EVALUATING THE ROLE OF CHEWING GUM AS A SUBSTITUTE REINFORCER FOR NICOTINE

BY

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Introduction

Each year cigarette smoking contributes to over 400,000 deaths (American Cancer Society [ACS], 1997). In 1996, one hundred and seventy thousand lives were lost to tobacco-related cancer, accounting for more than one in every six deaths in this country (ACS). Cigarette smoking precipitates eighty-six percent of lung cancer deaths (Department of Health and Human Services [DHHS], 1990) and smokers are ten times more likely to develop lung cancer than non-smokers (DHHS, 1990). Cigarette smoking is also a major contributor to coronary heart disease, malignant neoplasms, and stroke (DHHS, 1988).

Despite the fact that smoking continues to be the number one preventable cause of death (DHHS, 1990), at least 53 million Americans continue to smoke cigarettes (Pierce, Fiore, Novotny, Hatziandrea & Davis, 1989). Many smokers struggle with quitting. A variety of programs have been established to aid smokers wanting to end their addiction. These programs have included a variety of behavioral and pharmacological interventions. Success rates vary from program to program; however, less than 1 in 10 smokers will succeed in quitting (Kessler, 1994).

In an attempt to increase the number of people that can quit smoking and stay quit, researchers interested in cessation methods have begun to explore treatment alternatives from a number of theoretical perspectives. One area that has begun to receive substantial support in the substance abuse literature is behavioral economic theory. Current research from the field of behavioral economic has been applied to a variety of drugs that include cocaine, caffeine, heroine, morphine, and nicotine (for a complete review see Bickel, DeGrandpre, & Higgins, 1995; Bickel, Higgins, & Hughes, 1991; Cohen, Collins, & Britt, 1997). Recent investigations have focused on the application of specific behavioral economic principles to understanding the environmental contingencies that influence consumption of nicotine (e.g., Cohen et al., 1997; Cohen,

Britt, Collins, Stott, & Carter, 1998). These studies provide evidence suggesting that behavioral economic theory can adequately describe the reinforcing properties of nicotine consumption and the influence of alternative reinforcers, such as non-nicotine chewing gum, to reduce craving and withdrawal symptoms.

The present paper further examines withdrawal and craving reduction for smokers using non-nicotine chewing gum, but extends the analysis to investigate the reinforcement contingencies for chewing gum as an alternative to smoking. The paper first reviews the principles of behavioral economics to provide a conceptual framework to explain the basis for research in this area. Behavioral economic theory is discussed in relation to drug consumption in general and to nicotine consumption more specifically. Second, the reinforcing properties of nicotine and the role of withdrawal symptoms resulting in alteration in nicotine consumption will be examined. Third, issues associated with nicotine replacement methods and a discussion of the reinforcing qualities of chewing gum are also discussed. Finally, a study is presented which incorporates behavioral economic principles into an examination of the reinforcing property non-nicotine chewing gum on smoking behavior.

Behavioral Economics Theory

Concepts used in the field of behavioral economics have been applied to drug self-administration. This area of research focuses on changes in drug consumption as a result of environmental conditions (Bickel et al., 1995). Behavioral economics applies microeconomics, specifically consumer demand theory (Hursh, 1993), to the experimental analysis of behavior (Hursh, 1980). Economics is valuable to understanding behavioral concepts used in psychology and is based on (1) empirical validity when tested in the laboratory with individual subjects and (2) utility when compared to established behavioral concepts (Hursh, 1984). The field of behavioral economics is extensive and a full description is beyond the scope of this paper. However, several concepts are critical for a basic understanding and will be addressed in the following sections.

Law of Demand

The relationship between reinforcer cost and consumption is best explained by the Law of Demand. Hursh (1980) states that the behavior of the individual is ideally a balance, or equilibrium, between the supply of a commodity and consumer demand. Specifically, how much soda will people drink at a certain price versus how much soda will be produced at that same price. One important determiner of equilibrium in behavioral economics is the demand curve. This is defined as the amount a person will consume at a given price, for a given rate of consumption (Hursh, 1980). The law of demand states that as the cost of a commodity increases, consumption decreases (Samuelson & Nordhaus, 1985). Therefore, according to the law of demand, a person who likes pizza will decrease consumption as the price goes up. In a real-world situation, the law of demand is influenced by outside factors and a perfect relationship rarely exists. Rather, this basic rule of economics is influenced by the level of reinforcement for certain substances or commodities. To illustrate, if a commodity has a high reinforcement value and the cost of that commodity increases, consumption of the highly valued commodity will decrease less relative to consumption of a commodity that is considered less reinforcing.

Elasticity. One term used to explain when certain substances are consumed based on their reinforcement value is elasticity of demand, or the degree to which consumption decreases as response requirement, or price, increases (DeGrandpre, Bickel, Hughes, & Higgins, 1992). A highly elastic commodity would decrease consumption greatly as the price of the commodity increases. Products with high elasticity are those that are considered luxuries and are more likely to be given up when the cost gets high. Not all products are considered elastic and their consumption may decrease very little even when the price continues to increase. These substances are termed inelastic and apply to products that are considered necessities. One example is gasoline; even though the price of gasoline may greatly increase, very little change in the amount of consumption is

noticed. It is important to note that the difference between elastic and inelastic reinforcers is not absolute and exists on a continuum. At the same time, all reinforcers will results in decreased consumption when the price is adequately raised (Hursh, 1993).

To understand the difference between these types of reinforcers, some theorists have proposed a point of transition between the inelastic and elastic demand called the P_{max} (Hursh, 1993). The P_{max} coincides with the peak responses an organism produces on a demand curve. In other words, an organism will produce a response rate at a level that allows it to receive the reinforcer, and then, at the P_{max} will significantly decrease the amount of work it is willing to perform for the commodity. When the P_{max} occurs at lower prices, the commodity is considered to be more elastic.

Total Daily Consumption and Unit Price. The concepts of total daily consumption and unit price also are used to assess commodity demand. Total daily consumption is the "weight of the drug per day adjusted for the weight of the subject", allowing the total amount consumed to serve as a control while considering the effects of dose (Hursh, 1993). Total daily consumption can be further defined as the number of response requirement completions multiplied by the reinforcer magnitude, equaling the total amount consumed (Bickel, DeGrandpre, Higgins, & Hughes, 1990). Thus, the total daily consumption calculation provides for a standardized value to compare across individuals despite varying dosage levels and individual weights.

Another important term related to demand is unit price. Unit price is defined as the cost-benefit ratio that sets the amount of effort required for each unit of reinforcement (Hursh & Winger, 1995). Unit price can be thought of as the response requirement divided by the reinforcer size (Hursh, Raslear, Shurtleff, Bauman, & Simmons, 1988). Using a common unit price allows comparison of demand across doses of the same drug and amount of work required to receive a certain amount of the drug. For example, if ten responses are required for five puffs of a cigarette, the unit price would be two. However,

if twenty responses are required for ten puffs on a cigarette, the unit price would still be two.

The presence of more than one reinforcer can result in several responses. Substitutions, complements, and independent interactions exemplify the functional relationship between consumption of one commodity and the price of another (Hursh, 1993). If the consumption of commodity A increases with price increases of B, commodity B will be a substitute for A. For example, if Coke serves as a substitute for Pepsi, the consumption of Coke will increase as the cost of Pepsi increases. Another concept related to secondary commodities is a complement. When consumption of one commodity decreases with increased cost in another, the first is said to be a complement of the other. For example, if syrup serves as a complement to pancakes, we would expect a decrease in syrup consumption as the cost of pancakes goes up. Finally, if there is no consistent relationship between the consumption of commodities, they are said to be independent. These relationships can be used to understand how different commodities interact and have been used to understand the reinforcement of different drugs. Understanding how drugs either serve as substitutions, complements, or are independent of each other can allow interventions and response prevention when attempting to modify drug-taking behavior.

Application of Behavioral Economics to Drug Administration

Drug self-administration has incorporated the economic concepts of demand elasticity and unit price (Bickel et al., 1990). Current research has evaluated the ability of different drugs to act as substitutes, complements, and independent reinforcers (Bickel, DeGrandpre, & Higgins, 1995). Certain substances have properties that allow for

substitutability. For example, ETOH has been shown to serve as a substitute for PCP (Carroll, 1987). Therefore, when PCP consumption is limited, ETOH consumption will increase. It appears that although substitution can occur between commodities, the response is not always bi-directional. For example, PCP does not serve as a substitute for ETOH (Carroll, 1987).

Preference for drug self-administration also changes in relation to alternative reinforcers (Carroll, 1985). Specifically, with concurrent access to both phencyclidine and saccharin, a decrease in drug self-administration can be seen when the concentration of saccharin is increased. Alcohol and drug consumption may also vary inversely with the presence of alternative reinforcers even in individuals with a previous physical dependence to the drug (Samson et al., 1983; Vuchinich & Tucker, 1988). A decrease in alcohol or drug consumption is expected when increasing constraints exist for access to the drug. However, when alcohol consumption is a single reinforcer within several, decreased access to other reinforcers can expect an increase in alcohol consumption (Vuchinich & Tucker, 1988). These findings show that substitutes may be a viable alternative, especially when the price for alcohol or drugs increases. In addition, substitutable reinforcers may act as a deterrent for continued drug use, even in dependent individuals.

When comparing two drugs directly, differences in dose and potency must be accounted for to properly compare changes in elasticity. Elasticity is seen as a function of properties of the specific drug. A variety of substances have been used to examine demand curve analysis; however, there are concerns about directly comparing different drugs. To prevent the previous confounds of varying drug does and potencies when using

more than one reinforcer, Hursh and Winger (1995) developed a formula that has successfully normalized demand-curve analysis. This formula facilitates dose and potency-independent results that can be used to compare different drugs. One application of this procedure is to compare effectiveness of interventions for substitutes that is independent of shifts in magnitude.

Behavioral Economics and Nicotine

The principles of behavioral economics, particularly demand-curve analysis, have been applied to the study of nicotine for several reasons. First, nicotine dependence shares many features with other drugs of dependence. It shares many of the withdrawal symptoms including anxiety, difficulty concentrating, impatience, and restlessness (Hughes, Higgins, & Bickel, 1994). Among other effects, nicotine also is time-limited, is influenced by instructions/expectancy, and withdrawal can be effected by replacement therapy. The major differences between nicotine, and sedative and opioid withdrawal syndromes are nicotine's resulting decline in heart rate, increased eating and weight, and the absence of readily observable physical effects (Hughes et al., 1994). Although there appears to be many symptoms that are similar, much research needs to be performed to understand the extent to which nicotine both resembles and is different from other drugs of dependence.

Studies on human cigarette smokers have shown that varying combinations of nicotine dose (e.g., 1, 2 or 4 puffs), all with the same unit price, has little or no effect on the amount of work produced to receive nicotine or nicotine consumption. However, as unit price increases, nicotine consumption decreases (Bickel et al., 1991). Additional studies have also suggested that a shift in the P_{max} (i.e., the point of greatest consumption at the highest price before a decrease in consumption) occurs with the availability of money (simulation of employment) and the ability to engage in recreational activities (simulation of recreation; Bickel et al., 1995). Thus, there is evidence to suggest that cigarette smoking decreases as unit price increases, and at high prices the availability of a

substitute reinforcer decreases nicotine consumption. These findings also suggest that the mere presence of a substitutable reinforcer, despite the specific properties of that reinforcer, will decrease drug-seeking behavior for the commodity at high prices (Bickel et al., 1995). In general, it appears that people will continue to smoke until the price for consumption reaches its highest point before consumption decreases (P_{max}), and that any available alternative may lower the point at which this transition occurs.

Although there is reason to suspect that alternative reinforcers for smoking exist, it is important to point out that smoking may be maintained not only by environmental contingencies, but by nicotine's direct physiological influence as well. The following sections briefly review the literature on the reinforcing properties of nicotine from both smoking and from nicotine gum.

Reinforcing Properties of Nicotine

Smoking

Smoking behavior is at least partially maintained by the reinforcing properties of nicotine. Although the reinforcing qualities differ across persons, effects can also include mood control agents when individuals are over-excited or anxious, the ability to decrease fatigue and drowsiness, to suppress appetite, and reduce irritability (Mangan & Golding, 1984). Nicotine enhances the release of neurotransmitters that produce arousal and activate the sympathetic nervous system (Klesges, Benowitz, & Meyers, 1991). Continued smoking has also been related to increases in problem-solving abilities, improvement in selective attention and reaction time, and mood-lifting effects (DHHS, 1988).

With continued smoking, users develop a substantial tolerance to the arousing effects (Benowitz, Porchet, & Jacob, 1989) and experience significant withdrawal symptoms when the nicotine is removed (Goreczny, 1995). Research often focuses on smokers that smoke one pack (20 cigarettes) or more per day for at least one year (Zelman, Brandon, Jorenby, & Baker, 1992; Killen, Fortmann, Kraemer, Varady, &

Newman, 1992) and accordingly rates these smokers on their level of dependency. Heavy smokers that have difficulty abstaining, have a high tolerance to nicotine, and experience increased withdrawal when deprived from nicotine, are seen as highly dependent (Killen, Fortmann, Newman, & Varady, 1990).

Dependent smokers will often continue to smoke to avoid withdrawal. Although the sensations experienced by smokers can vary by person, typical symptoms are experienced. Tobacco withdrawal includes irritability, anxiety, difficulty concentrating, restlessness, weight gain, depressive symptoms, anger, frustration, increased heart rate, and insomnia (American Psychiatric Association, 1994). Smokers tend to maintain a certain level of nicotine in their blood through self-administration that will eliminate the most withdrawal symptoms and increase personal comfort (Benowitz, 1988). The use of nicotine chewing gum has been found to reduce withdrawal in dependent smokers and will be discussed in the following section.

Nicotine Chewing Gum

Recent trends in treatment of nicotine dependence have focused on nicotine replacement therapies (Hajek, 1994). Nicotine replacement is based on the idea that smoking behavior is maintained primarily by pharmacological reinforcers and conditioned cues rather than by the smokers psychopathology (Hajek, 1994). These replacement systems are designed to systematically reduce nicotine over time and unlink smoking behaviors (Lewis, 1994).

Pharmacological treatments for smoking cessation have included a variety of methods using nicotine replacement. These include intravenous administration, oral capsule, nasal spray, and across the skin in the form of patches (Jarvik & Henningfield, 1988). Of these, nicotine gum was the first nicotine replacement form (Fagerstrom, 1994) and has been found to be very effective in reducing tobacco withdrawal and aiding smoking cessation (Jarvik & Schneider, 1992).

Nicotine gum has been found to reduce anxiety, tenseness, difficulty concentrating, restlessness, impatience, somatic symptoms, insomnia, increased eating and drowsiness in women smokers (Hatsukami et al., 1991). These results were comparable to male self-quitters (Hughes, Gust, & Pechack, 1987). Studies have shown nicotine chewing gum to be effective when combined with group therapy (Basler et al., 1992), and with other intensive treatment strategies (Cepeda-Benito, 1993).

Research focusing on withdrawal from nicotine and use of nicotine gum with a placebo show total withdrawal for the nicotine gum group steadily decreased for the entire 10-week treatment duration. Subjects in the placebo group showed an increase at first in withdrawal, and then a steady decrease. Nicotine gum has not been shown to be effective in reducing craving (Gross & Stitzer, 1989; Hughes, 1984; Schneider & Jarvik, 1984; West et al., 1984). Although nicotine gum use in smokers clinics has shown an increase in those able to stop smoking for a year, in general medical practice, there is no evidence that nicotine gum showed more improvement over placebo (Foulds, 1993).

Nicotine gum has been found to serve psychological functions that include stress control, stimulation/alertness, feelings of pleasure, and psychomotor gratification (Parrott & Craig, 1995). Although these results suggest that nicotine gum may have some function, psychological gains may be resulting from the quitters ability to regulate the withdrawal symptoms.

Although there appears to be some gains with the use of nicotine gum, it is not clear to what extent the withdrawal and craving symptoms can be modified with chewing gum that does not contain nicotine. The following section reviews evidence suggesting that chewing non-nicotine gum can serve as a substitute reinforcer for nicotine.

Chewing Gum

The impact of chewing gum on the American culture can be seen in the extensive number of people that chew gum, as well as the many advertisements and billboards that exist. It is approximated that fully half of Americans chew gum (Hendrickson, 1976).

Although no reasons for chewing gum have been proven, several ideas exist. A panel of psychiatrists and psychologists proclaim the number one reason is relief from feelings of loneliness and boredom. This is followed by a release of nervous energy and finally a socially acceptable outlet for anger and irritation. Other benefits from gum chewing include, among others, alleviating thirst and hunger, keeping drivers alert and helping deter smokers from smoking (Hendrickson, 1976).

Preliminary evidence exists for the relaxing effects of chewing gum. The idea that chewing is associated with eating, and relaxing behaviors are conditioned to eating, allows a person to feel relaxed when engaging in chewing behaviors (Hollingsworth, 1939). The stimulation of the jaw muscles while chewing gum may account for the connection to emotional responses. The facial muscles have been connected to an emotional output system (Dimberg, 1988) and it has been suggested that if the movement of facial muscles in smoking is reinforced positively, than smoking behavior may be continued (Cohen, 1996). Because commodities have been found to serve more effectively as substitutes when they share similar properties and effects (Hursh & Bauman, 1987), chewing gum should serve as an effective substitute for smoking, based on the similar stimulation of facial muscles, and other oral stimulation.

Chewing gum has been found to serve as a substitutable reinforcer in situations where smoking is not permitted (e.g., a movie theater; Cohen et al, 1997). Two studies have been conducted examining chewing gum as a substitute for smoking. Results from Cohen et al. (1997) have shown that in a simulated movie setting, when chewing gum was available in place of smoking, subjects had significant drops in craving and overall withdrawal. Reduction of specific withdrawal symptoms was not shown, possibly due to the individual differences in smoking withdrawal. All subjects showed an increase in withdrawal during the session; however, subjects with chewing gum available showed significant reductions in overall withdrawal. One notable difference is that for smokers without available chewing gum, craving increased.

Cohen et al. (1998) replicated conditions in Cohen et al. (1997) where participants were given both cigarettes and chewing gum; however, they were rewarded for not smoking. Results from Cohen et al. (1998) showed that participants who had gum available waited significantly longer before taking their first puff than participants in the no-gum condition. Also, subjects in the gum condition took significantly fewer puffs than those in the no-gum condition. The difference in number of cigarettes smoked was not statistically significant, although results exhibited a trend for participants in the gum condition to smoke fewer cigarettes.

The Present Study

The present study represented an extension of the Cohen et al. (1997, 1998) studies and examined both the reinforcement value of nicotine in dependent smokers and the ability of chewing gum to serve as a substitute reinforcer for smoking. Unlike previous studies, however, the present investigation varied the cost (i.e., response demand) for smoking across both gum and no-gum conditions. Utilizing principles of behavioral economics theory as a guide, the present study incorporated two primary goals: (1) to replicate the findings of previous studies demonstrating fixed-ratio schedules for nicotine consumption; and (2) to determine response contingencies for non-nicotine gum as a substitutable reinforcer for smoking.

Method

Participants

Six dependent smokers were recruited from introductory psychology classes and the Oklahoma State University college community at large. All eligible participants were given extra credit for their participation. All participants were given entrance into a $50 lottery for their participation. The lottery was conducted at the end of the semester and following the final session for all participants. All subjects gave written consent prior to their participation in the study. Participants were in good health and were not addicted to

any other drugs but nicotine. The mean age for the six participants was 21.67 years (SD = 3.08) with a range in age from 18 – 27 years. All participants served as their own control for each condition. Each participant smoked at least one pack of cigarettes per day and the mean length of time smoked was 6.83 years (SD = 4.67). At the time of the study no participants were attempting to quit smoking and continued to smoke at their usual rate throughout the course of the study. All participants scored at least a 4 on the Fagerstrom Tolerance Questionnaire, a self-report measure of nicotine dependence (Fagerstrom & Schneider, 1989) and had at least a score of 12 ppm of alvelar carbon monoxide (COa) in a breath sample at the initiation of each session.

Alvolar carbon monoxide (COa) is an indirect measure of smoking history. Smoking levels are typically at or above 12 parts per million (ppm) for smokers. All smokers obtained levels of at least 12 ppm after smoking the initial cigarette and before the initiation of each session of the study.

Apparatus

Aloveolar Carbon Monoxide (COa). Alvelar carbon monoxide (COa) measures were taken to exclude nonsmokers from the study and to measure COa boost following cigarette smoking. Samples of each participants' breath were obtained using a Vitalograph BreathCOa monitor (Model 29.700). Each participant was asked to hold their breath for 30 s, then to exhale half of their breath away from the monitor and to exhale the remaining air in their lungs into the monitor. A sterile mouthpiece was used for each session. Timing of inhaling and exhaling during COa was timed using a second-hand watch. The final digital reading on the monitor comprised the measure.

When participants chose to earn puffs, they depressed a metal plunger that was connected to a lighted box with three lights. A green light indicated that the apparatus was ready for the participant to begin pressing, a red light, also accompanied with a buzzer, indicated the end of the schedule, and a blue light was presented each time the participant depressed the plunger.

Setting

When participants arrived, they were escorted to an isolated 5' X 12' room where they were allowed to smoke. Each session was conducted in a second, isolated 5' X 12' room with the apparatus on a table in the center of the room. Subjects were observed from a one-way mirror in both rooms during the experiment. All subjects were given access throughout the session to newspapers, magazines, or books to read when not responding.

Procedure

Participants were involved in seven sessions lasting approximately three hours for each session. Sessions were conducted twice a week with at least one day between each session. The first session was to familiarize the participant with the apparatus and the laboratory setting, while clarifying the study and time requirements. The initial session lasted approximately one hour for all participants. Participants entered the room and were given a measure of their alveolar carbon monoxide (COa). Approximately ten minutes before the start of the session a uniform cigarette was given to each participant to ensure comparable pre-session nicotine exposure. A time line is listed in Appendix A to demonstrate the time for each event upon arriving to participate in the study. Upon entering the room where earning was available, participants were then allowed to read

magazines or play a computer game of solitaire. During this initial session, two puffs of a cigarette were given after 200 responses on the lever press. Upon completion of the response requirement, participants were given a five-minute inter-trial interval to use their puffs. Participants earned two puffs for every completion of the response requirement. All puffs were used during the five-minute inter-trial interval used immediately after each schedule completion. During the sessions of the study that were gum conditions, participants were required to chew a piece of gum immediately following the second COa reading. Each participant was asked to remove the piece of gum before smoking their earned puffs and then chew a new piece of gum immediately following the smoking of the earned puffs. Following the pieces that the participants were asked to chew, they were told they could chew as much or as little gum as they would like throughout the course of the study.

The following six sessions (three with chewing gum and three with no chewing gum) were conducted in a similar fashion as the practice session. Each session was conducted on a fixed-ratio schedule that systematically varied the response requirement order for each subject across sessions. Response requirements were set at 400 (low), 800 (medium), and 1600 (high) for both gum and no gum conditions. Subjects completed the three schedules under both the chewing gum and no chewing gum conditions. Using a within subject design, each subject was randomly assigned to begin in either gum or no gum conditions. Subjects remained at the same schedule for the entirety of each session. At the beginning of each session, the subject was told the amount of work required to earn two puffs, and the response requirement for the session (i.e., 400, 800, or 1600 presses) was displayed on a 2" x 3" laminated card.

Measures

The Nicotine Abstinence Scale (NAS) is a 15-item self-report questionnaire that assesses the eight DSM-IV symptom areas for nicotine withdrawal (e.g., depression, irritability, anxiety, etc.) and five additional non-diagnostic items (i.e., craving, headache, stomach pain, fatigue, and impatience). Participants are asked to, "Please rate the degree to which each of the following descriptive words applies to you at this moment." Responses range from 0 (None) to 3 (Severe); items 2 through 14 are summed to yield an overall withdrawal score. Item 15, a yes/no question measuring difficulty sleeping, was not added into the overall withdrawal score.

Craving is measured by item 1 on the NAS. Responses range from 0 (None) to 3 (Severe), indicating the level of craving for a cigarette. Although craving is not currently listed as a criterion item for DSM-IV nicotine withdrawal, it has been shown to be one of the most common signs of tobacco abstinence (Hughes & Hatsukami, 1986) and has been shown to be a reliable predictor of smoking relapse (Covey, Glassman, & Stetner, 1990). For these reasons, craving and its associated symptoms were incorporated into the present study.

Hypotheses

Hypothesis 1: It is anticipated that as the unit price of cigarette puffs increases, the number of puffs on a cigarette to earn puffs will decrease. Similarly, the mean latency to the first puff taken will increase significantly as the unit price for cigarette puffs increases.

Hypothesis 2: It is anticipated that the 1600 fixed-ratio response schedule will be significantly lower in number of puffs earned than both the 400 and 800 response requirements. It is also expected that the mean latency to the first puff will be significantly longer for the 1600 fixed-ratio response schedule than for both the 400 and

800 response schedules. Thus, regardless of gum condition, smoking responses will decrease substantially under conditions of high response demands. Also, a delay in smoking is expected under conditions of high cost regardless of gum condition.

Hypothesis 3: It is anticipated that the greatest difference in puffs taken between gum and no gum conditions will be observed at the 1600 fixed-ratio response schedule. Similarly, the greatest difference in mean latency to the first puff will be observed at the 1600 fixed-ratio response schedule. Thus, as unit price increases an even greater decrease in smoking should be observed under gum conditions.

Hypothesis 4: Since it is expected that as cost increases, consumption decreases; and withdrawal is linked to consumption, it is anticipated that as cost increases, withdrawal should increase as well. The same effects are expected for craving levels. The addition of gum is not expected to effect these patterns.

Results

Results were first graphed and visually examined (see Appendices B - H). Repeated measures analysis of variances (ANOVA) and paired comparisons t-tests were used to test Hypotheses 1 through 4 and several exploratory hypotheses. The primary analyses are described in detail under Hypothesis 1; Hypotheses 2, 3 and 4 were tested using these same analyses. Separate analyses were used to test exploratory hypotheses.

Hypothesis 1:

a. Figure 1 (Appendix B) presents mean number of puffs earned by condition. It was anticipated that for both conditions, as price increased, consumption would decrease (e.g., the Law of Demand). Performance in the no gum condition was consistent with the

Law of Demand; however, for the no gum condition, participants' number of puffs earned remained constant across varying levels of cost.

A repeated measures 2 X 3 (condition X cost) ANOVA was performed for number of puffs earned at each condition and level of cost. No significant differences were revealed for the main effects of cost, condition, or cost by condition (p's ranging from .098 to .363). Although the ANOVA was not significant, this was to be expected based on the small number of participants and subsequent low power. Therefore, paired samples t-tests were performed to test differences in the specific means. Table 1 (Appendix I) represents the means for the varying levels of cost and condition. Paired samples t-tests for each condition (gum and no gum) at each level of cost (400; 800; 1600) were performed to test for differences in number of puffs earned during the session.

The first set of paired comparisons examined differences in the number of puffs earned across the three levels of cost in the no gum condition. Results indicated a significant difference in the number of puffs earned between FR 400 and FR 1600 levels of cost $t(5)=-3.80$, $p<.05$ for the no gum condition. No other comparisons in the no gum condition resulted in significant differences (p's ranging from .18 to .20).

The second set of paired comparisons examined differences in the number of puffs earned across the three levels of cost in the gum condition. Results revealed no significant differences across any of the paired comparisons (p's ranging from .61 to .81). Thus, performance in the gum condition did not result in any significant decreases in the mean number of puffs earned (inconsistent with the Law of Demand). Finally, t-tests comparing the mean number of puffs earned revealed a significant difference between gum and no gum conditions only at the FR 400 schedule, $t(5)=-3.16$, $p<.05$. No

significant differences existed between gum and no gum conditions at either the FR 800 (p=.36) or FR 1600 (p=.47) schedules. It is apparent in Figure 2 that puffs earned in the no gum condition decreased more than in the gum condition at FR 1600; however, this decrease was not statistically significant. Thus, the addition of gum significantly decreased the number of puffs taken, but only under conditions of low cost.

b. It was also anticipated that the mean latency to the first puff would increase significantly as the unit price for cigarettes increased. Figure 3 (Appendix C) demonstrates that participants in the no gum condition steadily increased the number of minutes as the level of cost increased. When participants had chewing gum available to them, they tended to wait longer to earn puffs at low cost. At the 800 fixed-ratio response schedule, participants' appeared to wait the same amount of time whether they had chewing gum present or not. At the highest level of cost, the presence of gum appeared to decrease the number of minutes until they earned puffs. Specifically, participants tended to wait a shorter amount of time to smoke when they had gum at 1600 fixed-ratio response schedule.

A repeated measures 2 X 3 (condition X cost) ANOVA was computed for number of minutes to first puff. Results revealed a significant effect for cost $F(2,4)=11.71$, $p<.05$. No other significant effects were found for condition or cost by condition (F's ranging from .17 to .83).

Further analyses were performed to determine specific differences between means at each level of cost for both conditions. Latency in minutes to first puff was examined using paired comparisons t-tests. The first set of paired comparisons examined differences in mean latency across the three levels of cost in the no gum condition.

Results revealed a significant difference in mean latency to first puff between no gum FR 400 and FR 1600 schedules, $t(5)=4.15$, $p<.01$. This suggests that when no gum was available, participants increased the amount of time they waited to earn puffs as the cost increased. No significant differences in mean latency were observed between no gum FR 400 and FR 800 schedules ($p=.52$) nor between no gum FR 800 and FR 1600 ($p=.11$). Although the amount of time until the first puff in the no gum condition did not statistically differ across levels of cost, overall, as the cost increased, participants tended to wait longer to earn their first puff.

The second set of paired comparisons examined differences in mean latency across the three levels of cost in the gum condition. None of the comparisons revealed significant differences (p's ranging from .13 to .56). Participants did not seem to increase of decrease the amount of time they waited to have their first puff when gum was present.

The third set of paired comparison t-tests revealed no significant differences between gum and no gum conditions at each level of cost (p's ranging from .072 to .909). At the FR 400 schedule, the difference in mean latency between gum and no gum conditions approached significance, $t(5)=2.28$, $p<.10$. Suggesting that at low cost, the gum condition resulted in a longer mean latency to first puff when compared to the no gum condition. When the cost increased for the gum condition, it increased slightly at the high cost. The presence of gum at high cost appeared to decrease the amount of time the participants waited to smoke. This suggests that the influence of chewing gum on smoking behavior changes when the level of cost is high from the influence when cost is low.

Hypothesis 2:

a. It was anticipated that the number of puffs taken would be significantly lower for both gum and no gum conditions when participants responded to the FR 1600 level of cost. Figure 2 demonstrates the only group that showed a reduction at high cost was the no gum condition. Those participants with chewing gum present remained constant in their smoking behavior across conditions. The expected decrease across conditions is important when understanding that at high cost, the gum condition was anticipated to be lower than the no gum condition. At FR 1600, the gum condition was higher than the no gum condition, in the opposite direction than was anticipated.

Results revealed a significant difference between FR 400 and FR 1600 $t(5)=-3.80$, $p<.05$ for the no gum condition. Therefore, participants showed a significant decrease in the number of puffs taken at FR 1600 only in the no gum condition. Differences between the number of puffs earned for the gum condition did not reveal any significant results (p's ranging from .611 to .809).

b. The greatest increase in mean latency was expected for the FR 1600 level of cost regardless of gum condition (Appendix C). As already indicated, at high cost, the no gum condition showed a significant difference from the FR 400. However, the gum condition did not show a significant increase in mean latency from the either FR 400 or FR 800. Therefore, the overall increase in mean latency expected at FR 1600 was not demonstrated.

Hypothesis 3:

a. It was anticipated that the greatest differences in puffs taken between gum and no gum conditions would be at the highest cost schedule of reinforcement. Figure 2 in

Appendix B demonstrates the differences between groups at the FR 1600 schedule of reinforcement. The expected difference in FR 1600 number of puffs earned was not represented by the data. The no gum condition decreased as anticipated, showing a decrease in consumption as the cost increased. However, the gum condition did not show the expected decrease, but rather stayed constant across varying levels of cost. This is significant because the expected significant difference between gum and no gum conditions at FR 1600 was hypothesized in the opposite direction from the data revealed in the study. It was anticipated that at FR 1600, the no gum condition would show a less dramatic decrease than the gum condition if chewing gum served as a substitute reinforcer. However, at FR 1600 participants in the gum condition consumed more than when they were in the no gum condition.

Paired comparisons t-tests revealed no significant differences in puffs earned between gum and no gum conditions at FR 1600, $t(5)=.791$, $p<.5$.

b. Results were anticipated to show an increase in mean latency at FR 1600 between gum and no gum conditions. No significant differences in mean latency to first puff between gum and no gum conditions was observed at FR 1600, $t(5)=-.868$, $p=.425$.

Hypothesis 4:

a. Withdrawal was anticipated to be linked with consumption, as cost increased consumption was expected to decrease. Further, the level of withdrawal would increase with a decrease in consumption. Figure 4 (see Appendix D) demonstrates the results of the participants' withdrawal in all conditions and levels of cost. The no gum condition showed a slight increase in withdrawal as cost went up. The FR 400 showed the lowest level of withdrawal overall, and the FR 800 and FR 1600 showed almost identical levels

of withdrawal. The gum condition showed very similar levels of withdrawal levels at the no gum condition for FR 400 and then decreased slightly for FR 800. Participants with gum had a slight increase in withdrawal at FR 1600, similar to the level of withdrawal for participants when they had no gum available. Therefore, it appears that gum had only mild effects on withdrawal at FR 800 and did not have any effect on withdrawal levels at FR 1600.

A repeated measures 2 X 3 (cost X condition) ANOVA was computed to examine withdrawal as related to condition and cost. Results revealed no significant differences in withdrawal across condition or cost (F's ranging from .258 to .495). Paired samples t-tests were also performed to test for the effects of condition (gum and no gum) at each level of cost (400; 800; 1600). Withdrawal was measured at the end of each session for each participant. Paired comparisons t-tests revealed no significant differences in level of withdrawal between gum and no gum conditions at any level of cost (p's ranging from .067 to 1.00). However, at FR 800 the difference between gum and no gum conditions approached significance, $t(5)=-2.33$, $p=.067$. Thus, at moderate cost the no gum condition resulted in marginally elevated levels of withdrawal (see Figure 4).

b. Similar to the hypothesis for withdrawal, craving was expected to be the highest at FR 1600 for both conditions. Based on the Law of Demand, it was predicted that craving would increase as the cost increased for both gum and no gum conditions as a function of decreased consumption at high cost. Figure 5 (see Appendix E) demonstrates the effects of condition and cost on levels of craving. Only at high cost does there appear to be an increase in craving for gum conditions, although this is not a significant increase. The no gum condition showed craving to remain relatively steady across levels of cost.

When participants were provided with gum, they showed a slight decrease at FR 800 and an increase at FR 1600. At the high cost, craving for a cigarette with gum present, slightly surpassed the level of craving when the participants did not have gum. The no gum condition showed almost identical levels of craving for FR 400. At FR 800 with no gum available, levels of craving increased slightly and then decreased slightly at FR 1600. These findings suggest that gum did not help levels of craving for any of the available levels of cost.

A repeated measures 2 X 3 (condition X cost) ANOVA examined craving at all levels of cost and condition. Results revealed a significant interaction effect for cost by condition, $F(2,4)=10.00$, $p<.05$. Univariate contrasts revealed a significant change from FR 800 to FR 1600 in the gum condition, $F(1,5)=6.79$, $p<.05$. Results revealed a significant difference in craving between the gum and no gum conditions only at FR 800, $t(5)=-2.71$, $p<.05$. No significant differences were observed between gum and no gum conditions at FR 400 ($p=1.00$) or at FR 1600 ($p=.70$) for craving. Thus, craving was significantly lower when participants received gum, but only at the FR 800 cost schedule.

Exploratory Hypotheses

1. Figures 6 and 7 (see Appendices F and G) demonstrate the number of puffs per hour for gum and no gum conditions. Puffs for the gum condition showed that most puffs occurred during Hour 2. Hour 1 for FR 400, FR 800, and FR 1600 was the lowest consumption. FR 800 for the gum condition shows a steady increase through Hour 3. Both FR 400 and FR 1600 show a steady increase until Hour 2 and then a decrease in Hour 3.

Figure 7 demonstrates the number of puffs per hour for the no gum condition. Hour 1 had the lowest rate of consumption for all levels of cost and all levels of cost then increased in Hour 2. FR 400 showed an increase through Hour 2 and then a decrease at Hour 3, as did FR 800. However, FR 1600 showed no puffs earned in Hour 1 and then a steady increase through Hour 3.

A 2 X 3 X 3 (gum condition X cost X time) repeated measures ANOVA was performed to examine the number of puffs per hour. Results revealed a main effect for time on number of puffs per hour, $F(2,4)=7.77$, $p<.01$. Contrast comparisons indicated a significant increase in puffs per hour from Hour 1 to Hour 2. It appeared that participants tended to wait until the second of three hours to take their first puff, regardless of cost or condition.

2. The number of pieces of gum by level of cost is displayed in Figure 8 (see Appendix H). Figure 8 demonstrates that overall there appears to be a relatively constant consumption of chewing gum across levels of cost. FR 800 demonstrates a slight, although not significant, decrease in the number of pieces of chewing gum consumed. If gum served as a substitute reinforcer for nicotine, then as cost went up and puffs went down, chewing gum consumption should have increased. This did not occur in the present study, suggesting that chewing gum did not serve as a substitute reinforcer for smoking behavior.

Number of pieces of chewing gum consumed was analyzed using a one-way ANOVA across the three cost schedules for participants in the gum condition. Although a slight decrease in pieces of chewing gum consumed was observed at FR 800, compared to FR 400 and FR 1600, these differences were not statistically significant. The amount of

gum chewed did not differ significantly by cost; rather, all participants appeared to chew the same amount of gum despite different schedule requirements to earn puffs.

The statistics performed for the present study were extensive to allow for the most thorough investigation of the data. Exploratory hypotheses were incorporated based on the potential for a more specific investigation of the data. Due to results being contradictory to the original hypotheses, investigating puffs per hour and pieces of gum chewed potentially allowed for a more careful investigation of how participants responded to the change in cost and condition.

Limitations to Number of Statistics

When a Bonferroni correction was employed to correct for the large number of t-tests, a significance level of $p<.017$ was needed. All tests were corrected with the Bonferroni correction to determine those that remained significant. Only number of puffs from FR 400 to FR 1600, $t(5)=-3.80$; $p<.015$, and latency to first puff, $t(5)=4.15$; $p<.010$, remained significant following the correction. Therefore, the results of the present study need to be taken conservatively. Further replication would allow for a more representative picture of the data.

Discussion

The purpose of the present study was to examine the ability of chewing gum to act as a substitute reinforcer for smoking behavior. Three fixed-ratio (FR) schedules of cost were used to evaluate the effects of chewing gum on smoking behavior. Specifically, participants were exposed to both gum and no gum conditions and were given the opportunity to earn puffs of cigarettes across FR 400, FR 800, and FR 1600 cost schedules. It was anticipated that results of the present study would demonstrate the Law

of Demand as described by Hursh (1984). The Law of Demand states that when the price of a commodity increases, consumption of that commodity decreases. The addition of chewing gum was anticipated to accentuate the Law of Demand, specifically, to show an even greater decrease in consumption at high cost over conditions of no gum.

When the level of consumption for a second commodity increases as the target commodity decreases, the second commodity is considered a substitute reinforcer. In the present study, it was anticipated that the presence of gum (second commodity) would decrease the number of puffs earned (target commodity) at high cost, thus accentuating the Law of Demand at high cost. Consumption of chewing gum was expected to increase as the consumption of smoking decreased at high cost. Therefore, it was expected that smoking would decrease to a greater extent at high levels of cost when chewing gum was present.

Participants showed a decrease in consumption as cost increased for the no gum condition, demonstrating the Law of Demand. However, the addition of chewing gum appeared to disrupt the normal curve of the Law of Demand. At FR 400, the presence of chewing gum significantly reduced smoking behavior, suggesting that gum may help reduce smoking at low cost. Overall consumption was steady across levels of cost for the gum condition, demonstrating that overall, there was no effect of cost on the consumption of smoking when gum was present. At high cost, smoking behavior did not decrease as expected according to the Law of Demand, giving results different than those at low cost.

The effects of chewing gum on consumption are unclear and appear to change as the level of cost varies. When earning puffs at low cost, the absence of gum resulted in a higher level of smoking behavior. Chewing gum reduced smoking at low cost; however,

it did not show the same ability to decrease consumption as cost increased. Because the presence of chewing gum failed to alter participants' effort to smoke at higher cost, chewing gum may not reduce smoking in all situations. Indeed, it may be that at low cost, any distracter, not gum specifically, serves to reduce smoking behavior. However, at high cost, different substitute reinforcers (e.g., nicotine gum) may be needed to demonstrate significant decreases in cigarette consumption.

Results obtained at the FR 400 cost schedule are consistent with previous research examining the ability of chewing gum to serve as a substitute reinforcer for smoking behavior at low cost (e.g., Cohen et. al, 1997, 1998). Participants in these studies were exposed to brief nicotine withdrawal in a time frame similar to the present study, or were encouraged not to smoke by earning food coupons as incentives when they chose not to smoke. Smoking behavior was reduced when gum was available in conditions when smoking was not allowed (Cohen et. al, 1997). Further, when participants were allowed, but were encouraged not to smoke, they delayed smoking when chewing gum was available (Cohen et. al, 1998). Therefore, smoking behavior appears to be influenced by chewing gum in situations of low cost and the present study further replicated these results.

Examination of levels of withdrawal and craving revealed contradictory evidence for the effects of chewing gum. Both withdrawal symptoms and levels of craving for a cigarette decreased at the gum FR 800 cost schedule when gum was present, while puffs earned remained constant. This is unusual because withdrawal and craving both increased for the gum condition from FR 800 to FR 1600, although levels of smoking again remained constant. Thus, craving and withdrawal in the present study appeared to

have no consistent relationship with smoking behavior. This finding is perplexing and may indicate that smokers in the present study experienced some form of learned helplessness or negative anticipation at the highest level of cost. It may be that an expectancy to not earn a cigarette prepares individuals to curb their craving for a cigarette. Subjects may have begun the session knowing that they were not willing to press 1600 times for two puffs and prepared themselves not to smoke in some manner. Also likely, this finding may be related to the low number of subjects and with further replication may not be found.

Research on the desire to smoke has shown that for smokers, the desire to smoke begins to increase within minutes of finishing a cigarette (Schuh & Stitzer, 1995). Maximum levels of desire to smoke were reached in less than three hours of abstinence. The smokers used in the present study may not have been as dependent as those in Schuh & Stitzer (1995) and their scores resulted in lower levels of desire to smoke, and perhaps lower overall withdrawal and craving.

Although the present study demonstrated important findings related to smoking behavior, several issues could be addressed and improve future studies of similar construction. In cases where more than three t-tests are performed, a Bonferroni correction is often employed to correct for the number of comparisons that are made. When a Bonferroni correction was used in the present study, the majority of the comparisons were no longer significant. Only number of puffs earned from FR 400 to FR 1600, and latency to first puff remained significant after the correction. Therefore, an interpretation of the present results should be conservative. Further replication is needed

to more fully understand the mechanisms involved in the use of chewing gum as a substitute for smoking behavior.

The behavior evidenced in the present study may not be similar to patterns of smoking for older, more chronic smokers. Chronic smokers tend to have difficulty abstaining and experience withdrawal when deprived of nicotine (Killen et al., 1990). Perhaps, the level of dependency assessed for the smokers in the present study was not significant enough to properly investigate smoking behavior. A replication of the present study using a more chronic group of smokers that perhaps has more severe levels of dependency at baseline or smoke more cigarettes per day may provide a more clear representation of how chewing gum alters smoking behavior.

Based on the fact that earning puffs for the different schedules took varying amounts of time, it may be that the time to complete the schedule and the level of cost were confounded. Rather, because it took longer to press 1600 times than it took to press 400 times, participants did not have the same opportunity to earn the same number of puffs based on their schedule. Piloting demonstrated that if participants were to begin pressing and continue without any pauses, FR 400 would take approximately two minutes, FR 800 approximately four minutes, and FR 1600 approximately six minutes. Therefore, the amount of time differentiating the various schedules was minimal. Although this is potentially a confound to the results of the study, participants did not get close to earning the maximum amount available in the three-hour period. Many of the participants waited to earn their puffs and then earned all of the puffs without pausing. It appeared that participants chose the amount of time to earn puffs based on desired effort.

Therefore, although the confound of time and cost may be important to consider, it appears that in the present study the effects were minimal.

There may also be some mechanism of expectation that is present in the subjects' knowledge that they can leave the situation in three hours. Research has shown smokers' expectancy for their own level of efficacy can be modified by hypothetical incentives (Concoran & Rutledge, 1989). These results demonstrated that smokers' expectations about smoking cessation could be reliably modified when using incentives. Perhaps, in the present study, the expected efficacy that a smoker can avoid smoking for three hours may be influenced by the presence of chewing gum. Chewing gum may act as an incentive and produce more flat levels of performance for smoking when present. Chewing gum availability may modify the naturally occurring process that occurs in longer periods of withdrawal and higher cost for consumption.

Furthermore, research has shown that smoker's subjective feelings of withdrawal and arousal were influenced by the expectancy they were receiving nicotine (Gottlieb, Killen, Marlatt, & Taylor, 1987). Smokers were able to reduce their level of withdrawal when expectancy was involved. It may be that when participants do not expect to smoke for three hours, they monitored and modified their own level of withdrawal and desire to smoke. Perhaps, participants expected that they would not press in situations of FR 1600, and subsequently modified their level of withdrawal with expectation. It may be that the level of withdrawal that occurred in the participants was changed by expectation. Perhaps, a study conducted over the course of several days where subjects could smoke only what they earned would produce more severe levels of withdrawal. With more severe levels of withdrawal, the effects of chewing gum may change. In this situation, a

smoker may not be able to change their level of withdrawal by expectancy and a more representative picture of the process would be evident.

The results of this study offer a few practical considerations. As more people in the United States attempt and succeed in quitting smoking, an understanding of substitutes for smoking behavior becomes more important in maintaining and extending the number of successful quitters. The literature (i.e., DeGrandpre, Bickel, Higgins, & Hughes, 1994; Bickel et al., 1995) demonstrates that smoking behavior tends to follow the law of demand; as price increases, consumption decreases. Further, studies (Cohen et al., 1997, 1998) have suggested that at low cost, smoking behavior can be manipulated with chewing gum. Therefore, smoking can be decreased and delayed with chewing gum if a person is in a low-cost situation (e.g., choosing not to smoke). The present study demonstrated that, at high cost, the Law of Demand was disrupted with the addition of chewing gum. Although high cost situations may prove to be more subjective in the real world, one might predict that quitting is a high cost situation. Using chewing gum may help someone to delay smoking for a short time, or not smoke in a low cost situation, but may not prove extremely helpful for someone attempting to quit smoking.

Individual differences in smoking behavior may be of concern when using a small sample size. The generalizability of the results obtained from this study may be limited due to the small sample size. Smokers whose smoking behavior is modified by chewing gum may possess different characteristics than other smokers. Perhaps there is something different about smokers that would choose gum versus those that would not, in situations of high cost. Chewing gum has been seen as a way to release tension and anxiety (Hendrickson, 1976). Perhaps those participants who responded well to or would choose

gum had higher levels of anxiety and found the chewing gum helpful in reducing anxiety. A study looking at differences between smokers who readily chew gum in situations of high cost as well as overall levels of anxiety would be beneficial to understand individual differences in smoking behavior, withdrawal and craving. Participants should also be put into a condition where their level of gum-chewing behavior is controlled and a baseline established. An understanding of whether their gum level increased or decreased from normal levels, would be important in deciding whether chewing gum served as a substitute for individual subjects. Related to gum chewing, there may be different ways that subjects manipulate the substance when chewing. Most of the subjects in the present study continually chewed the gum until asked to spit it out to smoke the puffs they earned. How they manipulated the gum when chewing may be an indication of how they attempt to cope with their withdrawal from nicotine.

One further extension of the present study may be to add other possible substitutable reinforcers. Research has shown that the combination of several smoking cessation methods is more successful when quitting smoking (e.g., Hughes, 1991; Fagerstrom, 1994). By extending the study to include nicotine replacement therapies, mints, or toothpicks, perhaps a lower level of smoking behavior would be exhibited. The presence of some or multiple distracters may lower levels of withdrawal that are not specific to chewing gum alone. Also, participants were allowed to read magazines and play computer solitaire during the sessions. It may be that these alternatives to pressing served as substitutes. With no other available activities, participants may have earned more puffs than when they were given other activities. Another extension may not allow participants any other available activities to demonstrate the effects of reading and

solitaire. Further investigation is needed to more fully understand the mechanisms involved in smoking behavior and substitutable reinforcers.

In summary, the present study did not find that chewing gum served as a substitute reinforcer for cigarette smoking. However, chewing gum did appear to disrupt the normal Law of Demand. With the addition of chewing gum, there appeared to be no influence of cost on consumption of smoking or chewing gum. At low cost, chewing gum did appear to reduce smoking behavior; however, as the cost for the commodity increased, no reduction occurred in the conditions where chewing gum was present. These findings suggest that chewing gum has some effect on the Law of Demand, although its exact mechanism is currently unknown. More intensive investigation on the influence of chewing gum on cigarette consumption as related to variation in cost is needed to more closely understand the mechanisms at work.

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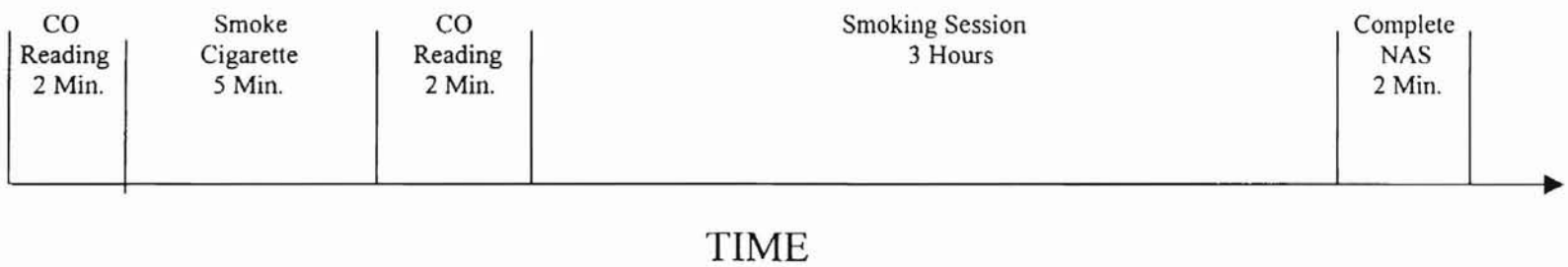
APPENDIX A

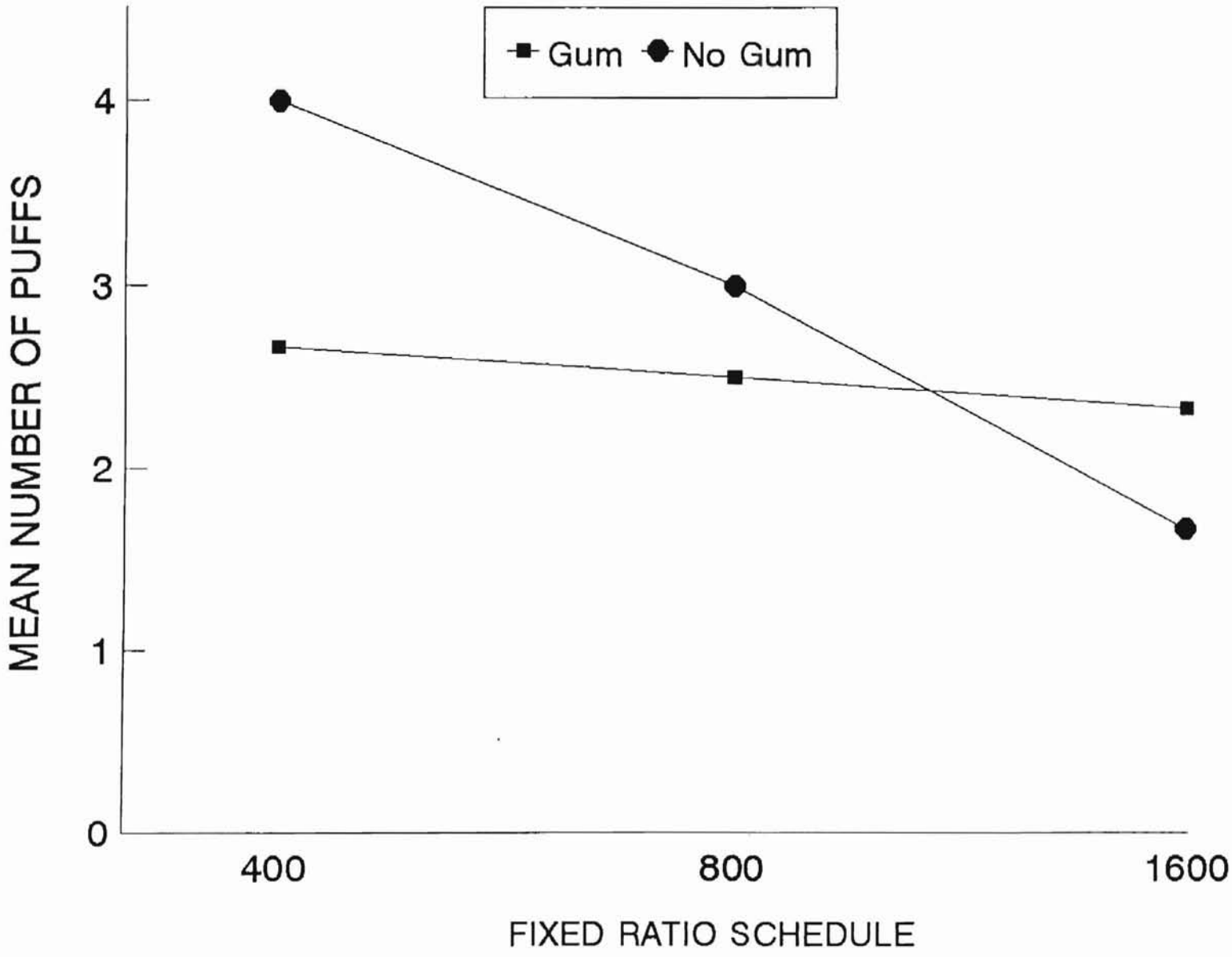
FIGURE 1. TIME LINE FOR EXPERIMENTAL SESSIONS

TIME LINE FOR EXPERIMENTAL SESSIONS



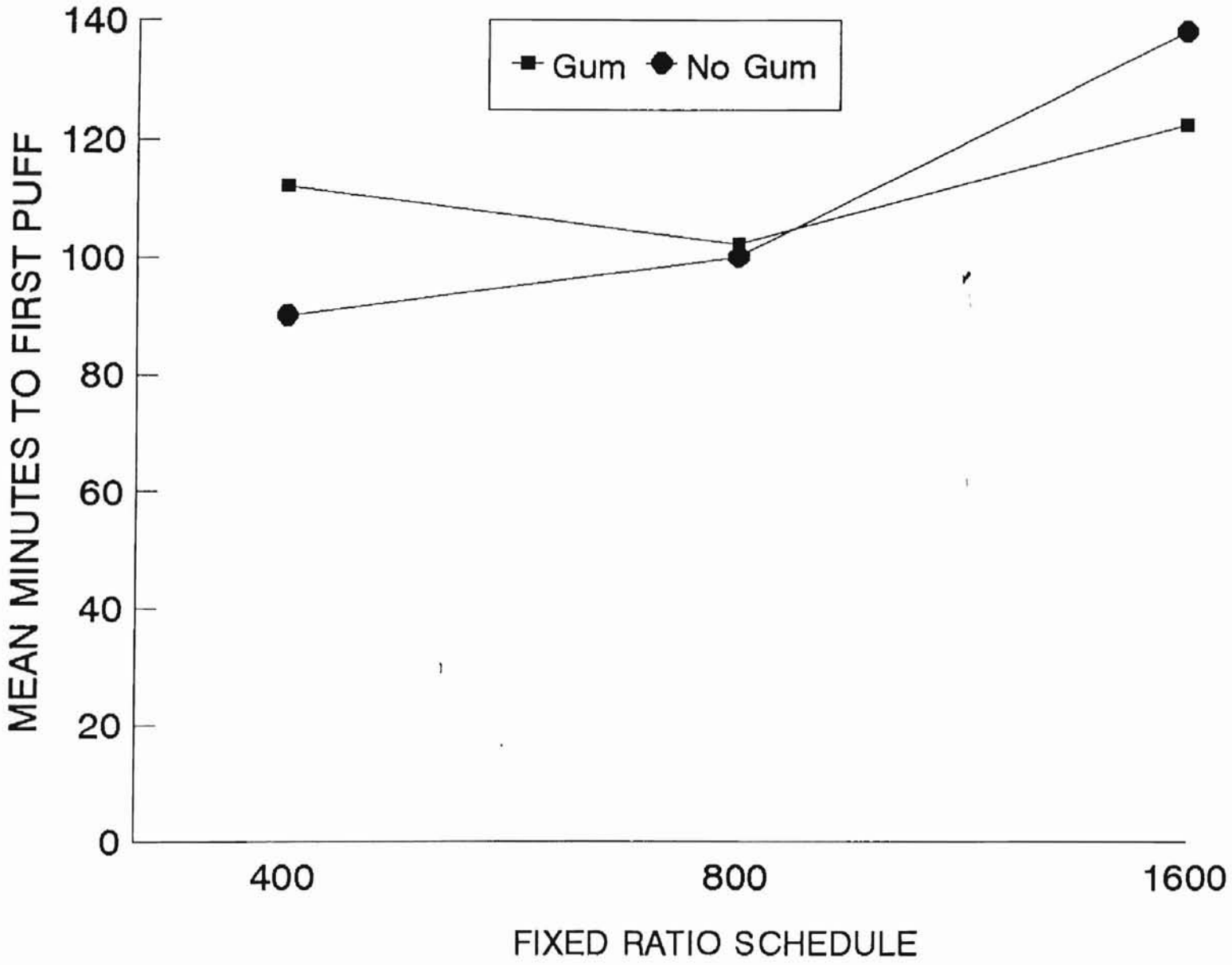
APPENDIX B

FIGURE 2. MEAN NUMBER OF PUFFS BY GUM CONDITION AND COST SCHEDULE


Gum
No Gum
MEAN NUMBER OF PUFFS
4
3
2
1
0
400
800
1600
FIXED RATIO SCHEDULE

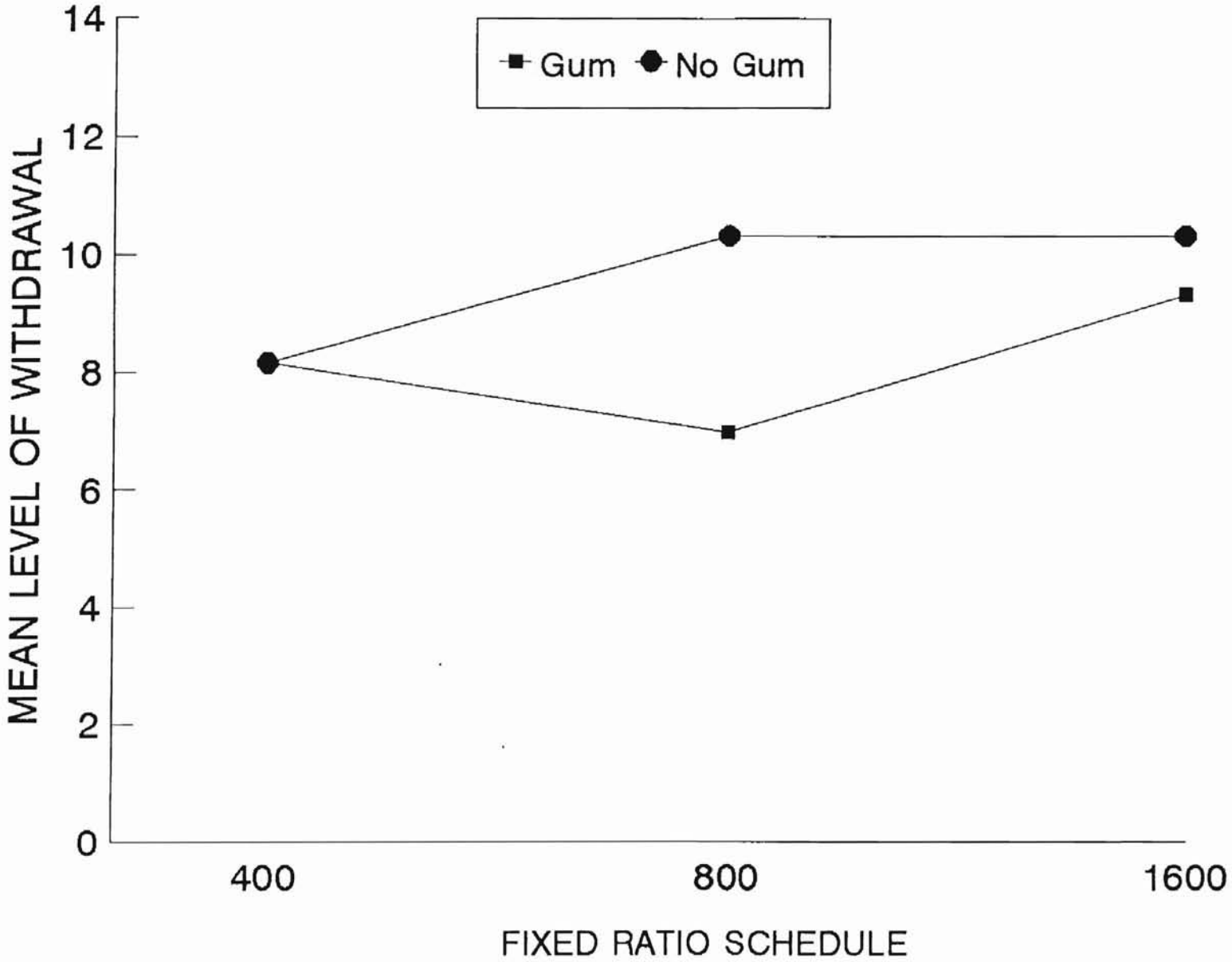
APPENDIX C

FIGURE 3. MEAN LATENCY TO FIRST PUFF BY GUM CONDITION AND COST SCHEDULE


Gum
No Gum
MEAN MINUTES TO FIRST PUFF
140
120
100
80
60
40
20
0
400
800
1600
FIXED RATIO SCHEDULE

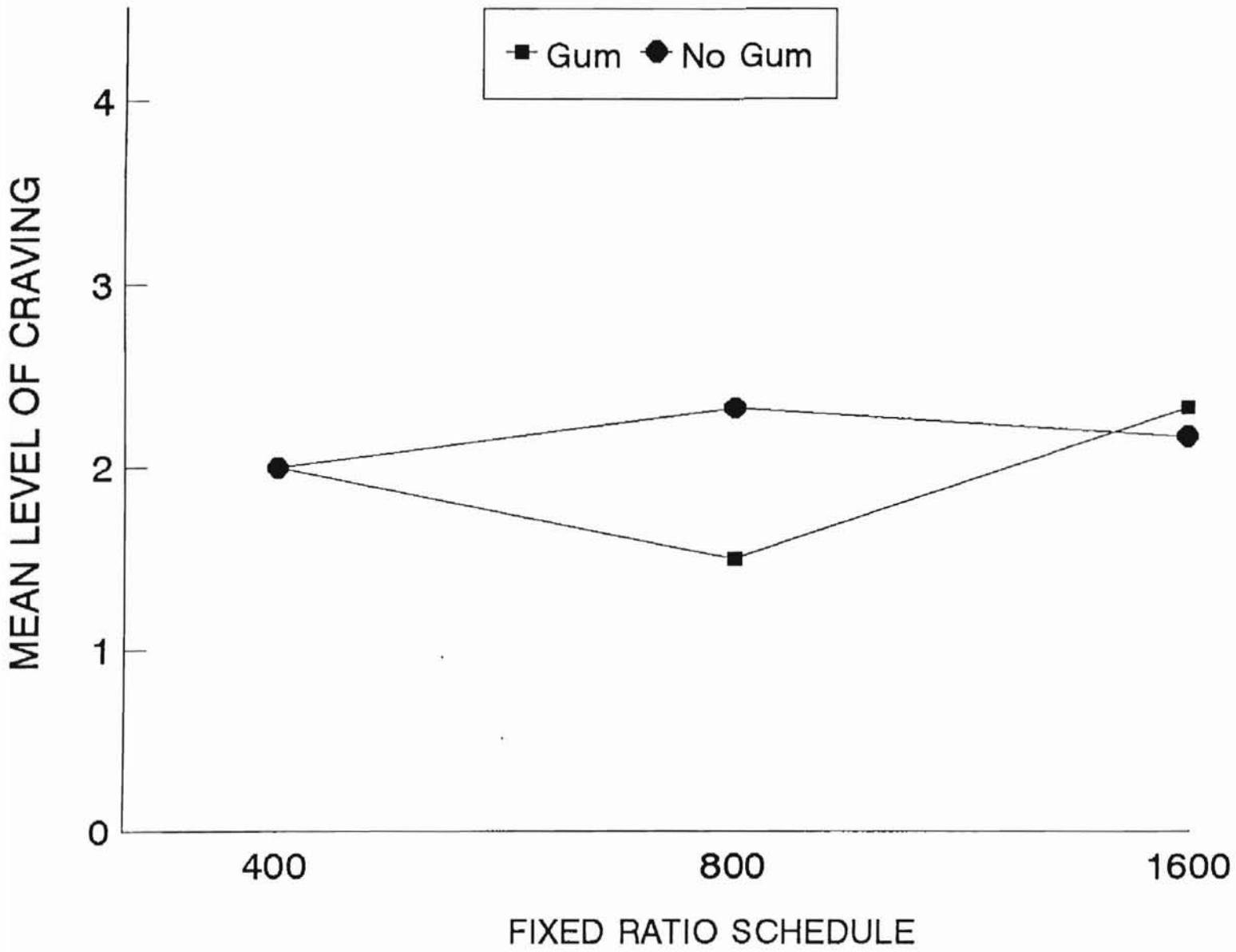
APPENDIX D

FIGURE 4. MEAN LEVEL OF WITHDRAWAL BY GUM CONDITION AND COST SCHEDULE


Gum
No Gum
MEAN LEVEL OF WITHDRAWAL
14
12
10
8
6
4
2
0
400
800
1600
FIXED RATIO SCHEDULE

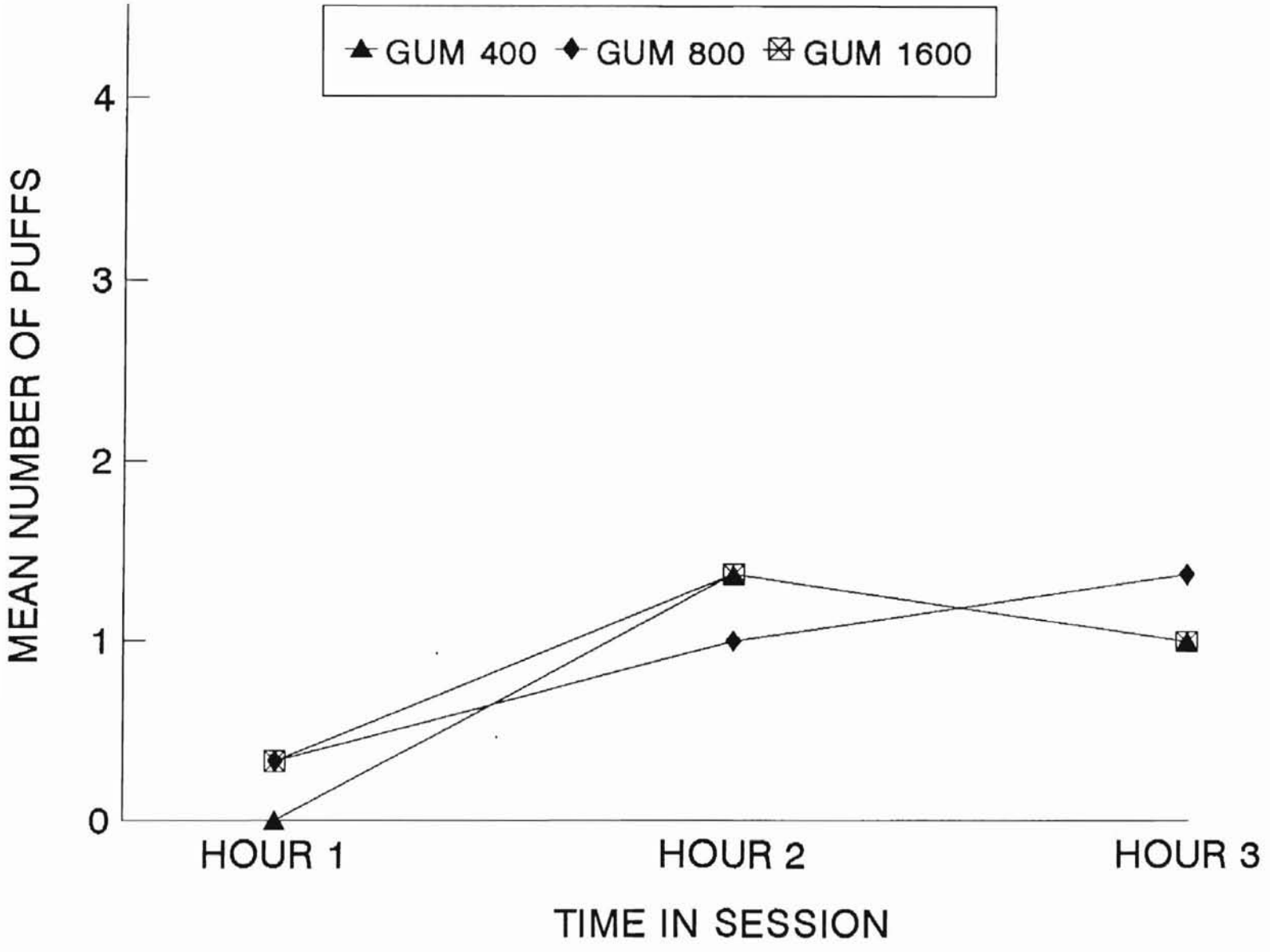
APPENDIX E

FIGURE 5. MEAN LEVEL OF CRAVING BY GUM CONDITION AND COST SCHEDULE


Gum
No Gum
MEAN LEVEL OF CRAVING
0
1
2
3
4
400
800
1600
FIXED RATIO SCHEDULE

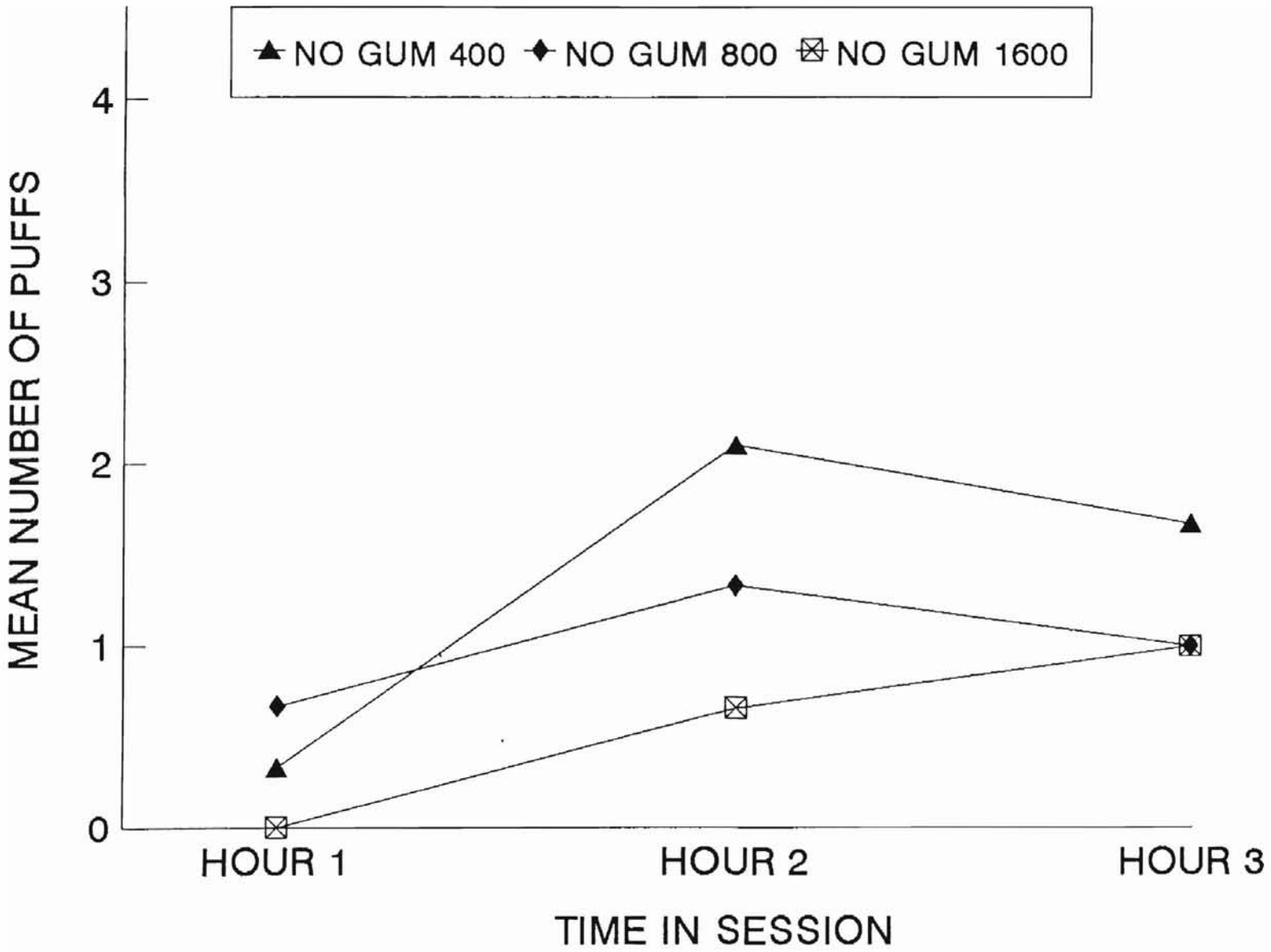
APPENDIX F

FIGURE 6. MEAN NUMBER OF PUFFS PER HOUR BY COST SCHEDULE FOR GUM CONDITION


GUM 400
GUM 800
GUM 1600
MEAN NUMBER OF PUFFS
0
1
2
3
4
HOUR 1
HOUR 2
HOUR 3
TIME IN SESSION

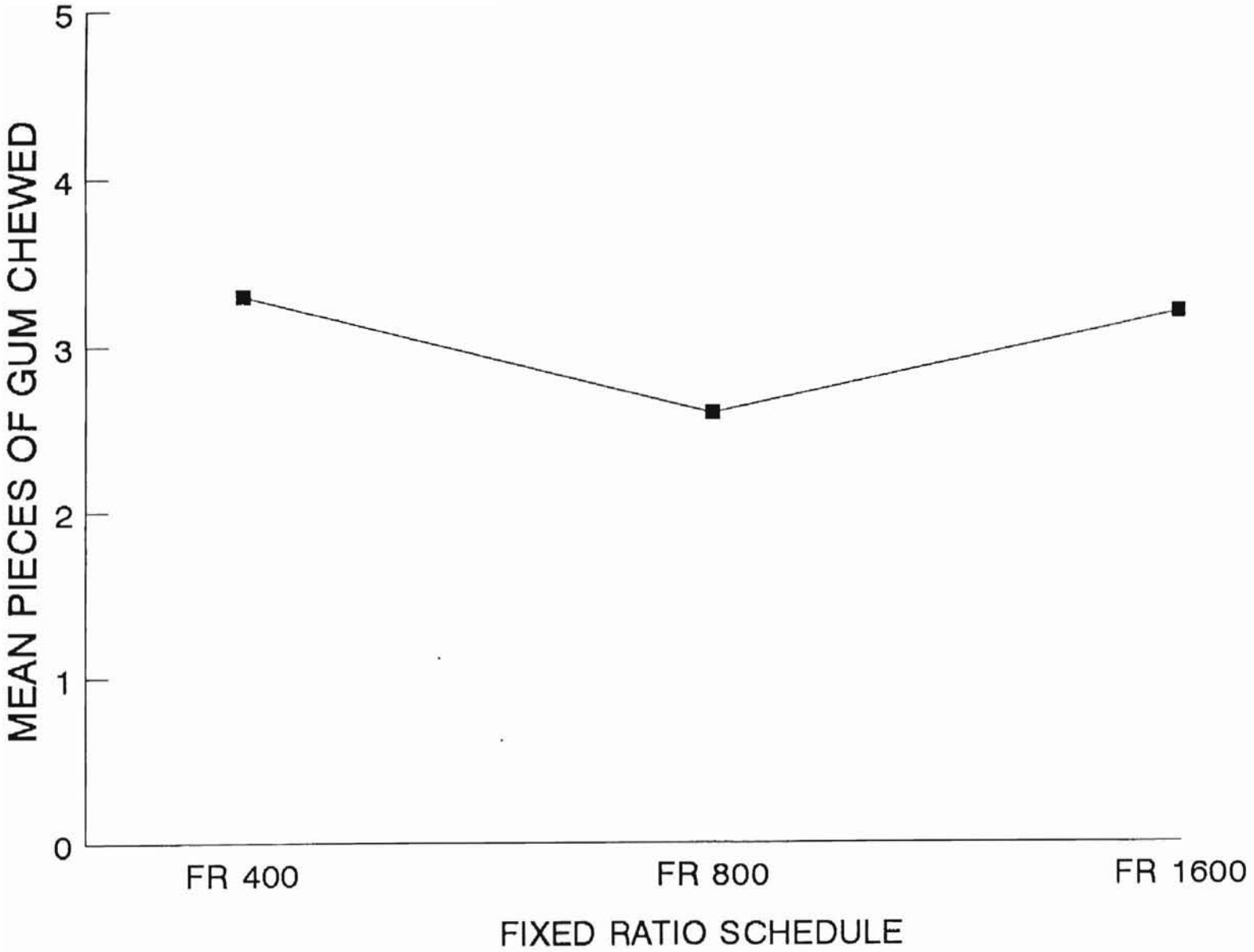
APPENDIX G

FIGURE 7. MEAN NUMBER OF PUFFS PER HOUR BY COST SCHEDULE FOR NO GUM CONDITION


NO GUM 400
NO GUM 800
NO GUM 1600
MEAN NUMBER OF PUFFS
4
3
2
1
0
HOUR 1
HOUR 2
HOUR 3
TIME IN SESSION

APPENDIX H

FIGURE 8. MEAN PIECES OF GUM CHEWED BY COST SCHEDULE


MEAN PIECES OF GUM CHEWED
5
4
3
2
1
0
FR 400
FR 800
FR 1600
FIXED RATIO SCHEDULE

APPENDIX I

TABLE 1. MEANS AND STANDARD DEVIATIONS FOR DEPENDENT VARIABLES BY GUM CONDITION AND COST SCHEDULE

Table 1.

Means and standard deviations for dependent variables by gum condition and cost schedule

	CONDITION					
	GUM			NO GUM		
	FR400	FR800	FR1600	FR400	FR800	FR1600
Puffs						
M	2.67	2.50	2.33	4.00	3.00	1.67
SD	2.42	1.76	2.34	1.79	2.10	1.51
Latency						
M	112.17	102.33	122.67	90.17	100.17	138.33
SD	55.03	28.26	49.43	40.36	45.75	42.98
Withdrawal						
M	8.17	7.00	9.33	8.17	10.33	10.33
SD	2.64	2.53	2.80	4.58	4.23	1.97
Craving						
M	2.00	1.50	2.33	2.00	2.33	2.17
SD	.63	.84	.52	.89	.52	.98

Note. FR400 = Fixed-ratio 400; FR800 = Fixed-ratio 800; FR1600 = Fixed-ratio 1600.

APPENDIX J

INSTITUTIONAL REVIEW BOARD APPROVAL

FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 11-06-97 **IRB#:** AS-98-024

Proposal Title: EVALUATING THE ROLE OF CHEWING GUM AS A SUBSTITUTE REINFORCER FOR NICOTINE

Principal Investigator(s): Frank L. Collins, Jr., Heather D. Stott

Reviewed and Processed as: Expedited

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING, AS WELL AS ARE SUBJECT TO MONITORING AT ANY TIME DURING THE APPROVAL PERIOD.
APPROVAL STATUS PERIOD VALID FOR DATA COLLECTION FOR A ONE CALENDAR YEAR PERIOD AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Disapproval are as follows:
The reviewer sees nothing wrong with the basic design, but wouldn't it be appropriate to have a briefing session with subjects after research is completed to update them about alternatives to smoking, since that seems to be a side benefit of the research goals?

Signature: _____ Date: November 6, 1997
Chair of Institutional Review Board
cc: Heather D. Stott

VITA

Heather Stott Bailey

Candidate for the Degree of

Master of Science

Thesis: EVALUATING THE ROLE OF CHEWING GUM AS A SUBSTITUTE REINFORCER FOR NICOTINE

Major Field: Psychology

Biographical:

Personal Data: Born in Jacksonville, Florida, on October 1, 1974, the daughter of Norman and Linda Stott.

Education: Graduated from Jenks High School, Jenks, Oklahoma in May of 1992; Received Bachelor of Science degree in Psychology from Oklahoma State University, Stillwater, Oklahoma in May, 1996. Completed the requirements for the Master of Science degree with a major in Psychology at Oklahoma State University in July, 1998.

Experience: Performed research in the Department of Psychology at Oklahoma State University as an undergraduate and as a graduate research assistant; completed practicum requirements as a therapist in the Psychological Services Center from Fall 1996 to present; employed by Oklahoma State University as a graduate instructor for Introductory Psychology from Fall 1997 to Spring 1998; Oklahoma State University, Department of Psychology, 1996 to present.

Professional Memberships: Association for the Advancement of Behavior Therapy, American Psychological Association, Oklahoma Psychological Association, Psychology Graduate Student Association.