to determine some signs of maladaptive use in order to better target those in need of treatment. The Diagnostic and Statistical Manual of Mental Disorders fourth edition text revision (DSM-IV-TR) describes the essential characteristics of substance dependence as a “ cluster of cognitive, behavioral, and physiological symptoms indicating that the individual continues use of the substance despite significant substance-related problems” (American Psychological Association [APA], 2000, p.192). The DSM-IV-TR provides specific criteria that are thought to be the most notable symptoms of this disease. Of the following seven criteria, an individual must meet three or more in order to be classified as dependent: (1) tolerance is an experience where larger amounts of a particular substance is required in order to attain the same effect *or* experiencing a diminished effect when using the same amount of a

substance, (2) withdrawal is manifested by the characteristic pattern of symptoms which occur when the use of a specific substance is terminated *or* when the use of the same or similar substance relieves withdrawal symptoms, (3) over use of the substance due to the ingestion of larger doses or for a length of time longer than intended, (4) persistent desire to quit the use of the substance or failed attempts to decrease use, (5) time spent engaging in activities to obtain, use, or recover from the effects of a substance has become considerable, (6) loss or decrease of important activities in a variety of domains such as social, professional, or recreational due to substance use, (7) knowledge of physical or psychological harm that has occurred, or been exacerbated by, continued use of a substance does not end the use of the substance. Awareness of these general criteria for substance use must be elaborated on in order to obtain the full picture of nicotine dependence and how it is unique from other substances.

The criteria for the diagnosis of substance dependence has been clearly set forth in this discussion; however, if one is familiar with the DSM-IV-TR and its section on substance-related disorders they will also be aware that another classification of “abuse” is also listed. Along with the diagnosis of dependence, many abused substances meet criteria for an abuse label established by the DSM-IV-TR. The distinguishing feature of this category of substance-related disorder is the “recurrent and significant adverse consequences related to the repeated use of substances” (APA, 2000, p. 198). According to these criteria, the label of substance abuse is not applicable for nicotine use. There are consequences that occur because of nicotine use, but as of yet it has not been found that they are due to an intoxicated state caused by nicotine. These social, occupational, and/or

psychological manifested impairments would also have to occur at a level that was clinically significant for treatment. As of yet, this evidence is still lacking.

Nicotine is one of the few drugs that is classified by the DSM-IV-TR as having a dependence disorder, but not an abuse disorder (Hughes, 1994). The controversy over how to classify nicotine use stems from the fact that people who qualify for classification in abuse could also be classified in the dependence category, making two categorizations unnecessary. The classification of nicotine use is further clouded by the fact that nicotine use is often referred to as a habit. However, Perkins (1999) argues that the term “habit” is inappropriately applied to nicotine use not only because it is not a scientific term, but it also confuses smoking with other activities that are easier to change and separates nicotine from other abused substances. In regards to other terminology, the terms *dependence* and *addiction* are many times used interchangeably. Medical and scientific communities prefer the term dependence and thus for the sake of consistency with research literature the term dependence will be used in this review. In addition, the term addiction is not currently used as a technical term by APA or World Health Organization (Kozlowski, Hennington, & Brigham, 2001). As has been described in a more detailed manner, the term *abuse* is not synonymous with addiction and dependence due to its inclusion of different characteristics.

In addition to the differences seen between nicotine and other substances in terms of the classification of maladaptive use, there are other aspects of the criteria that deserve to be revisited. The *DSM-IV-TR* provides a specific section on criterion differences as they apply to nicotine and differ from other substances of abuse. As discussed previously, a pattern of repetitive self-administration of a substance may lead to consequences such

as tolerance and other irrational drug-related behavior. Tolerance is experienced in a person who is dependent on nicotine as the decrease of the intense negative symptoms (e.g. nausea and dizziness) that they may have experienced when first attempting to use nicotine. Despite repeated intake of large amounts of nicotine the individual will not experience these negative consequences. In terms of irrational behavior, nicotine does not necessitate the time commitment that other substances produce. The amount of time that a nicotine user will spend obtaining nicotine may be minimal (due in part to its legal status for those over the age of 18), but the time spent consuming the drug may be substantial especially in the case of a chain smoker. Although a smoker may not need to relinquish many activities or career paths in order to continue maladaptive use of nicotine, they may experience some impact due to smoking being prohibited in many areas. A dependent smoker may choose to forgo or decrease participation in activities if they occur in non-smoking areas. One criterion that appears to be of special importance to nicotine dependence is the continued use despite awareness of its health impact and the presence of tobacco-induced medical conditions.

### *Nicotine Withdrawal*

Lastly, the criterion of withdrawal will be discussed specifically as it relates to nicotine. Withdrawal symptoms occur when an individual is physically dependent on the substance and the body has reached a point where the nervous system has adapted to functioning in an environment where the drug is a constant presence. The cessation of the substance, after heavy use, results in disequilibrium, which is manifested in a withdrawal syndrome specific to that substance (Shiffman, 1991). Classical theories of dependence describe this process as neuroadaptation, which occurs when the body becomes

accustomed to a level of nicotine following repeated administration of a substance. The process of nicotine withdrawal begins after an individual has been using the substance for at least several weeks usually on a daily basis and then attempts to stop or decrease the use of a nicotine-containing product. In order to be classified as nicotine-induced withdrawal, four of the following eight criteria must be present within 24 hours of cessation or decrease in the use of nicotine: “(1) dysphoric or depressed mood; (2) insomnia; (3) irritability, frustration, or anger; (4) anxiety; (5) difficulty concentrating; (6) restlessness; (7) decreased heart rate; (8) increased appetite or weight gain” (APA, 2000, p. 266).

Among those investigating the phenomenon of nicotine withdrawal a clear and specific withdrawal syndrome has been described which occurs at an onset of approximately 12 hours and has a duration of 3 weeks or longer. Manifestations of withdrawal are mostly affective and include: irritability, depressed mood, difficulty concentrating, insomnia, anxiety, restlessness, anger, and increased appetite (APA, 2000; Seidman & Covey, 1999; Stolerman & Jarvis, 1995; Van de Creek & Jackson, 1999). Benowitz, (1998) reported very similar symptoms of withdrawal including “nervousness, restlessness, irritability, anxiety, impaired concentration, impaired cognitive function, increased appetite, and weight gain” (p.289). This withdrawal syndrome occurs with all forms and methods of administration of nicotine (Miller & Cocores, 1991). Nicotine replacement as a form of treatment for dependence is able to alleviate this withdrawal syndrome and provide a more compelling argument for the addictive nature of nicotine. In terms of comparison with other substances of abuse Hughes, Higgins, and Bickel (1994) investigated the differences between nicotine withdrawal and withdrawal from

other addictive drugs. The specific effects of nicotine withdrawal were divided into two classes, physiological and behavioral. The physiological effects of nicotine withdrawal are “decreased adrenaline, Cortisol, heart rate, orthostasis, thyroid function, and tremor and increased taste for sweets, resting metabolic rate, weight and metabolism of several drugs and slowing of the EEG” (p. 1461). The behavioral effects of withdrawal are “decreased performance (especially on vigilance tasks) and increased aggression and caloric intake (especially sweet/fat combinations)” (p. 1462). These withdrawal symptoms can begin 6-12 hours after the last nicotine administration and last up to 4 weeks after tobacco cessation. Even more persistent are craving and increased appetite. Anton and Drobles (1998) stated that craving involves the active resistance and inhibition of thoughts and impulses about the addictive substance. Furthermore, craving can be influenced by environmental stimuli as well as through a person’s cognitive and emotional state. Amazingly, both types of symptoms can last for longer than 6 months post cessation. Based on their 1994 investigation Hughes et al. felt that the symptoms of nicotine withdrawal, for some smokers, can be more severe than the symptoms of sedative or opioid withdrawal. The authors continued their evaluation of withdrawal symptoms by stating that these symptoms are often reported to be distressing and as being related to relapse.

#### *Relevant Gender Issues*

Males and females appear to experience aspects of cigarette smoking differently, although with withdrawal, there continues to be an inconclusive picture. Some researchers have found that there are no significant differences between genders in terms of the experience of withdrawal symptoms during a quit attempt (Perkins, 2001) while

others have found women experiencing more severe withdrawal from nicotine gum (Hatsukami, Skoog, Allen, & Bliss, 1995). This is an interesting finding since other research points to females in general being less dependent on nicotine and more dependent on environmental and social cues related to smoking (i.e., sight of tobacco, conversation; Zeman, Hiraki, & Sellers, 2002; Perkins, 2001). It has also been reported that female smokers appear to utilize smoking as a means to manage their experience of negative affect (Collins et al., 2004). For this reason, females may be more likely to need another means to cope with negative affective experiences such as stress. With regards to smoking behavior, females tend to report using lower nicotine containing cigarettes, smoke fewer cigarettes per day, and inhale less deeply when smoking (Zeman et al., 2002).

The gender differences within the smoking experience are also exemplified in the consequences involved with smoking cigarettes. Perkins (2001) reports that female smokers appear to be at greater risk for smoking-related diseases when compared to men. One example reported by the author was a finding related to women of all ages being at an elevated risk for myocardial infarctions. Female smokers also need to be concerned with medical difficulties related to smoking and the use of oral contraceptives as well as the impact that smoking has on menstrual bleeding, pregnancy, and menstrual cycle length (Perkins). In regards to quitting smoking, female smokers appear to be more concerned with weight gain related to smoking cessation (Bohadana, Nilsson, Rasmussen, & Martinet, 2001). The largest overall gender difference that has been cited is the lack of success that female smokers have in terms of quitting smoking (Perkins, 2001; Collins et al., 2004). This gender difference has been found across a wide variety of formal

treatments including behavioral counseling, nicotine replacement therapies, and self-quitting. Perkins also reported that nicotine replacement therapy, specifically, is less beneficial for female smokers. This may be related to the earlier reported findings that females may be less dependent on the nicotine involved with smoking. The author further discussed the possibility that females may be more in need of sensory substitutes to smoking due to their reporting of sensorimotor effects of cigarettes as a reason for smoking. Based on this information it appears as though the female smoking population is at an increased risk, compared to males, of not successfully completing a quit attempt and may experience more severe medical consequences as a result of this lack of cessation. Thus treatments developed for women should take into account their lessened dependence on nicotine, their need for negative affect relief, and their potential benefit of a sensory substitute for smoking.

#### *Measurement of Nicotine Use and Dependence*

The manner in which nicotine dependence is assessed has progressed over time. It was once mainly assessed using quantity of cigarettes smoked per day (Fagerström, 1991). Due to the development of self-report measures as well as technology to assess biological markers related to nicotine the assessment of nicotine dependence has evolved over time. The trend with new assessment tools has followed the scientific literature suggesting that nicotine dependence be viewed from several different perspectives (e.g., psychological and medical) in order for effective long-term treatment to be achieved (Fagerström, 1991). Additionally, assessment can be useful in determining the type of treatment that will maximize successful cessation (Jarvis & Sutherland, 1998). As it appears now clinicians and researchers have a variety of tools including self-report

instruments, biological marker measurements, and clinical interviews to better determine levels of nicotine dependence. In terms of clinical interviews, it should be noted that it is suggested that every individual that presents for treatment for nicotine dependence should be asked about current and past nicotine intake (Ziedonis, Wyatt, & George, 1998).

Obtaining a full picture of nicotine use (past and present) can provide a wealth of information such as a preliminary estimate of dependence level as well as the individual's pattern of use over time. The measures that are the primary focus of this review are those that are used to measure cigarette smoking and not other methods of nicotine administration (e.g., cigar smoking, chewing tobacco).

Let us first begin with an investigation of self-report measures, as they are particularly useful for clinical practice and research. These measures appear to be popular and effective due to their brief administration time and relative low cost. Many of the measures focus their attention on various aspects of cigarette smoking such as frequency, consequences of smoking, and belief in the ability to quit the habit. At this stage in measurement development there appear to be less tools that look directly at use among special populations or even at other methods of nicotine administration. As there are few measures that examine other forms of nicotine administration, one approach has been to adapt cigarette-smoking questionnaires to be utilized with smokeless tobacco users. This review will begin with two such measures due to their current utilization: the Fagerström Test of Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) and the Smoking Self-Efficacy Questionnaire (SSEQ; Colletti, Supnick, & Payne, 1985). Another relevant measure is the Smoking Consequences Questionnaire (SCQ; Brandon & Baker, 1991), which was developed to examine the expectancies of smoking.

Lastly, stage of change will be reviewed for its utility as a theory as well as an assessment tool

*Fagerström Test of Nicotine Dependence (FTND)*. The FTND is a 6-item questionnaire, which was revised from a previous measure named the Fagerström Tolerance Questionnaire (FTQ; Fagerström, 1978). The most important alteration between the measures was the removal of two questions from the FTQ. Following the removal of these questions, internal consistency increased to .61 (Heatherton et al., 1991). The FTND has become a popular measure with researchers in the field as well as clinicians. Questions on the FTND primarily focus on aspects of individuals' smoking routine (e.g., How many cigarettes per day do you smoke?). There are a total of six items with a range of scores 0 to 10, where higher scores demonstrate a greater physical dependence to nicotine. The FTND, when utilized among a non-clinical sample of smokers, has been found to have a test-retest reliability of .882 as well as a Cronbach's alpha of .64 (Pomerleau et al., 1994). Studies investigating the use of the FTND with a sample of smoker's enrolled in a smoking cessation program, found that this population received a mean score of 6.34 with a standard deviation of 2.02 (Payne, Smith, McCracken, McSherry, & Antony, 1994). When looking at the FTND and its correlation with other behavioral indicators of nicotine dependence, it was found that the FTND has a significant correlation (.52;  $p < .001$ ) with the number of years smoked (Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994).

The FTND is a measure that is being widely used among researchers in the field of nicotine dependence. This however does not mean that the measure is without its faults. Some of the limitations of the FTND include the fact the measure has been found

to demonstrate low content validity and be susceptible to floor effects (Etter, Vu Duc, & Perneger, 1999). One major argument comes from the fact that many aspects of dependence (as set out by the DSM-IV-TR) are not measured. One study undertaken using a previous version of the DSM (DSM-III-R) examined the concordance between criteria for diagnosis of nicotine dependence obtained through a structured clinical interview and scores obtained on the FTND (Moolchan et al., 2002). The most important finding was that these two sources of information (DSM interview and FTND) appeared to be focusing on different aspects of nicotine dependence. It should be of no surprise that the DSM was measuring issues such as psychopathology related to nicotine dependence among other aspects. The FTND on the other hand focused mostly on assessing symptoms of the physical dependence on nicotine. There was probably much overlap in terms of items/questions that were similar between the two sources, but based on their different purposes and development it is clear that different aspects of dependence were being evaluated. It is important to note that researchers continue to believe that the FTND is a “reasonably psychometrically sound, valid measure of nicotine dependence” (Payne et al., 1994, p. 316).

*Smoking Self-Efficacy Questionnaire (SSEQ).* The SSEQ is a 17-item questionnaire that is used to assess one’s beliefs about their ability to control urges to smoke in a variety of situations (Colletti, Supnick, & Payne, 1985). The measure consists of 17 individual situations, which the smoker then rates in terms of their confidence in being able to control smoking urges. Thus, the final total score is an indicator of the smokers overall confidence in handling smoking urges. The SSEQ was developed utilizing a group of participants that were participating in a behavioral treatment program

for the reduction of smoking. In terms of psychometric data, the SSEQ has demonstrated test-retest reliabilities ranging from .41 to .62 and a posttreatment internal consistency alpha of .91.

*Smoking Consequences Questionnaire (SCQ).* The SCQ (Brandon & Baker, 1991) was developed to assess the expectancies associated with cigarette smoking in a college student population. The SCQ is a 50-item measure that has four factors. These include negative consequences, positive reinforcement/sensory satisfaction, negative reinforcement/negative affect reduction, and appetite/weight control (Brandon & Baker, 1991). The SCQ was found to validly predict withdrawal symptoms that are typically occur with the cessation of smoking as well as the subjective experience of distress due to the abstinence (Wetter et al., 1994). The SCQ-Adult (Copeland, Brandon, & Quinn, 1995) is an extension of that measure for an older population of dependent smokers. The SCQ (Brandon & Baker, 1991) was developed to assess the expectancies associated with cigarette smoking in a college student population.

*Stages of change.* The stage of change of an individual includes four stages that represent the temporal, motivational, and constancy aspects of change (DiClemente & Prochaska, 1985). An individual attempting to terminate their problem behavior moves through the stages of change within the model: precontemplation, contemplation, action, and maintenance (Prochaska & DiClemente, 1986). Before entering treatment for a problem behavior an individual may believe that they do not have a problem and so are not considering altering their behavior (precontemplation). The individual may come to the realization, either on their own or through persuasion, that they do have a problem and may wish to obtain more information about their problem (contemplation). It should

be stated that at this point there is not yet commitment to actually alter their behavior. When an individual has made the commitment to change, and begins to alter their behavior as well as any environmental conditions that may be affecting their behavior, they have progressed to the action stage. In the final stage of maintenance an individual works to maintain the positive achievements that they have made and not relapse back into their problem behavior. Relapse is the termination of the current stage of the individual (action or maintenance), which then prompts a cyclical movement for the individual back thru the stages beginning with precontemplation or contemplation. For many of the addictive disorders such as nicotine dependence, movement through the stages of change usually occurs in a cycling as well as recycling of the stages (DiClemente & Prochaska, 1985; Prochaska, Velicer, DiClemente, Guadagnoli & Rossi, 1990).

Measuring the stage of change of a smoker is useful because it aids in understanding the subtleties that occur in a smoker's thought processes and actions prior to quitting (Rustin & Tate, 1993). An expanded stages of change model was proposed by Rustin and Tate (1993), which was an extension of work by DiClemente and Prochaska (DiClemente & Prochaska, 1982; Prochaska & DiClemente, 1983). Rustin and Tate (1993) developed a measure to assess a smoker's current stage of change during smoking cessation treatment. Six stages are identified that represent distinct categories or *ladders* (Rustin & Tate). The ladders are: precontemplation/contemplation, determination, action, abstinence, maintenance, and relapse. The authors suggest that this measure can help to clarify the amount of progress a patient is making during treatment and could be used to help evaluate the effectiveness of a treatment program. Many times a stage of change

measure will appear as an actual ladder instead of individual questionnaire items. The ladder may have anchor points that describe different stages of change such as whether the individual is considering changing or has actively started the change process. The ladder is used as a visual guide to help participants choose a number that best fits their current thinking. There is little psychometric data on these types of measures; however they have demonstrated concurrent validity with significant correlations with other measures of readiness to make a quit attempt (e.g. prior quit attempts).

### *Biological Assessment*

Even among the variety of self-report measures listed above the most popular measure of nicotine use is a single question asking the amount of cigarettes smoked per day. Some believe that this measure may not be the best measure of actual exposure to tobacco smoke (Etter & Perneger, 2001). The lack of consistency and even reliability may be both malicious (e.g., lying) and accidental (e.g., miscalculation, lack of attention). Whatever the reason there is a concern within the field to produce more consistent assessment. While paper and pencil measures provide information quickly and inexpensively, biochemical measures are able to provide a consistent measure of an individual's actual nicotine intake. This new technology is slowly becoming more common inclusion in nicotine research. With such advances that appear to produce much more scientific measures of nicotine use one might wonder why these assessment tools are not more readily applied to research. Although biochemical measures are useful, clinicians often do not have the resources necessary to gather this type of information. Some of the data is difficult to obtain and may be quite expensive to analyze. Jarvis and Sutherland (1998) identify several biochemical assessment tools for tobacco use that may

be more accessible to those within the field. Two measures that can be found in blood, saliva, and urine are thiocyanate (SCN) and cotinine. Nicotine levels in blood and carbon monoxide (CO) in exhaled air or blood can also be examined. Some of these tools require more invasive techniques (i.e., drawing blood) while others simply require the examination of expired air. The choice of assessment tool may be related to which will attract rather than scare off potential participants.

Due to the fact that many of these tools continue to elude researchers and mental health professionals due to financial or practical reasons, some feel that these measures are not a *necessity* for those in clinical practice (Society for Research on Nicotine and Tobacco [SRNT] Subcommittee on Biochemical Verification, 2002). It seems as though we have moved from inconsistent results with self-report measures to more consistent results that may be unattainable for many at the current time. If one is able to include biological measures of nicotine (biomarkers) use they can be a reliable way to corroborate data collected from interviews or self-report measures. These biomarkers may also serve an additional purpose besides data collection. They can be used to help determine the applicability of nicotine replacement treatments or other types of medications to aid with potential withdrawal from nicotine (SRNT, 2002).

The most straightforward biomarker listed above is the measurement of the level of nicotine (instead of a by-product) in the blood of participants. Being that what is desired is an accurate measure of nicotine use, nicotine levels in the blood seem to be the ideal measure. This measure is not without its drawbacks. Nicotine in the blood has a short half-life, which means that levels would have to be collected within the last 8-12 hours in order to detect any traces of the nicotine that was ingested (Benowitz & Jacob,

1994; SRNT, 2002). Not only is it difficult and costly to obtain repeated blood samples from participants, but in order to obtain accurate results, collection of the samples would need to fall within the window of nicotine's half-life. Of course one fear with this measurement would be whether the lack of nicotine in the blood was due to actual abstinence from nicotine or to an error in collection. SCN and cotinine, mentioned earlier, can be obtained through blood, saliva, and urine. Among these two, SCN is the assessment tool with the least support. This biomarker is a by-product of the liver from a substance that is present in tobacco smokers (hydrogen cyanide; SRNT, 2002). The use of SCN as a measurement tool is not widely recommended due to its lack of sensitivity (SRNT, 2002). In addition to this drawback, SCN is not useful in measuring the use of smokeless tobacco use. For those researchers that include both populations of nicotine users this would not be an efficient measurement tool. Cotinine, on the other hand, is considered a major metabolite of nicotine (SRNT, 2002). This strong measure of nicotine can be utilized in order to measure the amount of exposure to tobacco smoke (De Leon et al., 2002) and is considered the ideal biomarker (when Nicotine Replacement Therapies [NRTs] are not used; SRNT, 2002). One benefit in terms of cotinine's applicability is its usefulness in measuring tobacco use for both smokers and smokeless tobacco users. In terms of the difficulty with collection time frames, cotinine has a longer half-life than nicotine. Cotinine can be found in the blood several days after smoking cessation (SRNT, 2002).

The last and perhaps more user-friendly biological measure is the measurement of CO from expired air. The term user-friendly can be applied to both participant (lack of invasive procedure) and researcher (lack of sophisticated data analysis and

phlebotomists). The instruments used to collect expired air and dispense a CO reading are easy to use but do require an upfront cost by the researcher. Carbon Monoxide measurement is easier to collect and analyze, and furthermore, has proven to be an accurate biochemical measure. There is a strong relationship between CO measurements and tobacco smoke exposure although it cannot be used to measure smokeless tobacco use (SRNT, 2002). Interestingly, one of the drawbacks of CO measurement is the fact that it is a reliable measure of CO and so can be confounded by exposure to other forms of CO such as exhaust from a car. There may be some concern for false positive errors with this test due to elevated levels of CO unrelated to the individual's use of cigarettes.

#### *Treatment of Nicotine Dependence*

Once appropriate assessment materials have been utilized to provide a clearer picture of the individual's nicotine dependence, clinicians are better able to determine what types of treatment will be effective. Some smokers appear to be most reinforced by properties of smoking that are more social (e.g., talking with friends at smoke breaks) or due to habit (e.g., enjoying a cigarette after every meal). Psychological intervention is one of the major treatment approaches where an individual is aided in learning skills about their habit and modifying their behavior so as to eliminate some of the reinforcing properties. The other main treatment approach is the use of pharmacological interventions used to help eliminate the craving of nicotine. These interventions may include medications or other products that contain some nicotine. In many cases there is potential utility for both types of treatments to be used in unison. In addition to the information provided by assessments another valuable piece of information includes the smoker's reason for quitting (Fiore et al., 2000; Kozlowski et al., 2001). Discussing with the client

their concerns, reservations, and even past attempts could provide information useful for treatment planning.

In addition to determining what type of therapy will be most efficacious there is also a matter of timing of when therapies should be put into practice. For some individuals heavily dependent on nicotine who are initiating a quit attempt one option would be to use nicotine replacement therapy in order to help them step down their nicotine use. If for some reason these smokers are unable to utilize known pharmacotherapies in order to help them initiate their cessation, they may wish to consider the process of nicotine fading. (Ockene, Kristeller, & Donnelly, 1999). Just as some nicotine replacement products allow for gradual decreases in the amount of nicotine being administered, nicotine fading includes the use of various levels of cigarettes containing lower levels of nicotine. As the smoker decreases the level of nicotine per cigarette they also gradually decrease the amount of cigarettes being smoked (Hajek, 1994; Ockene et al., 1999). This gradual decreasing in the overall nicotine intake is a preparation for the upcoming quit date when the individual becomes completely free of nicotine. It has been suggested that an appropriate time to consider the quit date would be when the smoker has successfully decreased their cigarette usage to 5-10 cigarettes per day (Ockene et al., 1999). Fortmann and Killen (1995) suggested that nicotine fading is as effective an approach to decreasing nicotine usage as nicotine gum.

A large part of the treatment of nicotine dependence is knowing where there is potential for failure. For instance, it is essential that patients understand that the likelihood of their first quit attempt being successful is not very promising. Having to provide this piece of information would seem to be adding another dark cloud to an

already dreary situation. However, it is also important for the quitter to not underestimate the difficulty of cessation or become so frustrated with relapses that the thought of complete abstinence appears impossible. Because it is quite common for there to be a history of quit attempts both patients and clinicians should be aware of the difficult road ahead. Due to this difficulty clients may require a large amount of time with the clinician. More specifically, the time just after the quit date appears to be of large importance. Weekly contact for the first four weeks followed by bi-weekly meetings for another four weeks has been a suggested amount of aid from clinicians (Ockene et al., 1999). One major factor in the role that the clinician will play is the amount of additional social support that the ex-smoker has available. Those lacking in this support may require more frequent contact for a successful quit attempt (Ockene et al., 1999). The length of the commitment is also an issue as relapse is most likely during the six months following the quit date (Covey, 1999). Clients may continue to require assistance in their attempt and so it has been suggested that therapy be lengthen past the first couple of months in order to facilitate successful attempts (Kozlowski et al., 2001).

Once evaluations of the problem have been made and all involved are aware of the realities of the cessation process, more structured techniques may be initiated. As smokers are preparing to begin their cessation process the techniques of problem solving and skills training can be utilized (Fiore et al., 2000). These techniques may be applied in unison with other treatments including nicotine fading that was mentioned previously. The process of problem solving includes understanding the occasions and events that influence the individual to smoke. Within this process the smoker will learn more about their emotions and actions and their relation to the reinforcing properties of nicotine. An

addition to this process is the psychoeducation of the general process of dependence. Some researchers within the field feel as though education about how to complete a successful attempt should include information about the process of becoming addicted to nicotine (Fiore et al., 2000; Kozlowski et al., 2001). Since the treatment of nicotine dependence is similar to therapy in general, similar factors are also important of importance such as being supportive, encouraging positive expectancies, and developing a reasonable timeline for abstinence (Fiore et al., 2000; Hajek, 1994; Kozlowski et al., 2001). One of the skills learned within the cessation process should be coping mechanisms that can be called upon when urges and temptation occurs. A more behaviorally oriented intervention is stimulus control. Basically, the purpose of this training is to help the individual to break the strong association that has occurred between behavioral cues (e.g., when consuming alcohol) and smoking behavior (Perkins, Hickcox, & Grobe, 2000). In essence what is occurring is changing the habits that have been developed to include cigarettes. For each individual the specific situation may be different but the process of eliminating nicotine from the daily routine is the same. Another useful technique to help keep smokers from quickly reaching for their cigarette is for them to keep their cigarettes in a very inconvenient location (e.g., trunk of their car) so that the cost of smoking becomes greater. This change helps make it more difficult to smoke and may provide the smoker some time to consider their choice and weigh the consequences involved.

*Maintenance.* Some stimuli experienced by those attempting to quit will make returning to smoking seem pleasant and down right necessary. They may be experiencing the negative effects of withdrawal from nicotine, loss of interaction with those

acquaintances that continue to smoke, and even a disruption in their daily routines. For these reasons, the final stage of a therapeutic intervention for nicotine dependence is maintenance of nonsmoking behavior, which has been a persistent difficulty in treating individuals for substance abuse related problems (Ockene et al., 1999). Relapse prevention is a necessary component during treatment due to difficulty of maintaining this new behavior and the length of time that they individual may be vulnerable to relapse. Carmody (1992) found in an investigation of relapse prevention that relapse is actually very common, occurring in the vast majority of those smokers that are attempting to quit. In terms of the elimination of withdrawal symptoms, relapse provides the elimination of the urges, concentration difficulties, anxiety, tension, and even helps end the weight gain that many individuals encounter (Brigham, Henningfield, & Stitzer, 1990). Special attention may be needed for those individuals more heavily dependent on nicotine as they appear to be more vulnerable to relapse due to their experience of severe withdrawal symptoms (Carmody, 1993).

Continued during the period of maintenance training, is the understanding and practice of utilizing healthy coping mechanisms. At times of stress, for instance, an individual may have previously coped by turning to cigarettes (Perkins, Hickcox, & Grobe, 2000). In order for abstinence to be successful the individual needs to have an alternate way to cope with these stimuli in order to prevent a lapse or relapse. Much of the time there is a need to focus on dealing with negative emotional experiences that may push the individual closer to choosing cigarettes as a way to alleviate this stress. The strength of maintenance training is that it is preparation for events before they are able to occur and jeopardize progress (Carmody, 1993). If there were a mantra to smoking

cessation it probably would be “recognize, identify, and label” (Seidman & Covey, 1999, p. 231). This cognitive aspect of relapse prevention helps the individual better recognize their affective states that may be closely related to relapse. Being able to label affective states better helps individuals to realize when they may be desiring a cigarette and apply other methods of coping that have been learned. After better awareness and practice the individual will slowly break the strong association that previously existed between negative affective states and smoking behavior.

Other issues of importance during relapse prevention are weight gain, addictive thinking, and external stimuli. Many individuals experience weight gain during cessation attempts. Working with the individual on a cognitive level may be helpful in order to aid them in evaluating their assumptions and problem solving changes in diet that have occurred since the quit date. Carmody (1993) suggests other cognitive aspects related to relapse including “addictive thinking.” Identification of this occurrence is becoming aware of self-statements that encourage the belief that nicotine is a necessary part of their lives (e.g., I can't make it without a cigarette; Carmody, 1993, p. 99). Work in this area involves learning to counter these thoughts with alternative statements as well as utilizing coping mechanisms when the cognitions are strong and exert some negative influence. Much of the discussion on maintenance training has been on internal stimuli such as self-statements and emotional states. Another major difficulty in relapse prevention is dealing with external stimuli that can lead to urges to smoke. Smokers over time have become used to cues that influence their smoking behavior such as walking into a bar, or seeing a lighter, or even the sight of smoking acquaintances. During the beginning of abstinence these cues may have been avoided due to their dangerous potential to lead to relapse

(Seidmann and Covey, 1999). During maintenance training and beyond, individuals gradually expose themselves to these various smoking cues in order to help learn to cope with these difficult situations without cigarettes.

*First line Pharmacological Interventions.*

One assumption that can be easily made is that the use of pharmacological interventions is intended to fade the level of nicotine used by individuals in order to help with the experience of withdrawal symptoms. Another important aspect of the action of these interventions is their use as a reconditioning tool. Smokers have become accustomed over time to relate their nicotine intake with various external stimuli including events and individuals (Glover & Glover, 2001). When nicotine replacement products are used this conditioning is broken because the intake of nicotine is no longer continually associated with any external cue. By administering a slower and more consistent dose of nicotine to the individual these interventions are able to provide a decrease in withdrawal symptoms (Jarvis & Sutherland, 1998). In addition to the advance of a decreased withdrawal syndrome, the administration of nicotine is also healthier than smoking cigarettes, which contain a number of harmful chemicals. The focus of this review will be on first-line medications that exist for cessation of nicotine. The “Clinical Practice Guidelines” (Fiore et al., 2000) describe how these medications are approved by the FDA after they have established that they provide positive results for those attempting to quit their nicotine habit. First-line medications include both nicotine replacement treatments (NRTs) such as nicotine gum, patch, nasal spray, and inhaler as well as bupropion-SR (sustained release), which is a non-nicotine intervention. Second-line treatments have also been found to be efficacious just as first-line interventions but these

medications are limited in use due to the lack of FDA approval as well as potential for unknown side effects. Treatments included in this group are clonidine, nortriptyline, and a combination of nicotine replacement therapies.

*Nicotine gum.* Nicotine polacrilex (2 mg gum) was the first NRT given approval by the FDA as a treatment for nicotine dependence (Jarvis & Sutherland, 1998; Rose, 1996). The gum is available over-the-counter leaving individuals accessible to the product without consultation with a clinical or medical professional. Although it takes 20-30 minutes until the peak level of nicotine is reached the absorption of nicotine from the gum is rapid (Hatsukami & Lando, 1999). The recommended usage listed for this product is 3 months (Hatsukami & Lando, 1999; Miller & Cocores, 1991); however, the gum many times is used on an as needed basis in order to decrease cravings. Although the gum may be used in these different methods, research indicates that the method of having a fixed schedule is more effective as an overall aid to addressing withdrawal (Ockene, et al, 1999). In terms of the gum itself, there are both 2 and 4 mg doses. Usually the 4 mg does is recommended for those that are heavily dependent on nicotine (Fiore et al., 2000). The main complaint from those that have used the gum is the flavoring of the product. The peppery flavoring of the nicotine gum was actually a purposeful addition to the gum for the purposes of making it unpleasant for children and/or nonsmokers (Ferno, Lichtneckert, & Lundgren, 1973). This added flavoring causes the nicotine gum to have an unpleasant taste and a burning sensation. The role of the flavoring in this case was to provide a treatment while not encouraging the misuse of the product (Rose, 1996). It appears that a major concern was the over use of the gum by those populations (i.e., children and nonsmokers) that were not in need of treatment for nicotine dependence.

With the inclusion of the peppery flavoring a new problem arose in that those in need of the medicated gum were not obtaining a useful amount of nicotine because of noncompliance with the required dosing of gum (Rose, 1996). In addition to the difficulty produced by the flavoring, the reputation of the gum was tainted with dissatisfaction leaving smokers less likely to use the gum when they attempt to quit nicotine (Houtsmuller, Fant, Eissenberg, Henningfield, & Stitzer, 2002). Many individuals that would have greatly benefited from the use of nicotine gum will not try it due to the assumption that it will be unpleasant. For those that do use nicotine gum the administration method may be convenient for those that are not comfortable with the other NRT options that will be also be discussed.

*Patch.* The transdermal nicotine patch can be obtained over-the-counter or with a prescription (Fiore et al., 2000). One advance that the patch holds over nicotine gum is the ability to measure the amount of nicotine being continuously delivered (Miller & Cocores, 1991). This advance is mostly relevant to clinicians and medical professionals. The disadvantage of the absorption rate of the patch is definitely more relevant to the individual dependent on nicotine. The peak level of nicotine is not obtained until 4-9 hours after the administration of the patch, which is much slower than nicotine gum (Jarvis & Sutherland, 1998; Hatsumaki & Lando, 1999). There are different brands of the patch available with either a 24-hour (Habitrol, Nicoderm, and Nicoderm CQ) or 16-hour doses (Nicotrol). In terms of the amount of nicotine absorbed with these patches, the 24-hour patch delivers 21 or 22 mg of nicotine while the 16-hour patch gives 15 mg of nicotine (Hatsukami & Lando, 1999; Ockene et al., 1999). One study by Shiffman et al. (2000) was undertaken in order to investigate any differences that existed in the

performance of the two different patches (24-hour versus 16 hour). One main finding is related to early morning cravings, which are thought to be very important in terms of smoking cessation success. Results indicated that the 24-hour patch provided more relief from withdrawal symptoms experienced both in the early morning as well as throughout the whole day. In terms of more specific withdrawal symptoms, the 24-hour patch decreased an individual's temptation to smoke, level of anxiety and irritability, and well as restlessness.

*Nasal spray.* The nasal spray was another nicotine replacement product developed to provide some amount of nicotine during cessation attempts. This product is solely available with a prescription unlike other products that can be purchased over the counter (Fiore et al., 2000). Research on the effects of the nasal spray indicates that the rapid absorption of nicotine causes individuals to experience a decrease in craving within a few minutes of using the product (Hatsukami & Lando, 1999; Jarvis & Sutherland, 1998; Ockene et al., 1999). The nasal spray can be used for as long as three months although the product is usually prescribed for six to eight weeks when first initiated (Hatsukami & Lando, 1999; Ockene et al., 1999). In order to compare the nasal spray with another form of nicotine replacement Hurt et al. (1998) investigated the impact of the nasal spray (1-mg dose) and nicotine gum (4-mg dose) on withdrawal symptoms. Results indicated that despite the difference in dosing, the nasal spray produced more relief in the severity of withdrawal symptoms in the first 10 minutes when compared to the gum. After the initial 10 minutes it was determined that there were no significant differences between the effects of the products. Depending on the administration method that the individual prefers this product may be particularly useful for immediate relief of withdrawal symptoms.

*Inhaler.* The nicotine inhaler has been available for purchase since June 1998 (Ockene et al., 1999). One unique feature of the inhaler that is not present in other NRT's is the additional reinforcement provided by the actual method of administering the nicotine. Due to the fact that the inhaler itself has a mouthpiece and nicotine cartridge, it provides stimulation to the mouth and fingertips of its user (Hatsukami & Lando, 1999; Leischow et al., 1996; Ockene et al., 1999). These sensations are very similar to the ones that they experience when they are smoking a cigarette. In terms of the dose of nicotine administered, each nicotine cartridge contains 10-mg of nicotine (Eissenberg, Stitzer, & Henningfield, 1999; Hatsukami & Lando, 1999). A recent study showed that the inhaler increased success rates (using abstinence criteria) compared to a placebo (Schneider, et al., 1996). The authors suggest that due to the fact that the highest dropout rate was within the first week, actively preparing for craving early in treatment may be significant as well as combining inhaler treatment with other NRTs to increase nicotine levels during withdrawal. Although these results revealed that the inhaler is useful for the use of short-term abstinence there still remains a question as to its application for the use of long-term treatment.

*Combination NRTs.* As was mentioned before with psychological treatment of smoking cessation, the use of multiple treatments is usually a positive. This approach proves to be the same when discussing nicotine replacement treatments as well. The act of combining different types of interventions is used as a way of increasing the overall effectiveness of the treatment program (Eissenberg, Stitzer, & Henningfield, 1999; Fiore et al., 2000). Researchers have long been accustomed to undertaking investigations in order to compare and contrast the benefits of different treatments. In the case of

combination treatments researchers must look at different combinations and how they advance, above the presence of only one product, the positive impacts on withdrawal symptoms and relapse prevention (Hatsukami & Lando, 1999; Eissenberg, Stitzer, & Henningfield, 1999; Mielke, Jorenby, & Fiore, 1997; Rose, 1996). In the opinion of Hatsukami and Lando (1999) a combination of NRT's that includes the use of the nicotine patch may be very effective. This recommendation occurs because with the use of the nicotine patch an individual's overall nicotine level can be increased during the daytime when craving and urges are most likely at their highest. One potential concern for this approach of combining different types of NRTs is to have enough empirical evidence to know of potential complications or upper levels of nicotine and their impact on treatment.

#### *Non-nicotine Interventions*

*Bupropion – SR.* The medication Bupropion was developed as an antidepressant but has also shown to produce positive results when investigated as a treatment for smoking cessation (Johnston, Robinson, Adams, Glassman, & Covey, 1999). Bupropion is the only non-nicotine intervention for smoking cessation that has been approved by the FDA (Fiore et al., 2000; Glover & Glover, 2001; Johnston et al., 1999). Bupropion works at a neuronal level by blocking the uptake of dopamine and/or norepinephrine (Fiore et al., 2000; Glover & Glover, 2001). Research has been able to show how this medication acts on the brain but the specific actions on smoking cessation still remain unclear (Johnston et al., 1999). Do to the lack of knowledge available for this medication it is too early to determine what types of individuals or situations are most appropriate for this intervention.

Overall the general components needed for a successful quit attempt include the use of multiple approaches to treatment, the need for initial preparation and assessment prior to quitting, and an emphasize on maintenance over the long-term (Hatsukami & Lando, 1999). These components are general and their specifics should be applied depending on the needs of the individual. The best approach to treatment continues to be an individualized approach, which attends to the needs of each individual. Some individuals may benefit from different techniques based on their experience with nicotine and what needs are left when it is removed. For example, some smokers benefited from muscle relaxation as a substitute for their smoking behavior that was being eliminated (Dziegielewski & Eater, 2000; Ockene et al., 1999). Training in relaxation was able to help the smoker cope with stressful events using this new behavior rather than smoking (Dziegielewski & Eater, 2000; Hatsukami & Lando, 1999). In this way, relaxation provided relief that previously was solely provided by cigarettes. Additional research has been searching for other substitutes that are able to help individuals cope with the loss of nicotine and general smoking behavior. Research in this area has adopted the theory of behavioral economics in order to both develop new substitutes and understand how it is that the substitutes aid the process of cessation.

## Behavioral Economics

### *Overview of the Field*

The term behavioral economics used in this literature review is believed to be coined by Kagel and Winkler in a 1972 article published in the *Journal of Behavior Analysis* (Madden, 2000). At that time the term referred to economic research focused on the prediction of human behavior. The authors argued that the fusion of economic

principles with the procedures and methods of the analysis of behavior (e.g., schedules of reinforcement) would produce more productive models of human behavior that could be used for predictive purposes. Hursh (1980) believed that economic concepts should be considered as a contribution to the general theory and understanding of behavior. The difficulty in producing a review of this theoretical framework and methodology is the wide application of behavioral economics to the study of human behavior. Due to the many applications it is a great challenge to cite a single concise definition that encompasses an understanding of this continually evolving field.

One thorough definition has been provided by Madden (2000, p.6) who stated that behavioral economics is the

“combination of microeconomic concepts, principles, and measures along with concepts, principles, and experimental methods developed by behavior analysts (e.g., focus on the behavior of individual subjects and extensive use of animal subjects). Together, these techniques and principles are employed to gain a more complete understanding of the interaction between behavior and the economic context in which it occurs”

The frameworks of economics and the analysis of behavior are similar in the sense that economics is not looked upon as simply an “analogy” to psychology and its study of human behavior, but rather, is in itself a highly organized science investigating behavior (Hursh, 1984). In addition, Hursh described economic theory as a more descriptive and general framework to help us better analyze the types of relationships that could come about when investigating different reinforcers. Within this definition we are provided a sense of unity between similar sciences in the study of human behavior. It

appears as though the strengths of each framework are being combined to provide a further understanding of individual behavior within an economic environment.

In terms of individual behavior, behavioral economics is able to contribute methodology and techniques that better enable psychologists to analyze behavior. One economic term that has particular value in the analysis of behavior is *consumption*. Broadly applied, consumption may include a vast amount of activities (e.g., utilizing services, drinking, eating). It also can be used as a measure of problem behaviors (e.g., drug use, overeating) and the success of treatment programs (Madden, 2000). As one measures consumption, specific variables can be tracked in order to witness change and variability, which provides them with vast information to aid in categorization and/or treatment planning. A term very much related to the idea of consumption is *spending*. Spending can refer to an amount of money, labor, or time that an individual will give up in order to obtain a reinforcer (Madden). Just as discussed in terms of consumption, analysis of an individual's spending can provide information regarding how valuable a reinforcer is by the amount of spending that will be allocated for that reinforcer. In terms of drug behavior, spending can be used to assess treatment efficacy by looking at the spending involved in drug seeking and drug related behavior (Madden). Researchers are now examining human behavior in terms of what is being used up, the cost of that consumption, and the choices made between different reinforcers, which will be later discussed in detail. It is clear even up to this point that the terms and language being used to describe these functions of behavioral economics is perhaps new and different. It is within the unique aspects of behavioral economics such as its language, methodology, and general concepts that researchers are better able to quantify and investigate behavior

and the interactions of alternate reinforcers (Hursh, 1980; Hursh, 1984; Bickel, Hughes, DeGrandpre, Higgins, & Rizzuto, 1992).

### *Economic Terminology Translated into Behavioral Terms*

When attempting to apply economic theories to the study of behavior it is not unusual that some of the terms have carried over along with the theory. It is nearly the formation of a new language in that some is borrowed, some is changed, and others are the result of a combination of both areas. Just as these “borrowed” terms are not equivalent to those in economics they are also not synonymous with those used when talking about behavioral theories. These terms, and their meanings, are special in the sense that they are being used to describe new functional relationships that have previously not been investigated (Hursh, 2000). The terminology may be borrowed and altered but is being used to bring together two areas with rich knowledge and success in order to provide a better understanding of complex human behaviors and environments. The terms used have a different meaning as they are looking at behavior from a unique perspective.

The unique viewpoint that we are talking about is economics. The economist’s technical vocabulary includes *goods* and *services* to refer to tangible products and effort, which may motivate the labor of the consumer who would like to earn them (Madden, 2000). Those goods and services that are responsible for consumer motivation are referred to as reinforcers within behavior analysis. One of the most important terms that is the foundation for understanding behavioral economics and its usefulness in regards to behavior is the term *demand*. Demand on its own reflects the amount of a reinforcer that an individual will consume at the price at which it is being sold. Basically, the *demand*

*law* states that if all things were equal then consumption of a reinforcer would decrease as its price increased (Madden, 2000). Despite the fact that “things” usually do not remain equal, this law is very useful both in theory and in practice.

Research and investigation has looked at demand law on large-scale populations, which leaves questions regarding how well it can be translated and applied to individual consumption. Despite the uncertainty of shifting the large-scale approach of economics to the small-scale behaviors of individuals, there is strong hope in the applicability of the framework. One investigation by Bickel and Madden (1999) determined that the fundamental principles of economics are applicable to some behaviors such as cigarette smoking. Within this population the authors found this approach and its principles useful in understanding the behaviors of smokers. Drug dependence as a whole can be viewed in terms of its violation of the demand law in that individuals will consume their drug of choice at relatively the same rate despite price increases (Allison, 1983). Investigation of this violation in the laboratory has found that drug behavior actually does respond to increases in response requirement (i.e., price) and does in fact obey the demand law as well (Griffiths, Henningfield, & Bigelow, 1982; Bickel, Hughes, DeGrandpre, Higgins, & Rizzuto, 1992; Shahan, Odum, & Bickel, 2000). Even within this literature, which at first appears in complete violation of an economic principle, we find the application of behavioral economics. The opening in the case of smoking research is that this behavior, although challenging, does respond to reinforcers and thus can be manipulated using behavioral economic principles.

Moving on within the realm of demand, there is an issue of inequality. This inequality is seen within the environment as well as within reinforcers themselves and

their value to an individual person. The value and necessity of a reinforcer can be seen in its sensitivity to changes in price and the subsequent consumption by an individual. For example, if the prices of both ice cream and gasoline were to rise it is probably safe to say that the consumption of these reinforcers would decrease differently. Most individuals would decrease their consumption of ice cream more than their consumption of gasoline due to necessity. Thus inequality occurred when gasoline consumption decreased at a different rate than ice cream as a result of their unequal necessity to the individual. The idea of *elasticity* is used to describe how much a change in price will affect consumption of that reinforcer. Elasticity represents how sensitive the consumption of a reinforcer is to price (Hursh, 2000). The two types of elasticity have been clearly defined by Madden (2000) as:

“Demand for a reinforcer is defined as *elastic* if a 1% change in price produces greater than a 1% change in consumption. Conversely, when demand for a reinforcer is *inelastic*, a 1% price change produces less than a 1% change in consumption.”

In other words, elasticity is marked when the consumption of a reinforcer decreases rapidly as its price increases (Carroll, 1996). Inelastic demand has been defined by Hursh (2000) as a slow decline in consumption due to a proportionately large increase in the price of the reinforcer illustrating that the reinforcer is not very sensitive to the change in price. What we can conclude from these various definitions is the choice of an individual to continue to consume a good despite changes in price. If the good is valued and will be purchased at the same rate despite a price increase we see inelasticity; however an unnecessary or less valued good may decrease in consumption as would be predicted by elasticity.

Although these definitions are provided here in black and white terminology, elasticity is better understood in terms of a continuum of change. No one reinforcer is strictly elastic or inelastic. The consumption of reinforcers will be shifted to an elastic demand if the price is increased sufficiently (Hursh, 2000). At times it may be more useful to know not only what type of elasticity is characteristic of a reinforcer, but also at what point it shifts from being inelastic to elastic. Thus, it is better to understand elasticity in terms of its mobility rather than as a static characteristic. It is also important to note that elasticity is more a function of the economic context and not a property of a particular reinforcer on its own (Hursh, 1980). Here we can see the applicability of the theory to research and practice, as we are skilled at manipulating contexts. Since elasticity of reinforcers is not a fixed factor, researchers can investigate shifts that occur in elasticity and what causes those shifts by the addition and manipulation of reinforcers.

We have discussed the ends of the continuum of elasticity, but there is also much to be learned in the movement from Point A to Point B. Encompassed in this change we may have manipulation of prices, magnitudes, and reinforcement schedules all impacting (separately or concurrently) consumption. This range of points that occurs at different points of manipulation includes valuable information of the whole picture. The *demand curve* is this illustration of the complete relationship between reinforcer cost and consumption (Lea, 1978; Hursh, 2000). It shows the amount of consumption of a given rate of a reinforcer based on its price (Hursh, 1980). The demand curve is able to illustrate in a graphic nature the impact that a variety of prices has on reinforcer consumption. It is this demand curve that illustrates the results of the manipulation and where changes began to occur or not occur. To summarize this principle of elasticity of

demand it is an illustration of whether reinforcers are able to impact consumption. Researchers may wish to see such an impact of the consumption of drugs such as cigarette smoking and how it can be altered by the inclusion of other goods in the environment. When interventions are being tested for their effectiveness in changing behavior it is in the demand curve where one sees the potential of the intervention and how it is acting on the relevant outcome behaviors.

On some level these terms are basic and their application seemingly straightforward and deceptively simple: an individual wants a good, chooses that good over others and then spends in order to obtain it. Realistically price is a matter that affects nearly all consumption and the choice among goods. More specifically when price is measured in terms of the amount of spending (e.g., individual responses) it takes in order to obtain one unit of the reinforcer it is referred to as the *unit price* (Bickel, DeGrandpre, & Higgins, 1993; Madden, 2000). Price in this term is specifically, and parsimoniously, defined based on the amount of a reinforcer as well as the amount of the response requirement. Bickle, DeGrandpre, Higgins, and Hughes (1990) noted that erroneous results and conclusions could be drawn if there is comparison of dosing and reinforcing effects of different reinforcers without the use of unit price as a way of equating the comparison. In other words if one reinforcer is consumed at a higher price than another this means little without knowing how much of each reinforcer was being offered. So price, as well amount of the reinforcer, is important to know in any comparison. Unit price can be impacted by either changing the cost of the reinforcer (response requirement) or by changing the reinforcing quality (dose) of the reinforcer (Rachlin, Green, Kagel, & Battalio, 1976; Madden, 2000; Carroll & Campbell, 2000). Unit price is

a cost-benefit ratio that aids research in understanding and manipulating different costs (e.g. social, behavioral) that may go in to obtaining the reinforcer. Using unit price as a measure allows more specific evaluation of the impact of a price change because the amount of reinforcer present is taken into account. After all, an increase in price would not produce an effect if the amount of the reinforcer were also increased.

As you may have probably already gathered, unit price is much more than a measurement tool. It is descriptive of a powerful situation that arises when price, spending, and consumption come together in order to determine an individual's choice of activities or even perhaps drug use. The power of unit price is illuminated when its manipulation creates change in the consumption of a good that was considered essential and relatively resistant to change (e.g., cigarette smoking). Bickel, DeGrandpre, Hughes, and Higgins (1991) investigated the applicability use of unit price to the study of cigarette smoking. The question the authors posed was whether an increase in unit price would affect smoking behavior as would be predicted by the demand law (decrease in consumption). The authors manipulated reinforcer magnitude (number of puffs of cigarette) as well as the response requirement (i.e., lever pulls) in order to produce six different unit prices. Overall results across the five community smokers indicated that consumption of cigarettes did decrease as unit price increased. The author's referred to unit price as a parsimonious explanation for their findings rather than separating the impacts of magnitude or response requirement. These results illustrate the applicability and success of unit price within the study of drug use behavior.

Unit price is a crucial aspect of behavioral economics that allows researchers to test potential reinforcers, which may be able to impact the elasticity of different

behaviors. This can be particularly important when you are talking about drug behaviors and increasing their elasticity so that consumption will decrease due to the increase in alternate reinforcers. We have been discussing the complexity involved in determining change in the consumption of reinforcers based on numerous factors (e.g., unit price, spending). In addition to these factors, alternate reinforcers are typically available in the environment that may or may not be competing for an individual's resources (e.g., labor and money; Madden, 2000). One cannot fully understand the impact of a reinforcer without also investigating the other reinforcers in the environment and the interaction among the reinforcers (Green & Freed, 1993). For instance, at this moment the reinforcing consequences of writing this review are outweighing those of other sources of reinforcement in my environment such as watching TV or reading a book for pleasure. In the complex world of reinforcers, there are those that are consumed together, those that are not in competition, and even those that compete against each other. It is important to understand the different types of reinforcers (e.g., complement, independent, and substitute) as well as how they impact consumption differently.

We will begin with a discussion of a *complement*. When a complement is introduced into the economic context the consumption and spending to obtain another reinforcer is increased. One example that is typically cited is the complementary relationship between alcohol and cigarettes (Madden, 2000). When alcohol is being consumed the frequency of tobacco smoking is higher than when it is not consumed. This demonstrates that cigarette smoking is impacted in a specific direction by the presence of alcohol. A complementary relationship can also be witnessed when different reinforcers are impacted by a change in one of them. This would occur if for instance the price of

coffee were increased, which was then followed by a decrease in the consumption of both coffee and coffee creamer. If one is not going to consume coffee because of the price increase there is really no need to purchase or consume coffee creamer. In this example coffee and coffee creamer are complements that were both impacted by the increase in the price of only one of them.

In the case of complements, the alternate reinforcers are not competing against each other; in fact, their fates are intertwined because of their relationship to each other. An *independent* reinforcer is different because its introduction does not produce a change in the other reinforcer (Madden, 2000). The two reinforcers are not competing for time or resources, but are occurring independently. If the price of cola were raised it would not be assumed that it would have an impact on the consumption of corn because these two goods are independents.

We have seen how some reinforcers may be very much linked to each other (complements), while changes in some do not have an impact on others (independents). A *substitute* can be thought of as a reinforcer that shares properties with another reinforcer (Madden, 2000) or is able to satisfy a similar need (Hursh & Bauman, 1987). Because the alternate reinforcer may share functional or structural properties it can take the place of the old reinforcer. When this reinforcer is introduced (at a fixed price) the spending and resources allocated to the old reinforcer decrease (as unit price increases) and the new substitute reinforcer is consumed more (Carroll & Campbell, 2000). Nicotine replacement products were produced in the hopes that they would become successful substitutes for cigarette smoking in that smoking behavior would decrease and the individual's resources would be switched to a new source of reinforcement (nicotine

replacement products). Unless you are substituting a reinforcer for itself (e.g., cigarettes vs. cigarettes; perfect substitute) you can expect that there is going to be a great amount of variability in the way in which the new reinforcer can successfully compete with the old reinforcer. The reinforcer may be a great substitute and take over a lot of consumption or it may only partially substitute areas of the old reinforcer and not be consumed quite as much. It is also the case that a substitute relationship may not be interchangeable (asymmetrical; Carroll, 1996). This occurs when reinforcer A can serve as a substitute for another reinforcer B; however, in the opposite direction reinforcer B cannot substitute for reinforcer A.

One message resulting from these differing relationships between reinforcers is that the context (the environment) cannot be overlooked because within the context there are alternate reinforcers. The context, including alternate reinforcers, has the power to alter motivation and consumption, thus needing to be accounted for in order to obtain a complete understanding of behavior (Hursh & Bauman, 1987). When you want to understand a particular behavior and the interaction of that behavior with other reinforcers you need to have them all in the same environment and studying their interactions with each other (Johnson & Bickel, 2003). It is only when we understand the behavior and interacting reinforcers that we are able to predict behavior and know when and how to impact that same behavior.

### *The Application of Behavioral Economics to Nicotine Dependence*

Behavioral economics is a vast field that has encompassed the best of two worlds: behavioral psychology and economics. It has brought with it a new way of looking at behavior and the interaction between reinforcers. Over the past three decades the scope of

behavioral economics has widened to include many health-related behaviors. Its application to specific areas of human behavior, more specifically substance abuse, has been argued by Vuchinich and Tucker (Madden, 2000). Experiments using models of choice and alternate reinforcers have helped to expand this behavioral economic theory to the study of drug dependence. It was not until the late 1980's when behavioral economics became a consistent theory and framework within the research of drug abuse and dependence (Bickel & Madden, 1999). This framework has been applied to various drugs of choice including alcohol abuse (Vuchinich & Tucker, 1988), heroine and polydrug use (Petry & Bickel, 1998), as well as cigarette smoking (Bickel et al. 1990, 1991, 1992; Bickel & Madden, 1999). Among the drugs of abuse studied, cigarette smoking has been where behavioral economics has made the most impact and is one of the areas where the theory is most developed. Some authors (Bickel, Madden, & DeGrandpre, 1997; Bickel, DeGrandpre, Higgins, Hughes, & Badger, 1995) discussed their choice of using cigarette smoking as way to more closely approximate the behavior of drug-dependent individual's because it is a legal substance. In addition, the authors stated that smoking behavior, and its demonstrated demand curve, has similar features of other drugs. Cigarette smoking and its behaviors have proved to be amenable to behavioral economics.

This theoretical framework has been successfully applied to substance abuse research and has begun to change our focus within this area of research. Current research using behavioral economic theory has led us to consider more of the environment of change rather than simply focusing on terminating the drug behavior (Madden, 2000). Researchers are shifting their thinking to include the consideration of variables in the

individual's environment that can be used to help cessation intervention be successful. Especially in the case of drug-related behaviors that are extremely difficult to change, more creative interventions need to be utilized. In the case of nicotine dependence, substitutes and complements in the environment can be targeted to help decrease smoking behavior. For example, it is thought that alcohol consumption (complement) should be decreased because of its negative impact on smoking, while nicotine replacement products (substitute) may be chosen to take the place of cigarettes.

One review by Bickel, DeGrandpre, Higgins (1995) focused on understanding qualitatively different reinforcers and how they interact with each other within the substance abuse literature. The authors viewed drug use as a choice of using one reinforcer (e.g., cocaine, alcohol, cigarettes) over the wide variety of alternate reinforcers (e.g., water, food, coffee) in the environment. Studies reviewed included those where both types of reinforcers were concurrently available. In these studies reinforcers were either manipulated, held constant, or analyzed as a function of unit price. Results indicated that the interactions among reinforcers (complement, independent, substitute) were observed across experimental designs, species, and reinforcers (Bickel et al., 1991; Bickel DeGrandpre, Higgins, 1995). These findings suggest that these economic concepts provide a useful understanding of the reinforcers within the drug abuse literature. The authors emphasized that the future direction of this research could help determine the utility of suspected alternate reinforcers and their ability to compete with drug reinforcers. Researchers have used laboratory conditions in order to investigate the utility of alternative reinforcing activities (Madden, 2000, Shahan, Odum, & Bickel, 2000). Both within animal and human research investigating drug use, findings have

demonstrated that the presence of non-drug alternate reinforcers may decrease drug consumption and drug seeking (Bickel, DeGrandpre, Higgins, Hughes, et al. 1995; Carroll, 1996; Bickel et al., 1997; Carroll & Lac, 1998). These findings suggest that alternate reinforcers exist which may be reinforcing enough to drug users that at some point the demand for these alternative reinforcers may shift the amount of consumption of the drug.

A study by Bickel, DeGrandpre, Higgins, Hughes, et al., (1995) demonstrated how a non-drug reinforcer, which was added into the economic environment of a cigarette smoker, can decrease use of cigarettes. The authors included money and recreational activities (e.g., VCR, video games, remote control car) as alternate reinforcers in this study of eight male participants. Participants were able to make choices using plunger pulls. Results indicated that when an alternate reinforcer was present (either money or recreation) there was a significant drop in consumption of cigarettes relative to when no alternates were present. In addition, the authors also found that the presence of the non-drug alternates decreased drug-seeking behavior, defined as response output. Thus, the potential for impact on drug use behaviors by non-drug reinforcers is strong and may impact drug behavior on several levels.

Research looking into alternate reinforcers has focused on many areas including attempts to lessen drug-reinforcing behavior as well as treating the drug abuse (Carroll, 1996). The theory of behavioral economics with the technique of adding non-drug alternative reinforcers has been applied to many substances such as alcohol (Vuchinich & Tucker, 1988), opioid (Stitzer, Bigelow, Liebson, & McCaul, 1984), and tobacco (Hall, Tunstall, Ginsberg, Benowitz, & Jones, 1987). Within each of these different substances

economic theory can help break apart the important aspects of the drug behavior in order to obtain a better understanding of the particular reinforcing properties. Specific to tobacco, some believe that the response cost for smoking is low, which leads to a promotion of smoking as an individual is able to receive the reinforcement (e.g., nicotine) at little cost (e.g., social, behavioral, economic; Perkins, Hickcox, & Grobe, 2000). This reinforcement continues to be utilized as it is relatively inexpensive, legal to consume, and is readily available. It is important to understand how we view and interpret the behavior of smoking in order to have a better grasp on where behavioral economics may have an impact.

In addition, the language and application of behavioral economics impacts the way in which we look at the process that an individual goes through as a behavior turns into dependence (Perkins, Hickcox, & Grobe, 2000). When an individual is not yet dependent the amount of response cost they are willing to pay for the reinforcer (smoking) might be relatively low. The individual may stop smoking if the price of cigarettes is raised a few cents or if they experience some dizziness. However, as the individual becomes more dependent on nicotine they are willing to “pay” more costs such as physical discomfort and harm.

When determining an approach to change the behavior of smoking, the intervention can be understood in two ways (Perkins, Hickcox, & Grobe, 2000). A successful intervention may increase the response cost needed in order to receive the reinforcement. In the case of nicotine, reinforcement will likely include various social and behavioral reinforcers in addition to any physiological reinforcement. Another way to impact smoking behavior is to reduce the overall cost of quitting smoking behavior. In

essence this second prospective is alleviating the negatives that come about when one is abstaining from nicotine (e.g., withdrawal) as these consequences serve to reinforce smoking behavior. The use of a substitute alternative (chewing gum) is an example of the latter intervention where there is an attempt to find another item that can take the place of the original reinforcer (smoking). In taking its place, the alternative (chewing gum) is lessening some of the cost of missing the reinforcer (smoking). Being that the behavior of smoking is so complex it would be extremely difficult to find a reinforcer that is able to completely alleviate all costs of quitting. Thus it is important to understand how each alternative affects the behavior in order to realistically anticipate its impact on response cost.

There have been numerous attempts at utilizing the first approach to behavior change (i.e., increasing the response cost). Much work has been done in order to increase smoker's knowledge of the health costs of smoking in an attempt to raise the overall unit price of smoking. There have also been changes in terms of the behavioral costs of smoking (e.g., smoking outside, away from buildings). The cost of cigarettes has been raised in the hopes that it would also increase the cost of smoking to the point where some would choose not to smoke. Despite these attempts many choose to continue to smoke and obtain enough reinforcement to adapt to the changing cost of smoking. The remainder of this review will focus on the second approach to behavior change (i.e., reducing the cost of quitting smoking), which includes the investigation of the impact of reinforcers that may compete for the resources of smokers.

Different types of reinforcers have been investigated for their ability to ease the burden of quitting nicotine use. Research has shown that nicotine gum can function as a

substitute reinforcer to cigarette smoking (Shahan, Odum, & Bickel, 2000). In this study the authors found that increasing the price of cigarette puffs increased the consumption of the concurrently available nicotine gum. In this example of an alternate reinforcer it is probable that the nicotine gum functions similarly to cigarettes as a product containing nicotine. Behavioral economics has been used to investigate other alternatives that may interact with cigarette smoking without nicotine. This includes reinforcers that are qualitatively different than cigarettes. Although nicotine replacement products represent some of the nicotine research, this review will focus more on non-drug alternative reinforcers.

Throughout this review the issue of shifting demand curves through manipulation in order to increase the cost of smoking or decrease the cost of not smoking has been mentioned a few times. There are also shifts that occur naturally, such as negative affect and stress, which actually serve to increase the positive reinforcement of smoking (Perkins, Hickcox, & Grobe, 2000). At these times of stress one can witness a temporary shift in the demand for smoking. Because these acute influences do occur, interventions must be sensitive to these shifts and determine if the alternatives will help prevent these shifts. Some research has illustrated that smokers feel as though they smoke in order to relieve their subjective experience of tension and that this factor (stress, tension) stands directly in their way of a successful quit attempt (Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996). An alternative to smoking that can produce the same reinforcement (i.e., reduction in stress) that smoking is able to provide would be able to compete with cigarette smoking. One of the alternatives that has been investigated is relaxation techniques.

If the learned relaxation techniques are able to relieve the stress and tension felt by the individual then smoking will not be necessary and will be less appealing as it is no longer the only solution to the problem. In this case we see how an alternate reinforcer can take away some of the reinforcing properties of smoking, while also providing a healthy service. Although there is little empirical support for the successful use of these techniques within smoking cessation, there are clear similarities in terms of the function that both reinforcers serve (Perkins, Hickcox, & Grobe, 2000). In addition to relieving tension, both reinforcers can be completed quickly, involve deep breathing, and can be performed on demand. The similarities that are shared between the original reinforcer (smoking) and the alternate (relaxation) the more likely the alternate reinforcer will be successful in replacing the old reinforcer.

As we are slowly learning, there may be many partial substitutes for nicotine that are able to influence its demand curve and help decrease smoking behavior. These different reinforcers are successful because they replace a piece of what a person was obtaining from smoking cigarettes. We have discussed how some replace a certain amount of nicotine (i.e., nicotine replacement products) and others induce the same type of reduction of tension (i.e., relaxation). One of the costs involved with the abstinence of smoking is the lack of oral stimulation (Perkins, Hickcox, & Grobe, 2000). Although some may look at the alternatives of cinnamon sticks and plastic straws as simply distractions, their value as behavioral substitutes can be explained within the behavioral economic framework. Within behavioral economics it is important to understand that aspects of the behavior are important in terms of behavior ritual in addition to any reinforcing properties. For cigarette smokers it is very likely that oral stimulation has

become part of the ritual of smoking and in itself can be reinforcing because of its pairing with the positive effects of nicotine. Being able to find an alternative that can reduce this demand for smoking (oral stimulation) could help maintain abstinent behavior.

There has been one alternative to oral stimulation that has received perhaps the most attention. Cohen, Collins Jr., & Britt (1997) investigated the potential benefits of chewing gum on the effects of tobacco withdrawal. This study looking at 20 cigarette smokers who were asked to abstain from smoking in the laboratory for approximately three hours. One-half of the participants were able to chew gum during the abstinence period. Results indicated that being able to engage in chewing gum reduced craving and withdrawal symptoms during abstinence. Smokers who are unable to smoke for any given reason may use chewing gum as a way to help diminish the negative effects of withdrawal. Since chewing gum was not present concurrently with the availability of cigarettes we cannot be sure if chewing gum is a true substitute and could help reduce smoking in this environment. In order to answer that question an additional study was undertaken by Cohen, Britt, Collins, Jr., Stott, & Carter (1999). The main purpose of this study was to investigate the effects of chewing gum when participants were able to smoke. Similar methods were used as the previous study except participants in both groups (gum vs. no gum) were encouraged not to smoke and were rewarded for not smoking during the experimental session. Results revealed that the presence of chewing gum was related to a decrease in the number of cigarette puffs that were taken and increased the length of times of abstinence. This study extends the use of chewing gum as a potential tool useful for those who may be planning a decrease in their smoking habit.

Not only does chewing gum appear to minimize the withdrawal from oral stimulation, craving, and other specific withdrawal symptoms of nicotine, but it also may have other properties that can compete with cigarettes. Chewing gum, just like cigarette smoking, can be consumed socially. If this were not the case then the social draw of smoking may make it more likely that the individual will relapse to smoking. For example Hursh (1991) noted that the degree of substitutability of methadone as a substitute for heroin is diminished due to a lack in social ritual. Heroin is typically consumed in a more social manner whereas methadone must be consumed in a clinical environment isolated from the natural social context. Due to the lack of the complement of social reinforcement, methadone's value as a substitute is lowered. Chewing gum may not be considered a "social behavior" but it still remains important that it can be consumed in a social group comfortably and effortlessly as with cigarette smoking.

In addition to being social, the price of chewing gum also increases the value of this substitute. Johnson and Bickel (2003) investigated the interaction of alternate reinforcers (i.e. nicotine gum and money) to cigarette smoking. Cigarette consumption was measured alone, in the presence of one reinforcer, and then in the presence of both reinforcers. The authors noted that the price of a potential substitute (nicotine gum) for cigarette smoking could decrease its utilization due to money being a competing reinforcer. If a potential substitute costs the same amount as the original reinforcer, but has less reinforcing properties (less or no nicotine) it may be difficult for the substitute to successfully compete. Also implied in the findings of this investigation was that potential alternate reinforcers do not need to serve an identical function as the original reinforcer in order to effectively compete and replace it.

As you can see there are many reasons to consider chewing gum as a potentially useful alternate cigarette smoking. In order to understand chewing gum and its potential success within smoking behavior we will take a closer look at it

### Chewing Gum: Focus on Chewing and Flavor

It is believed that all people have at one time practiced a form of chewing for nonnutritional purposes (Hendrickson, 1976). Some forms of this behavior are very similar to what is practiced now with chewing gum such as Tasmanian people chewing natural gum from trees. There are accounts of other items being chewed such as wax, grains, string, and even tar. The sticky substance has even been said to be used as an organic insecticide, which causes the bugs to die of starvation as the gum sticks their jaws together. Not only does it appear as though the act of chewing is a behavior common among a variety of people it is also rooted in different superstitions. It is said that cannibals believe that chewing on the reproductive organs of their victims would help capture their sexual powers (Hendrickson, 1976). Moving to the chewing gum we have today, many have opinions of chewing such as using it as a substitute for eating to lose weight or in stressful situations in order to relax. The chewing gum we have now is still rooted in history as many of the flavors of chewing gum are closely related to items people were attracted to and tended to chew, such as mint leaves.

#### *Its Relevance to Nicotine*

Chewing gum has been investigated for its potential as an aid in the process of smoking cessation for those individuals dependent on nicotine. Cohen and colleagues (1997, 1999, 2001) have produced a line of research investigating the use of chewing gum on the reduction of withdrawal symptoms following brief periods of abstinence.

Results from their studies revealed that chewing gum was associated with changes in smoking behavior as well as the subjective experience of withdrawal when compared to control conditions. Their participants reported a decrease in the number of cigarette puffs that were taken, increased length of times of abstinence, and a reduction in the experience of withdrawal symptoms. This innovative line of research has shifted the focus from nicotine replacement products to other non-nicotine products that may provide some help to those attempting to quit. Finding additional sources to aid in the cessation process is extremely important especially if these products are more affordable, easily accessible, and safe for use by individuals who wish to quit or decrease their smoking habit. Due to the relative success that chewing gum has displayed with smokers there is a desire to find out more about how chewing gum can help with smoking cessation and how in fact it is able to make such an impact.

One primary questions remaining in this line of research is the determination of the active ingredient in chewing gum that helps reduce withdrawal symptoms. For instance, is it simply the act of chewing that reduces some of the withdrawal symptoms or perhaps the flavor that smokers enjoy and to which they respond? There is also the possibility that chewing gum with both components (chewing and flavor) is the most effective. Research has been conducted looking at the individual impact of chewing and flavor although they have not been investigated together with a smoking population. Some studies looking into the flavor impact of chewing gum have used brain activity and imagery in order to look at the physical impact of flavor. In one study by Yagyu and colleagues (1997) a comparison was made between flavored gum and candy. Based on blood flow to different areas of the brain the authors were able to determine that there

were no distinct differences in the way that the gum and candy affected the brain. The authors also reported that the smell and taste properties influenced the brain more so than did the act of chewing. Based on these findings the authors concluded that chewing by itself was of less importance for an individual to experience the benefits of chewing gum.

Flavor, especially sweet flavor, is believed to play a role within smoking cessation treatment. Let us first discuss a study conducted by Perkins, Epstein, Sexton, and Pastor (1990), which included women smokers being asked to remain abstinent from smoking for one week's time. During this week of no smoking it was observed that the women increased their consumption of sweets. When the women resumed their smoking habit, as part of the investigation, the consumption of sweets was reversed. The authors suggested that eating sweets during abstinence might have served as a substitute for smoking. If it were the cases that sweets were fulfilling some functional role in helping the women remain abstinent from smoking than this behavior would be a positive. Many women would probably argue that the weight gain that undoubtedly resulted from the increased consumption of sweets was not a positive. The investigation did however provide information for the potential utility of sweet products that can be utilized during cessation attempts in order to help maintain abstinence.

In another investigation also looking into temporary cessation, results demonstrated that simply providing sugar (dextrose) tablets was enough to cause a reduction in subjective craving ratings (West, Hajek & Burrows, 1990). The sugar tablets reduced craving for cigarettes in comparison to placebo tablets. This study provides more evidence that a sweet flavoring may be a useful tool during temporary cessation. The results from this study generalize the findings from the previous study to include non-

food items (i.e., tablets). In agreement with this finding, some researchers are of the opinion that the flavor of a substitute may, on its own, provide the craving reduction (Levin, Behm, & Rose, 1990). These combined results point to sweet foods as well as sweet flavors serving some positive function when individuals are attempting to abstain from smoking.

In addition to studies targeting foods or substitutes, flavor has also demonstrated its importance within nicotine replacement treatment through nicotine gum. One of the important aspects of nicotine gum is the peppery flavor, which was added as a deterrent to decrease its draw to both children and nonsmokers (Ferno, et al., 1973). Due to complications of this negative flavor such as a lack of compliance with recommended dosing, other research has been conducted in order to look at the impact of a sweet flavor for nicotine gum. One study (Houtsmuller, Fant, Eissenberg, Henningfield, & Stitzer, 2002) used nicotine gum with added mint flavoring in order to investigate its success as a treatment for smoking cessation. Results indicated that the nicotine gum with the improved flavor appeared to enhance craving reduction for cigarettes. Since sensory factors have demonstrated their affect on the subjective effects of smoking behavior. (Stolerman, Kumar, Pratt, & Reavill, 1987) it may be possible that the mint flavoring alone, without the nicotine, provided some reduction in craving. The authors were also of the opinion that flavoring added an important contribution to the reduction of withdrawal symptoms. Equally as important was the finding that this added flavoring to the nicotine gum produced no difference in terms of the gum's abuse liability among smokers. Research indicates that flavoring has a place within smoking cessation research whether it is in relation to nicotine replacement products or other substitutes for smoking. In

addition, flavoring on its own should be considered for its impact on the reduction of withdrawal symptoms such as craving.

In addition to an impact on craving, flavor appears to have influence on mood states. One study completed by Yagyu and colleagues (1998) investigated the impact of flavor on mood states by looking at the different experiences of individuals chewing flavored gum versus gum base. The authors used subjective feeling ratings as well as EEG data on brain activity. Participants were asked to chew the gum products for 5 minutes with measures obtained both pre and post chewing activity. The flavored gum used in the study contained a variety of perfumes including peppermint and lemon. Participants reported feeling more refreshed and comfortable after they had been chewing the flavored gum than after unflavored gum base. One limitation of this study was that the authors did not assess for any awareness of a taste difference or preference in either direction. The authors reported more specific results in terms of brain activity that are out of the scope of this literature review but can be surmised by saying that the brains of participants were activated in completely different ways by the presence or absence of flavor. The authors were impressed that the brain activity was not simply quantitatively different but rather showed such a functionally different response to the different conditions. In terms of mood states, the flavor of chewing gum appears to aid in its ability to produce a relaxed and uplifting effect. It appears as though the act of chewing gum as well as the flavor that may be involved, prove to be a more complex event with sensory stimulation that shows an impact on a neural level.

Up to this point in the review the focus of chewing gum has been on the flavor, or lack thereof. Another large component to chewing gum is the act of chewing itself.

Historically, there are many reasons why people chew the many objects that they chew. As has been discussed thus far, the act of chewing it is a necessary (i.e., eating) part of our lives and is a healthy and natural behavior. Chewing food and swallowing are clearly healthy behaviors in that the purpose is meant to obtain nutritional value (depending on what it consumed). However, when we chew a product that is not meant to be swallowed is this also a healthy behavior? In this case we are using the term “healthy” loosely applying to various areas in addition to physical health. Research investigating cardiovascular effects of exercise has found that (Farella, Bakke, Michelotti, Marotta, & Martina, 1999) prolonged use of chewing muscles produced not only local impact on the body but also general changes in heart rate and blood pressure. Heart rate and blood pressure increased slightly during chewing sessions. After 10 minutes of recovery from chewing participants demonstrated a higher heart rate than that of control participants. Despite the small size and movement of these muscles there is a more general impact on the body. This is important in understanding the more widespread impact of chewing and avoiding underestimating its potential impact. The question that the reader is left wondering is “what other impacts could chewing have on individuals if it is able to impact blood pressure and heart rate?”

In terms of different impacts on the body, chewing gum can be discussed in regards to its impact on emotional and cognitive well being. It is believed that chewing items such as gum, toothpicks, and even blades of grass provide some benefits such as relief from tension, boredom, loneliness, and even be an outlet for anger (Hendrickson, 1976). Hollingworth (1939) described how a variety of motor “automatisms”, such as chewing, are often explained as outlets for tension. In addition to chewing, other motor

activities such as fidgeting have been implicated as ways in which individuals relieve some tension. It would probably not come as a surprise that chewing appears to be one of the most popular motor releases of tension. One of the reasons that chewing may be more popular is its social acceptability in relation to other forms of release such as fidgeting or biting ones nails. Chewing gum especially may be viewed as more of a common occurrence than any type of “treatment” for anger or an outlet for tension (e.g., fidgeting).

In terms of the subjective experience of relaxation, chewing gum has been investigated for its calming effect. Hollingworth (1939) conducted an investigation in which individuals were followed at work under three different conditions: chewing flavored gum, having a flavored wafer dissolve in their mouth, or nothing present in their mouth. At various periods during their workday participants rated their subjective experience of strain or relaxation. Results indicated that workers experienced feeling more relaxed when chewing gum than in either of the other two conditions. Based on the experimental conditions (gum versus wafer) and the results it appears as though the act of chewing flavored products has an impact on the experience of relaxation since the chewing gum produced the most relaxation. Hollingworth went further and described an extension to the first study that changed from subjective reports of relaxation and shifted to measuring muscular tension. This study utilized the same three experimental conditions with the addition of participant’s muscular tension (at the elbow joint) being measured. These results indicated that the chewing condition again produced the largest impact by decreased muscular tension more so than the other conditions. The act of chewing a flavored piece of gum affects not only subjective ratings of relaxation but also

direct muscular tension as well. The findings indicate that chewing may produce some impacts on its own just as was seen with flavor.

One interesting hypothesis regarding the state of relaxation induced by chewing gum was given by Hollingworth (1939). The author proposed that chewing itself may be a conditioned stimulus which produces a relaxed state. It was described that the main function of chewing is in relation to food and eating. The act of eating is associated with being at rest, sitting, and even feelings of satisfaction. Thus, when an individual is chewing, even if there is no food involved, they may be experiencing the relaxation they experience when they are eating. In this way the sensory experience produced when eating would be transferred to chewing gum as well. In this case again it is the act of chewing which is thought to be the main component related to relaxation. In addition to these healthy reasons to chew gum (i.e., release of tension and relaxation), some argue for more novel benefits to gum. As with other actions, individuals use products in creative ways in order to obtain the most benefit from them. Many people have heard of the different and unique uses for chewing gum such as helping to pop one's ears when flying in an airplane or as an aid to stay awake while on a long drive (Hendrickson, 1976). One of the other uses that has been hinted at throughout the years is that chewing gum can help smokers to fight the urge for cigarettes.

Chewing gum has been discussed in terms of its two major components: chewing and flavor. Each of these components is related to different positive impacts to both smoking behavior (i.e., craving) and health in general (i.e., reduction of tension and anger, relaxation). The first of these impacts is clearly related to smoking cessation and the usefulness of chewing gum in reduction cravings that the smokers may be

experiencing. As discussed previously, some of the withdrawal symptoms that are experienced when attempting to quit or decrease nicotine intake are anxiety, irritability, and restlessness to name a few. From the studies regarding the benefits of chewing there is a clear reason to think that the act of chewing could help individuals experiencing these symptoms by producing a more relaxed state. As you can see there are many reasons to consider chewing gum as a potentially useful alternate to cigarette smoking. It would seem safe to assume that both the act of chewing as well as a sweet flavor would both be helpful for an individual attempting to quit smoking; however, another lesson that was learned through past research is that the act of chewing and flavor may be more complicated based on the neural impact and uncertainty behind the mechanisms of action. In order to understand chewing gum and its potential success within smoking behavior it is necessary to take a closer look into these two components in order to try to first determine whether one of them is more important in related to smoking cessation. Once we have this initial finding further research could focus more on determining the specific mechanisms of action in order to better equip clinicians to utilize chewing gum as an aid for smoking cessation.

With respect to chewing and flavor the importance of gender should also be considered. One study investigating chewing gum and children noted differences in the responses of boys and girls in terms of both the chewing of gum as well as the flavor preferred (Lewkowski, et al., 2003). This study looked specifically at the separate and joint impact that the action of chewing and sweet taste had on the children's ratings of pain. In boys, sweet taste combined with chewing behavior increased pain ratings. The opposite finding was true for girls where sweet taste with chewing behavior decreased

pain ratings. Sweet taste on its own without the addition of chewing behavior decreased pain ratings. Taking these gender differences into account, it may be that due to differential responses there will also be differential impacts on the effects that are of most concern to the individual (i.e., relaxation, reduced craving). Investigating the utility of each component across genders will also provide valuable information that will inform treatment. This is important given that women smokers have less success than men at quitting smoking and may be at greater risk from smoking-related illnesses (Perkins, 2001).

Thus, there are many reasons to consider chewing gum as a healthy alternate to cigarette smoking. It would appear that research supports both the act of chewing as well as sweet flavor as potentially helpful components in cessation packages. In order to understand chewing gum and its potential success within smoking behavior across genders, it is necessary to take a closer look at these two components in order to try to determine which of these components in isolation or in combination is more important in relation to smoking cessation. The purpose of this study, therefore, is to investigate the two components of chewing gum in a smoking population in order to better understand how chewing gum is impacting smokers' withdrawal experiences. This investigation will use flavored chewing gum, flavorless gum base, and flavor strips in order to tease apart the actions of chewing, flavor, and the combination of both in order to better understand this process.

## APPENDIX B

### Consent for Participation

Consent Form  
Texas Tech University  
Department of Psychology

You are invited to be a participant in a research project investigating cigarette smoking and chewing gum. The purpose of the study is to examine the reactions of cigarette smokers to chewing gum when they are not smoking. The results of this study may help in the treatment of cigarette smokers. Dr. Lee Cohen of the Department of Psychology at Texas Tech is in charge of the study. His phone number is 742-3711, ext. 236. You can also contact Monica Cortez-Garland, who is responsible for carrying out the procedures for the study at 742-3711, ext. 233.

### EXPLANATION OF STUDY SESSIONS

In addition to today's brief session (about 30 minutes), this study will consist of four sessions each lasting approximately 15 minutes. If you agree to participate you will be asked to abstain from cigarette smoking for twenty-four hours before you come into the research laboratory. During that twenty-four hour period you will be asked to consume a product we will provide to you at specific times during the day. In addition, you will be asked to refrain from consuming alcohol the night before each experimental session. Furthermore, you will be asked to provide an expired air sample each day that you participate in the study, which will provide biochemical evidence of your abstinence. Therefore, if you are unable to maintain abstinence for the full-24 hour period, you are encouraged to reschedule your experimental session (without penalty).

### RISKS

Although there are no anticipated risks for participants in this study, you may experience some mild discomfort due to symptoms of withdrawal during the 24-hour abstinence periods.

### BENEFITS

If you are enrolled in PSY 1300, you will receive an equivalent amount of research credit (1 point per research hour) for the amount of time you participate in this research that will count toward your Introduction to Psychology requirement. Other benefits that you may expect as a participant in this study include becoming more familiar with your cigarette smoking habit (including the experience of 24 hours of abstinence), which will help you if you decide to quit smoking cigarettes in the future.

### CONFIDENTIALITY

All information obtained during the study will remain confidential. Records will be coded by number only and your name will not appear on any forms other than

this consent form. No one but Dr. Lee Cohen, Monica Cortez-Garland, and their research assistants will see your answers. They will be kept in a locked file cabinet at Texas Tech in the behavioral pharmacology laboratory.

**YOUR RIGHTS & INFORMATION ABOUT YOUR CONSENT**

Your participation in this study is completely voluntary and you may discontinue participation at any time without consequences. If you decide to discontinue participation you will receive research credit for each session, or portion of a session, you have completed. If you would like to discontinue participation in the study, notification by phone or in writing to either Monica Cortez-Garland or Dr. Lee Cohen is sufficient. The research staff may discontinue your participation in this study at any time if you fail to attend three (3) sessions without prior notification, such as a phone call or voicemail message to the laboratory.

Dr. Lee Cohen or Monica Cortez-Garland (742-3711, ext. 233) will answer any questions you have about the study. For questions about your rights as a subject or about injuries caused by this research, contact the Texas Tech University Institutional Review Board for the Protection of Human Subjects, Office of Research Services, Texas Tech University, Lubbock, Texas 79409. Or you can call (806) 742-3884.

I certify that I am (please check one):

18 years of age or older

under age 18 and have presented the appropriate Parental Consent

form to

the experimenter

(initials of experimenter, verifying inspection of appropriate parental

Consent form)

If you sign this sheet, it means that you read this form and that all of your questions were answered. A copy will be given to me for future reference.

\_\_\_\_\_  
Printed name



\_\_\_\_\_  
Signature of Subject

\_\_\_\_\_  
Date

This consent form is not valid after January 31, 2006.

APPENDIX C

Community Recruitment Flyer

 <p><b>Are you a smoker?</b></p> <p>A study is being conducted within the Department of Psychology at Texas Tech University. If you complete the study your name will be automatically put in a raffle for several prizes:</p> <p><b>One \$75 Prize!! Two \$50 Prizes!!</b></p> <p>For more information, please call</p>	 <p><b>Are you a smoker?</b></p> <p>A study is being conducted within the Department of Psychology at Texas Tech University. If you complete the study your name will be automatically put in a raffle for several prizes:</p> <p><b>One \$75 Prize!! Two \$50 Prizes!!</b></p> <p>For more information, please call</p>
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APPENDIX D

Measures  
General Habits Questionnaire

Subject # \_\_\_\_\_

1. What is your age? \_\_\_\_\_
2. What is your gender? \_\_\_ Male \_\_\_ Female (check one)
3. What is your ethnic background/race?
  - a. Asian
  - b. Black
  - c. Hispanic
  - d. Native American
  - e. White (Non-Hispanic)
  - f. Other : Please specify \_\_\_\_\_
4. How many cigarettes per day do you smoke? \_\_\_\_\_
5. On an average week, how many cigarettes do you smoke? \_\_\_\_\_
6. Why do you smoke (Circle all that apply)
  - a. To relax
  - b. To relieve boredom
  - c. To concentrate
  - d. To keep awake
  - e. To relieve stress
  - f. To lift your mood
7. How often do you chew gum?
  - a. Every day
  - b. A few times a week
  - c. A few times a month
  - d. A few times a year
8. If you always chew stick gums (Extra, Big Red, etc.), how many sticks of gum do you normally chew at the same time?
  - a. Less than one
  - b. One
  - c. More than one

9. If you always chew pellet gum (Eclipse, Air Waves, etc.), how many pellets of gum do you normally chew at the same time?

- a. Less than two
- b. Two
- c. More than two

10. For how long do you usually continuously chew a gum?

- a. Less than 15 minutes
- b. 15 – 30 minutes
- c. 30 min. – 1 hour
- d. Greater than 1 hour

11. Which type of gum do you chew frequently? (Circle all that apply)

- a. Sugarless (Extra, Eclipse, Orbit)
- b. Sugared (Juicy Fruit, Double Mint, Winter Fresh)
- c. Bubble gum
- d. Others \_\_\_\_\_

12. What do you primarily use gum for? (Circle all that apply)

- a. To freshen breath
- b. To relieve boredom
- c. To keep your mouth busy
- d. To relax
- e. To enjoy
- f. To avoid eating when hungry
- g. To avoid smoking
- h. To keep awake
- i. Other \_\_\_\_\_

13. What time do you normally chew gum?

- a. Morning
- b. Afternoon
- c. Evening
- d. Nighttime

14. What aspects of gum do you enjoy? (Circle all that apply)

- a. Sweetness
- b. Flavor
- c. Chewing
- d. Texture

Subject # \_\_\_\_\_

Date: \_\_\_\_\_

**FTND**

Please circle the most appropriate response to each of the questions below:

1. How soon after you waking do you have your first cigarette?  
Within 5 minutes  
6—30 minutes  
31—60 minutes  
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  
No
  
3. Which cigarette would you hate most morning to give up? the day  
The first one in the  
Any other cigarette of
  
4. How many cigarettes per day do you smoke?  
10 or less  
11—20  
21—30  
31 or more
  
5. Do you smoke more frequently during the first hours after waking than during the rest of the day?  
Yes  
No
  
6. Do you smoke if you are so ill that you are in bed most of the day?  
Yes  
No

Subject # \_\_\_\_\_

Date: \_\_\_\_\_

Time: \_\_\_\_\_

Product: A B C

**Withdrawal Symptom Checklist**

Directions: Please rate (circle) the level of your **current** withdrawal symptoms.

	NOT PRESENT	MILD	MODERATE	
SEVERE				
1. Craving	0	1	2	3
2. Irritability	0	1	2	3
3. Anxiety	0	1	2	3
4. Difficulty Concentrating	0	1	2	3
5. Restlessness	0	1	2	3
6. Headache	0	1	2	3
7. Drowsiness	0	1	2	3
8. Intestinal Disturbance	0	1	2	3
9. Fatigue	0	1	2	3
10. Impatience	0	1	2	3
11. Hunger	0	1	2	3
12. Insomnia	0	1	2	3

Please list any somatic (bodily) difficulties you are currently experiencing (i.e. sweating, dizziness, nausea).

1. \_\_\_\_\_ 2. \_\_\_\_\_

3. \_\_\_\_\_ 4. \_\_\_\_\_

Have you noticed any changes since your last cigarette? Yes No

If yes, what have you noticed? \_\_\_\_\_

\_\_\_\_\_

Product Monitoring Form

Subject # \_\_\_\_\_

Date: \_\_\_\_\_

Product:    A     B     C

- 1) When you wake up: Time \_\_\_\_\_ am/pm    # of pieces/strips used \_\_\_\_\_    Length of time \_\_\_\_ min
- 2) Breakfast:                    Time \_\_\_\_\_ am/pm    # of pieces/strips used \_\_\_\_\_    Length of time \_\_\_\_ min
- 3) Lunch:                            Time \_\_\_\_\_ am/pm    # of pieces/strips used \_\_\_\_\_    Length of time \_\_\_\_ min
- 4) Dinner:                            Time \_\_\_\_\_ am/pm    # of pieces/strips used \_\_\_\_\_    Length of time \_\_\_\_ min
- 5) Bedtime                            Time \_\_\_\_\_ am/pm    # of pieces/strips used \_\_\_\_\_    Length of time \_\_\_\_ min

List any additional uses:

- Time \_\_\_\_\_ am/pm                    # of pieces/strips used \_\_\_\_\_                    Length of time \_\_\_\_ min
- Time \_\_\_\_\_ am/pm                    # of pieces/strips used \_\_\_\_\_                    Length of time \_\_\_\_ min
- Time \_\_\_\_\_ am/pm                    # of pieces/strips used \_\_\_\_\_                    Length of time \_\_\_\_ min
- Time \_\_\_\_\_ am/pm                    # of pieces/strips used \_\_\_\_\_                    Length of time \_\_\_\_ min
- Time \_\_\_\_\_ am/pm                    # of pieces/strips used \_\_\_\_\_                    Length of time \_\_\_\_ min

***Total Number of Pieces Chewed for the 24 hr period:***                    \_\_\_\_\_