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Smoking Cessation: A Human Factors Solution Approach

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DEDICATION

I would like to dedicate this thesis to my family – my parents, Kevin and Kathy, my brothers Bobby and Tommy, my sister and her husband, Megan and Jake Behm, and to my nephews William and Camden. Each of them has supported and encouraged me their own ways throughout my entire educational career. I also want to dedicate this Tyler Fox, and to my squirrel-friends: Briana Haguewood, Clare Goeken, Kelly Madsen, and Megan Jensen. Without them, this paper, my master's degree, my bachelor's degree, and Iowa State, in general, would have never happened.

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NOMENCLATURE

NIH	National Institutes of Health
IRB	Institutional Review Board
TCRB	Tobacco Control Research Branch
NRT	Nicotine Replacement Therapy
ACT	Acceptance and Commitment Therapy
MPSS(C)	Mood and Physical Symptoms Scale – urge questions only
QSU	Questionnaire on Smoking Urges (brief)
POMS	Profile of Mood States
TMD	Total Mood Disturbance
CO	Carbon Monoxide
EMA	Ecological Momentary Assessment
PPM	Parts per Million
MNWS	Minnesota Nicotine Withdrawal Scale
WSWS	Wisconsin Smoking Withdrawal scale
CWS	Cigarette Withdrawal Scale
SS	Shiffman Scale
CR	Craving Rating
ACT	Acceptance and Commitment Therapy

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ABSTRACT

The primary aim of the current study is to validate the use of healthy alternatives designed to increase the long-term success rates of smoking cessation programs. The objective of this research is to collect and critically analyze information about the effects of lifestyle-based exercise on smoking urges during abstinence. Existing research indicates that individuals who smoke cigarettes find quitting smoking to be difficult, and often do not achieve long-term success. Alternative methods to complement existing cessation programs are needed to improve and build upon the current rates of a success. One alternative to standard cessation programs is exercise. Smoking urges have been shown to decrease after brief, self-paced exercise following 15-hours of abstinence. In this study, smokers were asked to replace the act of smoking with walking, while engaging in a 24-hour period of smoking abstinence. Throughout the period of abstinence, smoking urges and mood states were assessed every four hours via survey. Each participant's activity was analyzed over the 24 hours by comparing their smoking urge scores to the amount of activity completed prior to the time of the survey. An individual analysis of each participant revealed that while some participants walked enough to reduce their negative affect, no participants walked enough to reduce smoking urges. To determine if walking can reduce smoking urges, it is necessary to control more factors of walking in relation to smoking urges.

CHAPTER 1: INTRODUCTION

Smoking has been a growing point of discussion since evidence of its harsh effects began to accumulate as early as the 1930's (The Reports of the Surgeon General, 1964). Today, there are approximately 42.1 million smokers in the United States (Jamal et al., 2014) while data continues to grow stating that the health effects of smoking are severely detrimental. According to the 2014 Report of the Surgeon General on the health consequences of smoking, the act is responsible for half a million deaths per year (U.S. Department of Health and Human Services, 2014). Carter et al. (2015) attributes about 60,000 deaths to smoking from diseases not previously related to smoking, while there are over 16 million smokers in the United States who currently live with a smoking related disease (U.S. Department of Health and Human Services, 2014). While many smokers are aware of the facts that confirm the negative effects, more factors are involved in quitting than knowledge of the health risks. In 2010, 69% of all adult cigarette smokers in the United States indicated that they wanted to quit smoking completely and 52% indicated that they had tried to quit in the previous 12 months (Centers for Disease Control and Prevention (CDC), 2011). Yet the number of unsuccessful attempts to quit far exceeds the success stories, with only about 3-5% of smokers remain wholly abstinent one year after quitting (Center for Disease Control, 2000; Hughes et al., 2004). Those who have successfully quit averaged three attempts before remaining abstinent for longer than one year (Curry and McBride, 1994). The detrimental health effects, low success of cessation, and the frequency of relapse are trends that demands different and more effective cessation methods.

Common cessation methods commonly used include self-help, nicotine replacement therapy, behavioral counseling, and pharmacological support (Tobacco Control Research Branch of the National Cancer Institute, 2016). While each method has been used with varying degrees of success, a search for alternative and more effective cessation methods continues. Physical activity has been studied as a healthy alternative to current cessation methods because of its power to reduce cigarette cravings and withdrawal symptoms. Short and light to moderate intensity physical activity sessions have been shown to significantly reduce the urge to smoke in short-term abstinent smokers (Daniel et al., 2007; Elibero et al., 2011; Scerbo et al., 2010). Specifically, self-paced walking has been shown to have a positive effect on the reduction of smoking urges for as long as 20 minutes post-treatment (Taylor et al., 2005). Current studies have investigated the effects of exercise post-abstinence; however, given the positive results of exercise, it is of interest to study the effects of integrating physical activity throughout smoking abstinence to decrease smoking urges, and ultimately increase smoking cessation success.

A human factors approach was used in this research to evaluate and test the hypothesis of utilizing exercise to aid in smoking cessation throughout abstinence. According *The Dictionary for Human Factors/ Ergonomics*, human factors is a "field which is involved in conducting research regarding human psychological, social, physical, and biological characteristics, maintaining the information obtained from that research, and working to apply that information with respect to the design, operation, or use of products or systems for optimizing human performance, health, safety, and/or habitability" (Scerbo, 1993). The act of smoking and smoking cessation have both been proven to influence and be influenced

by psychological, social, physical, and biological characteristics of the human body (West & Schneiders, 1987; Neal et al., 1982; George, 2011; Steptoe & Ussher, 2006, Guilford & Jacobs, 1966; Burns, 1969; Brecher, 1972; Perlick, 1977; Shiffman, 1979; Myrsten et al., 1977). Human Factors Engineering has also been defined as, "the application of human factors information to the design of tools, machines, systems, tasks, jobs, and environments for safe comfortable, and effective human use" (Chapanis, 1991). This study applies information collected from smoking and smoking and cessation research to design an aid (tool) in the smoking cessation process that optimizes human performance, health, and habitability (system) for successful (effective) human use.

This study assesses the effectiveness of moderate to vigorous physical activity throughout a smoking abstinence period as a tool to aid in reducing negative affects of cessation. Study participants were tested in two conditions for 24 hours each: abstaining from smoking while making no changes to their daily routines, and abstaining from smoking and walking whenever they felt the urge to smoke. Participants wore an activity monitor throughout the study and filled out a two-item smoking urges survey every four hours. The study was concluded with a psychological assessment of each participant to evaluate the changes in positive and negative affect.

The objective of this research was to gather information on the effects of physical activity on smoking urges and negative affect during abstinence by replacing the physical act of smoking with moderate and vigorous physical activity (MVPA). In the experiment designed to apply the objective it was hypothesized that during the 24-hour smoking abstinence, the

participants' urge to smoke would be lessened in the experimental condition upon replacing the act of smoking with walking.

The structure of this thesis will begin with an in-depth literature review detailing the rationale behind this study, followed by the decisions informing its key design. Following will be the methodology, results and discussion of the study, ending with the conclusion and recommendations for further study.

CHAPTER 2: LITERATURE REVIEW

2.1 SMOKING

This section begins with an introduction on smoking, nicotine, its effects on the body, and how those are measured. These topics were explored to understand how smoking affects the body physically and psychologically. This information was then used to define the research objectives, establish a hypothesis, and create a study framework.

The origin of this project stemmed from the need to identify and understand the process that occurs within the human body that leads to smoking urges and how that information can be used to counter-act an urge or craving. An urge has been associated with the behavioral intention to use the drug (Marlett, 1985). A craving is the desire to use a drug, however, it is also a subjective experience that requires awareness of the desire (Niaura et al., 1988; Kassel & Shiffman, 1992). These definitions opened two avenues of exploration that coincide with the psychological and biological characteristics of a human factors approach: addressing subjective experience of the drug, in the case of smoking, nicotine, or using a tool to address and counteract the neurobiological processes of smoking.

2.1.1 NICOTINE EFFECTS

The first path required an in depth look at the effects of nicotine on the body to understand the onset of smoking urges. The approach was to look at the body as a machine, not a "black box" – or to quantify not only the subjective experience, but also the nicotinic reaction. Nicotine is an addictive substance found in tobacco. The presence of nicotine in the body produces physiological responses that include decreases in skin temperature, increasing the heart rate by 10-20 beats per minute, increasing blood pressure by 5-10 mmhg (Neal et

al., 1982; George, 2011). It also affects the body's endocrine system, including cortisol levels (Steptoe & Ussher, 2006). Withdrawal symptoms begin within 2-3 hours (George, 2011) and peak between 24-72 hours following the last intake of nicotine (Hughes, 2007).

To quantify the physiological response to nicotine, first it was necessary to determine the biomarkers of nicotine and how they are currently being measured. The most common biomarkers used to measure exposure to tobacco are nicotine, cotinine (metabolite of nicotine), carbon monoxide, thiocyanate, and more recently, hemoglobin, DNA adducts, and nitrosamines (Benowitz, 1996). Cotinine is used in many studies because of its long half-life of 16 hours (compared to nicotine's half-life of 2 hours) and accuracy (Benowitz et al., 1983a). Approximately 70-80% of nicotine is converted into cotinine (Benowitz, 1996), and then bio transformed into three secondary metabolites (Dhar, 2004). The primary methods of measuring cotinine levels of a subject is through blood (plasma cotinine), saliva, and urine (Dhar, 2004). All three measures have been found to be correlated (Feyerabend & Russell, 1980; Haley et al., 1983; Bernert et al., 2000; Binnie et al., 2004). However, saliva is the least invasive with a higher sensitivity (Jarvis et al., 1987; Gorber et al., 2009). Analysis of saliva can be completed using various chromatography methods, colorimetry, enzyme immunoassay (EIA), enzyme-linked immunosorbent analysis, and screening dip-stick technology (Alterman & Niedbala, 2002; Gariti et al., 2002; Shin et al., 2002; Dhar, 2004). Chromatography is preferred because of its specificity, sensitivity, and efficiency (Obmiński & Stupnicki, 1990; Crooks et al., 1999; Dhar, 2004). Upon these conclusions, saliva and gas chromatography were established as the biomarker and method that best fit to determine the relationship between salivary cotinine levels and subjective urges to smoke while using exercise during a

smoking abstinence. This was not chosen as the objective and focus of this study, however, future research will explore the possibility of incorporating salivary cotinine levels into validating healthy alternatives and creating technology to predict smoking urges.

2.1.2 Behavioral Smoking Effects

The second path was an investigation of the behavioral aspects of smoking to understand the psychological responses caused by cessation. Recent studies have supported the need to return to more theory based treatments that focus on behavioral action (Rounsaville, et al., 2001; Niaura & Abrams, 2002). This method required a reverse engineering approach – looking at how the smoking cessation process affects the body, rather than looking at how the chemicals entering the body affect cessation. The ultimate goal is to aid in the smoking cessation process and increase the success of smoking abstention. Using the same non-black-box approach, it is the objective to counteract the physiological changes that cause an urge using healthy approaches, which can include using the body itself. Exercise has been shown to not only reduce smoking urges, but also the negative affect of withdrawals making it a plausible treatment for smoking cessation (Taylor et al., 2007; Roberts et al., 2012; Ussher et al., 2012).

Smoking urges, cues, short term withdrawal symptoms, and long-term relapse, are all behavioral and psychological aspects of smoking, and it is necessary to understand their cause and relation to understand current cessation methods. Smoking urges are defined as a subjective experience, caused by neurobiological reactions that induce the motivation and desire for nicotine (Niaura et al., 1988; Kassel & Shiffman, 1992) or the “feelings of need for a cigarette” (West et al., 2008). Smoking urges can be caused by nicotine withdrawals, the

positive reinforcing agents of smoking behavior and nicotine, the nicotine blood concentration levels, stress, and smoking and non-smoking cues (Schneiders, 1987; Niaura et al., 1988; West & Wise 1988; Perkins & Grobe, 1992; Jarvik et al., 2000; Kang et al., 2009). A craving or an urge can arise at any time during smoking abstinence, especially when stressed or bored (West & Schneiders, 1987). Smoking cues are any stimuli that elicits an urge or desire to smoke; cue induced cravings are also known as cue-reactivity (Sayette et al., 2000). Smoking or nicotine related cues have shown to increase smoking urges, and play a role in both smoking behavior maintenance and relapse (Abrams et al., 1988; Niaura et al., 1988). Withdrawal symptoms of smoking peak in 24-72 hours following the last cigarette and can last up to 4 weeks (Hughes, 2007). Withdrawal reactions are an individual experience and vary on strength, severity, and duration. (Cortez-Garland et al., 2010). Symptoms include cigarette and tobacco cravings, negative affects (e.g. irritability, anxiety, depression, hostility, and tension), sleep disorder, nausea, lightheadedness or headaches, tremors, constipation, chest tightness or palpitations, fatigue, impaired cognitive function, increased appetite, and weight gain (Guilford & Jacobs, 1966; Burns, 1969; Brecher, 1972; Perlick, 1977; Shiffman, 1979; Myrsten et al., 1977). It has been shown that 90% of all smokers will experience craving a cigarette as a withdrawal symptom (Guildford, 1966). Physiological responses to withdrawal are decreases in heart rate and blood pressure, as well as, metabolic changes (Shiffman, 1979). Smoking relapse has been given many definitions in the realm of smoking cessation research (Ockene et al., 2000), but Shiffman et al. (1996) quantified and standardized relapse with the definition of smoking five or more cigarettes per day for three days straight. Relapse has most strongly been attributed to cigarette cravings and withdrawal symptoms (Guilford

& Jacobs, 1966; Norregaard et al., 1993). Smoking cessation methods tested in the past and present have used these factors in attempts to reduce relapse rates.

2.2 Smoking Cessation and Exercise

This section discusses behavioral approaches and life-style exercises for smoking cessation. It provides an in-depth evaluation of smoking cessation and establishes exercise as a viable treatment method.

2.2.1 Smoking Cessation

Smoking cessation is the process of ceasing the use of tobacco cigarettes. Rather than a binary product, cessation success or failure, it has been defined as a process of cycling and recycling (Pechacek & Danaher, 1979; Diclemente & Prochaska, 1982; Diclemente & Prochaska, 1985; Prochaska et al., 1990). The process can be assessed using the four of the five stages of change discussed by DiClemente et al., that is pre-contemplation, contemplation, action, and maintenance (Diclemente et al., 1991). While the stage of change of the smoker effects their chance at cessation success (Diclemente & Prochaska, 1982; Diclemente et al., 1991), there are many other factors that contribute to cessation success – motivation being one of the most important (Osler & Prescott, 1998). Perceived risks and benefits, age, gender, home life, education, fear of weight gain, recent marijuana use, and daily consumption of tobacco are all factors that affect the outcome of smoking cessation attempts (Gourlay et al., 1994; Osler & Prescott, 1998; Lee & Kahende, 2000; McKee et al., 2004; Raherison et al., 2005). Number of cigarettes smoked in the first month of a smoking cessation attempt, dependence on nicotine, social smoking cues, heavy alcohol intake, and

recent failed attempts are factors that increase the likelihood of relapse (Hymowitz et al., 1991; Gourlay et al., 1994; Zhou et al., 2009).

2.2.2 Past Cessation Methods

Since smoking cessation became a topic of interest in the 1930's various methods have been tested to help smokers quit - some more successful for the long term than others (Surgeon General, 1964). Antismoking hypnosis began in the 1940's (Johnston & Donoghue, 1971). While a few successes were reported, a clear cause and effect relationship could not be established (Bernstein, 1969; Johnston & Donoghue, 1971), ruling it an ineffective method of smoking cessation (Bernstein & McAlister, 1976). Today, hypnotherapy for smoking is still practiced by some, however, no evidence remains to prove its effectiveness nor it has proven to have a greater effect than other interventions and self-help (Barnes et al., 2010). Sensory deprivation, especially using antismoking messages, reduced cigarette smoking (Suedfeld et al., 1972), but the abstinence rates were no better than other interventions (Bernstein & McAlister, 1976). Social learning techniques in the early phases of searching for smoking cessation treatments primarily focused on reducing the probability of smoking with systematic desensitization (stress control), stimulus control (environmental cues), punishment and aversive conditioning (shock therapy and aversive taste) (Bernstein & McAlister, 1976). Apart from systematic desensitization, which failed to prove its usefulness in the six studies analyzed by Bernstein and McAlister (1976), the rest of the social learning techniques followed the trend of the previously mentioned interventions – they generally yielded immediate reduction in smoking behavior, but did not contribute more to the cessation process than self-help mechanisms and did not show evidence to support the

treatment as a sustainable treatment for long term cessation (Bernstein & McAlister, 1976). Bernstein & McAlister (1976) commented on the fact that up until the point of their review, studies that focused on increasing the probability of alternative nonsmoking responses using contingency contracting, positive reinforcement, and non-smoking skill training methods were "overshadowed." This review also discussed a few methods including clinics and pharmaceuticals, which are still used today.

2.2.3 Current Cessation Methods

Countless other methods have been used and studied to aid in smoking cessation. Some of the most common approaches are self-help, educational, five-day plans, clinics, pharmaceuticals, nicotine replacement therapy (NRT), acupuncture, laser therapy, behavioral therapy (in person and telephone counseling), smoke aversion and other aversion techniques, physicians advice and interventions, internet quitting programs, a combination of counselling and medication, and e-cigarettes (Viswesvaran & Schmidt, 1992; Bullen et al., 2013; Tobacco Control Research Branch of the National Cancer Institute, 2016). The National Institutes of Health (NIH) smoking cessation website created by the Tobacco Control Research Branch (TCRB) of the National Cancer Institute lists acupuncture and laser therapy as a quit method, but reiterates that there is no research that proves these methods are successful. The TCRB lists the most effective methods as counseling and medication combination, pharmaceutical drugs, NRT, in-person counseling, NRT combined with pharmaceuticals, telephone counseling, and self-help, respectively.

2.2.4 Nicotine Replacement Therapy

Nicotine replacement therapy is the most popular form of smoking cessation help due to its low risk, low cost, and widespread availability (Etter & Stapleto10n, 2006). NRT is available in the forms of gum, patches, nasal sprays, inhalers, and tablets/ lozenges (Silagy et al., 2004). Its objective is to reduce the smoking withdrawal symptoms associated with cessation by slowly releasing nicotine into the blood and has shown to increase the likelihood of quitting by 50-70% (Stead et al., 2008). All NRT forms have the same level of effectiveness, although heavier smokers may need a higher dosage (Stead et al., 2012). Higher dosages in nicotine patches has shown to increase long term abstinence rates, but continuing the use for more than the initial 8-12 weeks did not increase cessation success rates (Tønnesen et al., 1999). The success of NRT is dependent on the amount of additional support given to the smoker (Silagy et al., 2004) though it is not dependent on additional counseling (Stead et al., 2012). NRT is easily combined with other smoking cessation aids and improves the chance of success when paired with antidepressants, bupropion (Stead et al., 2012). However, while NRT may double the likelihood of smoking cessation, the quit rate is only about 16% (Viswesvaran & Schmidt, 1992).

2.2.5 Behavioral Counseling

The types of counseling for smoking cessation support can be individual, administered on the phone, in a group setting, or a combination of each. Evidence shows that individual therapy sessions, lasting at least 10 minutes, can aid in the process of smoking cessation (Lancaster & Stead, 2008). There are varying types of individual counseling such as briefly receiving advice from a health care specialist or intensive individual therapy sessions

(Lancaster & Stead, 2008). Acceptance and Commitment Therapy (ACT) (Hayes et al., 1999) is one type of counseling that focuses on self-control and has shown to improve long-term cessation results (Gifford et al., 2004). The objective of group therapy is to evaluate participant's motivation, encourage emotional experiences, and provide information and new skill training. (Hajek et al., 1985; Hajek 1996). Group therapy has shown to be better than self-help methods and those who participated in a formal group intervention doubled their likelihood to quit in the first year (Hymowitz et al., 1991; Stead & Lancaster, 2009). It is unclear if group therapy is more effective than individual therapy sessions, however, in both group and individual sessions, more intensive measures interventions are more successful (Stead & Lancaster, 2009). Behavioral counselling interventions may aid in the smoking cessation process, however, therapist based programs reach a smaller number of smokers due to cost and availability.

2.2.6 Pharmaceutical Drugs

Pharmaceutical drugs have often been proposed as a tool in the smoking cessation process. The TCRB lists Varenicline and Bupropion SR as viable prescription medications that reduce smoking withdrawal symptoms (Tobacco Control Research Branch of the National Cancer Institute, 2016). Bupropion is an antidepressant that has been shown the increases smoking cessation rates more than nicotine patches (Jorenby et al. 1999) and improve long term abstinence rates (Hays et al., 2006). It has success alone and also in combination with NRT (Jorenby et al. 1999), but there is no evidence that suggests NRT provides additional benefit. (Hughes et al., 2011). Other anti-depressants that have been tested for smoking cessation purposes are nortriptyline, which was proven to be as successful as NRT, and

fluoxetine, paroxetine, and sertraline, which were not successful (Hughes et al., 2011). Side effects of the listed antidepressants can range from as mild as dry mouth and nausea, to as serious as seizures and suicide risk (Hughes et al., 2011). Varenicline was specifically designed to aid smoking cessation by addressing a nicotinic receptor in the brain (Obach et al., 2006). Varenicline was more successful in long term smoking abstinence than both a placebo and bupropion SR (Jorenby et al., 2006).

2.2.7 Self-Help

Another common method widely used for smoking cessation is self-help. While individuals who used assistance doubled their long-term cessation rate, only one in five smokers attempting to quit in the past year used an outside form assistance (Zhu et al., 2000). Self-help materials have limited success on smoking cessation, but may increase cessation rates more than having no intervention (Lancaster & Stead, 2005). There is also no evidence that self-help methods are more successful when combined with other cessation tools like NRT (Lancaster & Stead, 2005). Self-help materials have been designed for the different stages of change (Diclemente et al., 1991) and have progressed with developing technology (Prochaska et al., 1993). Greater success may be achieved with self-help programs that provide feedback in accordance to their stage of change, the process involved with change, urge levels, self-efficacy, and decisional balance (Prochaska et al., 1993). The quit rate using self-help approaches is 15% (Viswesvaran & Schmidt, 1992).

2.2.8 Healthy Alternatives

Smokers forego using the methods described for various reasons – whether it be past failure, pregnancy, or fear of using more substances, recent studies have investigated the use

of healthier alternatives to cessation. rChewing gum has been found to reduce the effect of smoking withdrawal symptoms and decrease smoking behavior (Cohen et al., 1999; Cortez-Garland et al., 2010). These results were a result of both flavor and the act of chewing (Cortez-Garland et al., 2010). Flavored gum was more effective than flavorless (Cortez-Garland et al., 2010) and vanilla flavored gum was more effective than baked apple and peppermint (Cohen et al., 2010). One study found that respiratory tract sensations are a key component in curbing cravings (Rose, 1988) and thus found that inhaling black pepper extract vapor reduces nicotine withdrawal symptoms (Rose & Behm, 1994). Other alternatives that fall in this category are hypnosis and acupuncture, which as previously discussed, hold no evidence of successfully aiding in smoking cessation (Tobacco Control Research Branch of the National Cancer Institute, 2016). A major healthy alternative for smoking cessation that has been extensively studied, and is the primary focus of this paper, is exercise.

2.2.9 Exercise for Smoking Cessation

Exercise has been suggested and tested as an alternative method of smoking cessation. First, exercise is both physically and mentally beneficial (Morgan, 1997; Warburton et al., 2006), but may provide extra benefits to smokers. Three reviews on exercise and smoking cessation provide evidence that exercise reduces urges to smoke, withdrawal symptoms, and negative affect (Taylor et al., 2007; Roberts et al., 2012; Ussher et al., 2012). Negative affect is subjective distress and unpleasant feelings that effect mood states (Watson & Clark, 1988). In smoking studies, negative affect primarily refers to these unpleasant feelings, mood disturbance, stress, anxiety, depression, irritability, hostility, tension (Ussher et al., 2000; Van Rensburg et al., 2008; Stathopoulou et al., 2006; Piasecki et al., 2000)

prompted by withdrawal symptoms during abstinence and evaluated using the Profile of Mood States (POMS). Exercise is also beneficial for reducing weight gain, including fear of weight gain, and reducing the number of cigarettes consumed (Kawachi et al., 1996; Taylor et al., 2007). Though the relationship between exercise, withdrawal symptoms, and urges is not fully understood (Ussher et al., 2012), similarities of the effects that both exercise and smoking have on the brain have been established.

Smoking effects neurobiological mechanisms by increasing β-endorphins, cortisol, and opioids levels, which exercise has shown to mimic, while also stimulating the central nervous system (Acevedo & Ekkekakis, 2006; Dishman & O'Connor, 2009; Leelarungrayun et al., 2010). β-endorphins are an "endogenous peptide opiate" (Dalayeun et al, 1993) that play a role in addictive behavioral patterns. β-endorphins and cortisol plasma levels rise during exercise and have been found to be highest after long durations of intense exercise, and also improve mood and reduce pain (Goldfarb et al., 1990). High levels of β-endorphins are found in heavy smokers (Dalayeun et al., 1993). Neurotransmitters are released by nicotine, which is illustrated with their reinforcing agents in Figure 1 (Benowitz, 2008). Catecholamines (adrenaline, norepinephrine, and dopamine) reinforce the effects of nicotine by signaling a pleasurable experience when released (Benowitz, 2008), but exercise has demonstrated the ability to be an alternative reinforcer to smoking by effecting dopamine, norepinephrine GABA, glutamate, serotonin, and β-endorphins (Marlatt & Kilmer, 1998; Dishman et al., 2006).

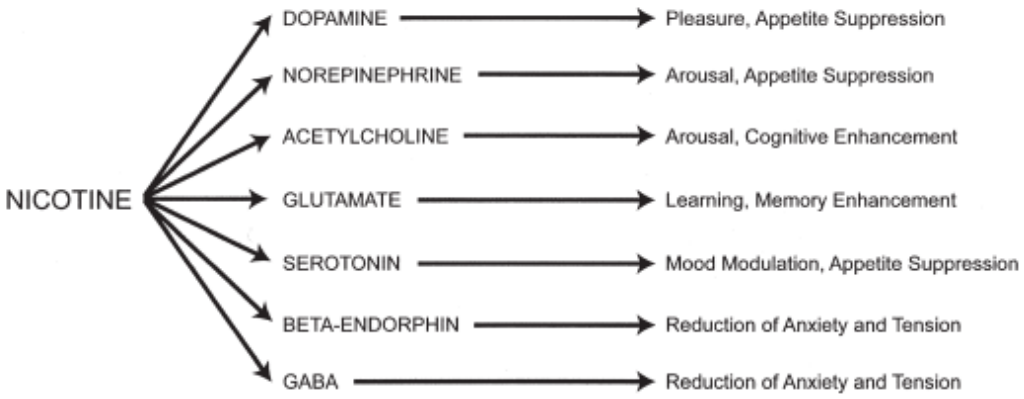

FIGURE 1: NICOTINE NEUROTRANSMITTERS AND THEIR EFFECTS (BENOWITZ, 2008)

Exercise has been tested as a cessation method using various intensities, durations, and types of activities. Each of the studies discussed in this section utilize different methods of exercise and methods of measuring intensity including VO2max, heart rate (HR) or beats per minute (BPM), heart rate reserve (HRR), maximal heart rate, physical work capacity (PWC), and watts (W). Three full reviews of the effects of exercise on smoking urges and withdrawal have been conducted by Taylor et al. (2007), Roberts et al. (2012), and Ussher et al. (2012) and should be referenced for in-depth analyses of this topic. It is the primary interest of this research to evaluate studies that investigate the effect of single bouts of exercise on smoking urges and withdrawal. First, there has been positive results with low intensity activities, but with very short abstinence periods. Taylor & Katomeri (2007) used a two-hour abstinence period to find that 15 minutes of brisk walking not only reduced cigarette cravings and withdrawal symptoms, but also, increased amount of time between cigarettes and helped reduce cue ensued cravings. Elibero et al. (2011) found similar results regarding cue induced cravings with 30 minutes of cardiovascular activity and found 30 minutes of Hatha yoga generally decreased cravings, with a one-hour abstinence period.

Longer abstinence periods have been tested on light, moderate, and vigorous activities. One study found that 15 minutes of vigorous activity (70-85% Heart Rate Reserve - HRR) in the form of cycling, after overnight abstinence, reduced cigarette cravings more when compared to 15 minutes of light and moderate activity (40-59% HRR) (Roberts et al., 2015). However, it has been shown that moderate activity has a similar effect on cravings and withdrawal symptoms as vigorous activity (Ekkekakis & Perzzelo, 1999; Everson et al., 2008; Scerbo et al., 2010; Haasova et al., 2014). Moderate activity may be a better choice over vigorous activity because it is easier for sedentary smokers to adopt and has a better effect on mood (Wankel, 1993; Everson et al., 2008; Scerbo et al., 2010). Studies conducted by Van Rensburg et al. (2009) and Daniel et al. (2007) support the reduction of cravings and withdrawal symptoms through moderate intensity activity. Daniel et al., (2004) found reductions in smoking withdrawal symptoms for up to ten minutes after five minutes of moderate intensity activity (compared to that with light activity) following an 11-14-hour abstinence. Taylor et al. (2007) found self-paced walking reduced urges to smoke up to 20 minutes' post-treatment after abstaining from smoking for 15 hours. Falkner et al. (2010) also found that self-paced brisk walking reduces cravings during treatment and may change smoking behavior.

2.3 Smoking Habit

Smoking has often been referred to as a habit, rather than an addiction. Habits can be attributed to psychological dependence and addiction can be attributed to physical dependence (Bernstein, 1969). Cessation and relapse treatments should rely on how psychological and physical dependences are defined. Per the World Health Organization, psychological dependence is the "experience of impaired control over drug use." Physical

dependence is defined as “tolerance and withdrawal symptoms”. First, while smokers build a tolerance to nicotine (Johnston, 1942; Winsor & Richards, 1935), they do not increase their doses of nicotine in the same manner as those who become addicted to narcotics (Bernstein, 1969). The Surgeon General Report (1964) points out that the withdrawal symptoms that smokers experienced are the same as reactions to an emotional disturbance from deprivation of a desired object or habitual experience. Drug habituation, also stated by Douglas Bernstein, is classified by the World Health Organization as “a condition resulting from repeated drug use involving a desire to continue taking the drug (at a relatively constant does) which results in psychological, but not physical dependence” (Bernstein, 1969). One theory of habituation which involves the “habit loop” of cue, routine, reward (Duhigg, 2012). In the habit loop, not only is the brain’s decision making power significantly reduced, but more so, the brain cannot tell the difference between good habits and bad habits (Graybiel, 2005; Thorn et al., 2010). However, creating new healthier neurological routines, such as an exercise habit, can override bad habits (Graybiel, 2005; Thorn et al., 2010). Using the theories addressed above, smoking cessation treatments need to address the behavioral aspect and the habit itself.

CHAPTER 3: CURRENT STUDY DEFINED

3.1 From Literature

This research follows methods of previous studies in many ways. First, it aims to utilize the neurobiological processes that occur in exercise to simulate those of smoking and attenuate the reinforcing agents of nicotine. As a single bout of moderate or self-paced exercise has shown to reduce smoking urges and negative affect after overnight to 15 hours of abstinence (Taylor et al., 2005), this study aims to use self-paced exercise, specifically walking, for the participants desired length of time and to their desired level of exertion, to reduce smoking urges and lessen negative affect.

This research also builds on existing studies with new methods. Of the 26 exercise studies combined in the Taylor et al. (2007) and Roberts et al. (2012) reviews, only one study (Ho et al., 2009) utilized a 24-hour abstinence period. The study conducted by Ho et al. looked at the effect of a single bout of resistance exercise and its effects on smoking withdrawal symptoms and smoking urges. This study is like the current study not only in its length of abstinence time, but also its small sample size of eight participants. It is different from the current study in that it only included men in its demographic. Other studies have ranged from 30 minutes to ~17 hours (Taylor et al., 2007; Roberts et al., 2012). Self-paced exercise has shown to reduce cravings and negative affect when performed after smoking abstinence (Taylor et al., 2005; Falkner et al., 2010), but to this author's knowledge, there are no studies that evaluate how self-paced exercise affects cravings during smoking abstinence. Finally, to this author's knowledge, there are no studies that aim to replace the act of smoking with physical activity. Such research may not exist for many reasons, however, a primary reason

this type of study has yet to exist could be related to the type of exercise primarily studied. Previous research using exercise to attenuate smoking largely focuses on moderate to vigorous activity (Ekkekakis & Perzzelo, 1999; Daniel et al. 2007; Everson et al., 2008; Van Rensburg et al. 2009; Scerbo et al., 2010; Haasova et al., 2014; Roberts et al., 2015). Because this type of activity may cause perspiration and usually requires exercise equipment (including exercise attire), this type of activity is not suitable for completing multiple sessions a day, at a moment's notice – like an onset of a craving, or in various settings like work, driving, or during day to day activities. Recent studies showing that low intensity, or life-style exercise, can have similar urge reducing effects as higher intensity activity (Elibero et al. 2011; Falkner et al. 2010; Taylor et al., 2007), has opened possibilities to not only incorporate more activity throughout a smoking abstinence period but also to measure its effects on smoking urges.

3.2 Study Key Design Decisions

In the study design phase, three factors were defined: target demographic, length of abstinence period, and survey administration schedule. The target demographic decisions included age range, gender, and smoking and exercise habits and were determined using Saul Shiffman studies (e.g. Shiffman, 1982; Shiffman et al., 1996a; Shiffman et al., 1996b; Shiffman et al., 1996c; Shiffman et al., 2002; Shiffman & Waters, 2004) to represent the average smoker. The minimum age was set to 24 because Burns et al., (2000) indicated that eliminating smokers under their mid-twenties removes those who are still developing their smoking habits and still experimenting with smoking and affected by a different set of factors. While smoking has been shown to affect more men than women (40% to 9%), it remains an

issue causing serious side effects, illness, and death in both genders (World Health Organization, 2010). This supports to use of both males and females in this study, as well as in most smoking studies referenced, for example: Daley et al., 2004; Daniel et al., 2004; Daniel et al., 2007; Everson et al., 2008; Faulkner et al., 2010; Haasova 2014; McBride, et al., 2006; Scerbo et al., 2008; Shiffman et al., 1996a; Shiffman et al., 1996b; Shiffman et al., 1996c; Shiffman et al., 2000a; Shiffman et al., 2000b; Shiffman et al., 2004; Taylor et al., 2005; Taylor et al., 2007a; Taylor et al., 2007b; Ussher et al., 2000.*

*Not an exhaustive list. Does not include all studies referenced in this paper that use both men and women.

The length of the abstinence period was set to 24 hours to capture the withdrawal symptoms peak (Hughes, 2007). This time frame was long enough to allow the participants to return to their daily activities and the smoking urges to be assessed in each participant's natural environment, which minimizes recall bias and symptom suppression found in laboratory settings (Hughes & Hatsukami, 1986). The length of time between the two conditions was set to one week because of the test-retest model that demonstrated the stability of interviews conducted seven days apart (Saslow et al., 1957).

Another experimental decision made was the administration schedule of the smoking urges survey. The goal was to understand how physical activity affected smoking urges throughout the 24-hour abstinence, so the survey needed to be distributed throughout the abstinence period. The two-item MPSS survey was given to participants every four hours while awake. This was determined to be a reasonable reference time between each survey for the frequency in which urges occur in addicted smokers (Igou et al., 2002), without encouraging a cue-induced urge (Niaura et al., 1988). Although this subjected the data to differences in the amount of times each participant took the survey, it is similar to the

methods ecological momentary assessment (EMA) by Shiffman & Stone (1994). EMA relies on repeated assessments of the participant's real-time state in their natural environment (Shiffman & Stone, 1998). EMA aims to minimize bias and reduce the effects of autobiographical recall, or the recollection of one's own life, by focusing on how subjects are currently feeling rather than how they feel in general (Hughes & Hatsukami, 1986; Shiffman et al., 1996). This approach allows for ecological validity because data is a result of how participants respond in day to day life situations (Shiffman & Stone, 1998). This study followed a similar procedure, except the survey was not administered at random intervals, which is key in the EMA approach (Shiffman & Stone, 1998), and still relied on autobiographical recall in four hour segments. However, by collecting the MPSS in real-time in the participant's natural environments, it is possible to address how urges increased throughout the abstinence period.

3.3 Questionnaire Considerations

There are many smoking questionnaires currently used in research, there are only a few that address the objective of this study. For surveys addressing smoking urges, research indicates that there is not a benefit to using multi-item questionnaires over shorter questionnaires (Etter & Hughes 2006; West, 2006; West & Ussher, 2010). With this information, only short (10-items or less) surveys that addressed smoking urges or cravings were considered for this study. The questionnaires or parts of questionnaires that were considered were the Minnesota Nicotine Withdrawal Scale (MNWS), Questionnaire on Smoking Urges – brief (QSU – brief), Mood and Physical Symptoms Scale (MPSS), Wisconsin Smoking Withdrawal Scale (WSWS), Cigarette Withdrawal Scale (CWS), Shiffman Scale (SS),

and Craving Rating (CR), as these were the brief surveys reviewed by West and Ussher (2010). The MNWS is originally a nine-item model, however, only one question was used to rate desire or the craving to smoke on a scale of zero ("none") to 4 ("severe"). It was validated as a reliable smoking withdrawal survey by Cappelleri et al. (2005) and the question on craving or desire to smoke was validated as an essential part of the survey by Toll et al. (2007). This survey was not chosen specifically because of the phrasing of the question in terms of craving and desire, rather than urge to smoke. The WSWS is originally a 28-item questionnaire with seven sub-scales used for research purposes and validated by Welsch et al. (1999). The craving sub-scale consists of four question addressing the frequency of urges, being bothered by the urge to smoke, and thoughts about smoking on a zero ("strongly disagree") to four ("strongly agree") scale (West & Ussher, 2010). This survey was not chosen for this study because of the thoughts on smoking are not part of this studies objective. The Cigarette Withdrawal Scale contains 21 questions with six factors and was validated to measure cigarette withdrawal symptoms and aid in predicting relapse (Etter, 2005). The craving factor asks about thoughts on smoking, feelings on smoking, the need to smoke, and the desire to hold a cigarette on a zero ("totally disagree") to four ("totally agree") scale (Etter, 2005; West & Ussher, 2010). While this questionnaire addresses smoking withdrawal, it does not specifically ask about urges to smoke and was therefore, not chosen for this study. The Shiffman Scale (SS) is commonly used in studies by Saul Shiffman and consists of a four-item questionnaire with a ten-point rating (1=low, 10=high) on the urge and need to smoke and the craving and need for a cigarette (Shiffman et al., 2000a, Shiffman et al., 2000b). This survey was not chosen because this study was not addressing "need." The Craving Rating (CR)

is a one-item survey that specifically asks “how much have you craved cigarettes today?” on a zero (“not at all”) to five (“a great deal”) scale (West & Ussher, 2010). This survey was not chosen because it asked specifically about “today” and this phrasing was not ideal for the structure of this study. Both the MPSS and QSU-brief specifically addressed the urges to smoke. The MPSS two-item survey was concise enough to be used multiple times throughout the 24-hour abstinence. The QSU-brief covered slightly more information with ten-items as the final urges survey with two factors relating to smoking urges. Using more than one survey on urges was intended to add breadth and reliability to the study.

The Profile of Mood States was the only survey considered for addressing the negative affect of withdrawal because of its widely accepted use and reliability, especially situations involving physical activity (Nyenhuis et al., 1999; Berger & Motl, 2000).

3.4 Engineering Analysis Formulation

The process that this study addressed was formulated using an engineering Black Box Model, shown in Figure 2. The black box model is used to analyze and answer questions in all areas of research, for example: it has been used to explain collaborative learning approaches in education, to decipher the constructs of different mental models in psychology, to analyze the effect of integrative leadership on the relationship between capacity and performance in public management, and re-visit the use of block ciphers for compression functions (Rouse & Morris, 1986; Andrews & Boyne 2010; Janssen et al., 2010; Hirose, 2014). While there are different types of Black Box Models, in all cases it is used to address cases with many unknowns and using the model is “an appropriate first step in understanding” the process inside the black box (Hirose, 2014). This is especially relevant to this study because there is

no current research on replacing the act of smoking with exercise, so this study can be considered the first step of many in understanding this method.

This black box model consists of four parts: controlled inputs, uncontrolled inputs, outputs, and the process that occurs. Because the problem being addressed is how to aid in smoking cessation for people, the process with in the black box is what occurs in the body during the study. While abstaining from smoking nicotine content is decreasing and withdrawal symptoms and negative affect is increasing. The controlled inputs are the number of cigarettes the person is consuming (zero), and how long the body is abstaining from cigarettes (24-hours). The outputs are the four readings the participants provide including: their smoking urges every four hours while awake (MPSS scores), their smoking urges at the end of the 24 hours (QSU score), the MVPA completed in 24 hours, and their mood state (POMS score) at the end of 24 hours. The uncontrolled inputs are the MVPA completed for daily activity, the MVPA activity completed to replace smoking, the amount of time spent sleeping, and the life events, stressors, smoking cues that effect smoking urges and mood states.

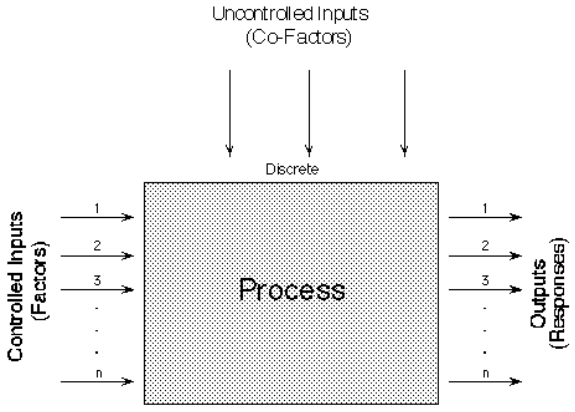

FIGURE 2: "DIAGRAM OF THE BLACK BOX MODEL" FROM "3.1.3.5. PROCESS MODELS" BY NIST SEMA TECH

CHAPTER 4: METHODOLOGY

4.1 PARTICIPANTS

Potential participants were recruited through a mass campus student e-mail at Iowa State University, Industrial Engineering departmental e-mails, class announcements, flyers, contacting local businesses, and personal communication. The inclusion criteria for this study were daily smokers of the ages of 24 to 40, averaged at least ten cigarettes per day and have a smoking history of at least two years, with a desire to quit smoking (Shiffman, 1982; Shiffman et al., 1996a; Shiffman et al., 1996b; Shiffman et al., 1996c; Shiffman et al., 2002; Shiffman & Waters, 2004). Potential participants were excluded if they engaged in high intensity aerobic activity for more than an hour each week, which included physically demanding jobs. Potential participants were also excluded if they had a history of diabetes, respiratory diseases, or cardiovascular medical issues (i.e. heart attacks, stents, and heart surgeries). Those requiring assistive walking devices (i.e. walkers, canes, etc.), who were pregnant or trying to become pregnant, and who are allergic to Polycarbonate and/or Polyvinyl Chloride materials were also excluded. Participants were not compensated.

4.3 MEASURES

Pre-Screening Medical History Form. Before the study began, volunteers filled out a self-report pre-screening Medical History Form. This form was created for this study as a preliminary measure to collect demographic data and to determine if the potential participants met the inclusion and exclusion criteria for the study. The Medical History Form consisted of each potential participant providing their name, date of birth, sex, and answering

questions about their smoking habits, occupation, daily activity, exercise habits, intentions to quit smoking, and history of respiratory diseases, and cardiovascular medical issues.

Mood and Physical Symptoms Scale (MPSS (C)) (MPSS; West & Hajek, 2004). A two-item version of the MPSS was used to assess participants urge to smoke. The MPSS (C) was chosen because of its direct relationship in assessing urges to smoking with 'strength of urges' and 'amount of time with urges.' The MPSS (C) was given approximately every four hours while awake during the 24-hour abstinence period. Responses were collected on a five-point scale including, 'not at all,' 'slightly,' 'somewhat,' 'very,' and 'extremely.' This modified version of the MPSS has shown to have the same sensitivity as the QSU-brief (West & Ussher, 2009), while remaining concise (West et al., 2006) and utilizing a multi-item measure (Shiffman et al., 2004).

Questionnaire of Smoking Urges - brief (QSU; Tiffany & Drobes, 1991). At the end of the 24-hour abstinence for each condition, a 10-item self-report questionnaire was given to assess the participant's urges to smoke. Responses were collected on a seven-point scale ranging from 'strongly disagree' to 'strongly agree.' This questionnaire was developed as a shorter alternative to the original 32-item survey, while still operating as a multidimensional craving measure (Tiffany & Drobes, 1991; Cox et al., 2001). The ten questions were broken into two factors: 'intention/desire to smoke' and 'relief of negative affect & urgent desire to smoke' (Toll et al., 2006).

Carbon monoxide measures (CO). CO measures are a simple, cost-effective biomarker of smoking status (Jarvis et al., 1987). Using a CoVita COmpact USB (CoVita, Heddonfield, NJ) CO reader, an expired air CO test was administered to validate self-reported 24-hour smoking

abstinence. Given the standards set by the Society for Research on Nicotine and Tobacco's Subcommittee on BioChemical Verification (2002), participants were required to register a CO level below 10 parts per million. This standard was also used as a measure of eligibility to for the participant's data to be used in the study and for further participation in the study.

Moderate and Vigorous Physical Activity (MVPA). Throughout the 24-hour abstinence, each participant's activity level was tracked using an ActiGraph GT3X+ (AG; ActiGraph, Pensacola, FL). This device is a noninvasive activity monitor that was to be worn around the waist during the waking hours of the study duration and removed only for water-based activities. This device has proven to be a valid method in measuring physical activity (Sasaki et al., 2011). The measures collected with this device were used to compare the amount of active time in each condition.

Profile of mood states (POMS). The Profile of Mood States (POMS; McNair et al., 1971) is a 65-item self-report questionnaire that assess positive and negative affects. While the positive affect (vigor-activity) is presented in this study, the primary focus is the change in negative affects of smoking withdrawal symptoms. Responses were collected on a 5-point scale with zero registering as 'not at all' and four as 'extremely.' The six moods that are assessed are tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment.

Experience Surveys. Two experience surveys were created for this study. Each survey addressed the nature of the condition and the subjective aspect of the participant's experience throughout the 24-hour abstinence. The control condition experience survey

consisted of two short answer questions. The experimental condition experience survey consisted of four short answer questions on the effectiveness of the methods used.

4.4 Procedure

Participants were sent the Informed Consent Document prior to filling out the Medical History Form and were instructed to read, print, sign, and bring it to the first meeting. Instructions were reiterated verbally via the consent form and then participants were provided the opportunity to ask further questions regarding the study.

After the pre-screening process was complete, participants met with the principal investigator to begin the 24-hour abstinence period. During this meeting, the first step was to administer an expired air CO test using the CoVita COmpact USB - the participant's baseline CO level measured in parts per million (ppm). The participants were given their Actigraph monitors, instructed on its uses, and randomly assigned a condition. There were two, counter-balanced conditions and each participant was asked to complete both conditions one week apart. The control condition was asked to abstain from smoking for at least 24 hours, while wearing the activity monitor, and fill out the MPSS(C) 2-item questionnaire on their urges to smoke every four hours (during waking hours), once before bed, and once upon immediately waking, without making any other changes to their daily routine. Text message reminders were scheduled by the principal investigator using an iOS application and sent to the participants every four hours based on an agreed upon schedule set during the first meeting. The experimental condition followed the same process, but participants were asked to replace their habit of smoking with walking – every time an urge to smoke would ensued. Participants were instructed to walk at their own pace and for as long as they would like.

At the end of the 24-hour abstinence period, the participants met with the principal investigator, again. The expired air CO2 test was once again administered and the results recorded. Each participant filled out the Questionnaire on Smoking urges 10-item survey on their current smoking urges based on their experience of the previous 24-hour abstinence. They also took the Profile of Mood States (POMS) Survey and a brief Experience Survey. All surveys were given online through Qualtrics. Participants were asked to return to their normal smoking routine in between experimental conditions.

4.5 Statistical Measures

MPSS. To examine the effects of MVPA on urges between the two conditions, each question was analyzed individually, as well as, the MPSS (C), or the total of the two questions. The average was taken for each question in each condition, for the total MPSS(C) score, and for the rate in which urges increased or decreased for each participant. Standard deviation and effect sizes were calculated for the averages.

QSU-Brief. To address smoking urges at the conclusion of each condition, the QSU-Brief was scored using standard procedures (Tiffany & Drobes, 1991). The sum of the two factors and the sum of all ten questions were calculated for each participant. Standard deviation and effect size was also calculated using each of the three average scores.

POMS. Each participants' POMS answers were scored using standard procedures, which totaled the scores for the six moods (tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment), as well as, a Total Mood Disturbance (TMD) (Lorr et al., 19971). The totals for each subscale and the TMD were

analyzed with averages, standard deviations, and compared between conditions with effect size calculations.

MVPA. The summation of the moderate and vigorous activity minutes, and number of steps for each participant was calculated. The difference in activity level between each condition was calculated. A scatter-plot was created to investigate the correlation between participants change in mood scores and change in activity.

Sample Size. A sample size test was run using the Sample Size and Power function for k-samples in JMP version 10 on the MPSS(C) survey results to determine the number of participants that would be needed to make the data significant. Using ten mean scores from the first ten participants total score in the control condition with a power of .8 and an alpha of .05, it was determined that 27 participants would be needed. Using this same method for the experimental condition, the sample size indicated the need for 26 participants.

Rate of Increase. Rate is the change in the y-axis over the change in x-axis which can be measured using the slope and graphically represented. To the author's knowledge, there has yet to be a study that addresses the rate of increase of smoking urges throughout a 24-hour abstinence. This is because there have been no studies that have looked at effects of exercise throughout an abstinence period with the intention of replacing the act of smoking with that exercise. However, this concept can be paralleled with human factors research and manufacturing principles. Rate of increase has been used to evaluate the rate that tendons heal by evaluating the slope of tensile strength over time (Mason & Allen, 1941). Another study analyzed tensile properties of repaired tendons with the slope of ultimate load and the length of the repair (Woo et al., 1981). Biomechanical models used for issue differentiation

and bone regeneration also have utilized rate of increase and decrease calculations to develop a model for fracture healings (Lacroix et al., 2002). This study utilizes rate of increase for the MPSS survey. Each participant took the survey multiple times over the course of 24 hours. These data points can be graphed followed by a slope calculation – this slope illustrates the rate of increase or decrease of urges over the 24-hour smoking abstinence.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 GROUP ANALYSIS

Demographic. The participant demographic consisted of 13 participants, five females and eight males. The average age was 27.1 (range=24 to 30) with an average of 13.2 cigarettes per day (SD= 4.3) and an average smoking history of 8.5 years (range= 2 to 14). Two participants did not comply with the abstinence stipulations and did not pass the Carbon Monoxide expired air test. Their data were not used in the analysis.

MPSS. The raw averages, standard deviations, and effect size for each question and the total score are listed in Table 1. The rate of urge increase was calculated using the slope of each participants scores over the 24 hours and the averages, standard deviations, and effect size of the slopes are shown in Table 2. The rate of urge increase ranged from -4.631 to 8.342. The effect size, in all cases, reveals the differences are not meaningful.

TABLE 1: MPSS RAW DATA

MPSS	Time		Strength		Total	
	Control	Exp.	Control	Exp.	Control	Exp.
Average	2.21	2.00	2.15	2.05	4.36	4.05
Std. Dev.	1.35	1.35	1.40	1.33	2.55	2.49
Effect Size	0.16		0.08		0.13	

TABLE 2: MPSS RATE OF URGE INCREASE

Rate of Urges	Time		Strength		Total	
	Control	Exp.	Control	Exp.	Control	Exp.
Average	1.27	0.99	0.74	1.21	2.03	2.16
Std. Dev.	1.61	1.56	1.64	1.70	3.03	3.05
Effect size	0.17		-0.28		-0.04	

QSU-brief. The average Questionnaire on Smoking Urges score and standard deviations are shown in Table 3. There was no meaningful difference in the averages for Factor 1, Factor 2, and the Total Urge to Smoke scores.

TABLE 3: QSU-BRIEF SCORES

QSU - Brief	Intention/ Desire (Factor 1)		Relief of Neg. Affect (Factor 2)		Total	
	Control	Exp.	Control	Exp.	Control	Exp.
Average	26.91	26.91	17.91	16.27	44.82	42.64
Std. Dev.	8.51	7.69	6.56	7.69	14.62	14.15
Effect size	0		0.22		0.14	

POMS. The average score, standard deviation, and effect score for each of the six moods and the TMD are shown in Table 4. The average score for anger was moderately higher in the control condition compared to the experimental condition. There were small differences favoring the experimental condition for the four remaining negative affect subscales as well as TMD, based on effect size calculations.

TABLE 4: POMS SCORES

POMS	Ten		Dep		Ang		Vig		Fat		Con		TMD	
Session	Control	Exp.	Control	Exp.	Control	Exp.	Control	Exp.	Control	Exp.	Control	Exp.	Control	Exp.
Average	14.73	10.64	9.36	6.00	15.18	9.73	11.73	10.55	8.09	6.64	8.36	6.00	144.00	128.45
Std. Dev.	8.99	7.68	12.50	6.78	11.53	8.21	4.56	3.83	6.83	4.90	6.56	5.93	41.48	33.04
Effect size	0.49		0.33		0.54		0.28		0.24		0.38		0.41	

MVPA. The average and standard deviations of activity in minutes and number of steps is shown in Table 5. As a group, there was a small effect size for Activity Time and Number of Steps. Averages for each participant that were used to calculate the overall averages shown below can be found in Appendix A.

TABLE 5: ACTIGRAPH DATA

ActiGraph	Activity Time		Difference	Number of Steps		Difference
	Control	Exp.	Exp.-Cont.	Control	Exp.	Exp.-Cont.
Average	227.84	192.67	-35.17	6650.36	5689.27	-961.09
Std. Dev.	113.07	90.96	82.81	4072.26	2772.55	3954.77
Effect Size	0.34			0.28		

5.2 Individual Analysis

The group analysis revealed little to no difference between the control and experimental conditions, so to better understand the connection between MVPA and its effects during smoking abstinence each participant was analyzed individually. A full analysis of each participant, including demographic information, activity levels at each survey point, and their qualitative experience is provided in Appendix B. Below three summary tables illustrate each participants change in average score between the experimental and control conditions. In Table 6, an improvement in average MPSS score is represented by a negative number, or a green highlighted cell. This shows that their average urge to smoke throughout the 24-hour abstinence was less in the experimental condition. In Table 7, an improvement in negative affect is illustrated by a positive number, or a green highlighted cell. This shows that there was less negative affect in the experimental condition. Finally, in Table 8 an improvement in average QSU score is represented by a negative number, or a green highlighted cell. This shows that their average urge to smoke was less at the end of the experimental condition.

Key Worsen | Improve | No change

TABLE 6: MPSS - CHANGE IN AVERAGE SMOKING URGE (EXP-CONT.)

	Time	Strength	Total
w1505	1.50	1.00	2.50
w1506	-0.58	-1.17	-1.75
w1507	-0.34	-0.34	-0.68
w1509	0.00	-0.60	-0.60
w1510	-0.25	0.50	0.25
w1511	-0.50	-0.50	-1.00
w1512	0.75	1.25	2.00
w1513	-0.25	-0.50	-0.75
w1615	-1.33	0.33	-1.00
w1616	-1.00	0.33	-0.67
w1617	-0.66	-1.00	-1.67

TABLE 7: POMS – CHANGE IN MOOD (CONT.-EXP)

	Ten	Dep	Ang	Vig	Fat	Con	TMD
W1505	10	22	18	-1	-14	0	37
W1506	13	-1	9	-2	6	2	31
W1507	-5	-2	-4	-3	-1	1	-8
W1509	0	5	7	5	0	2	9
W1510	4	0	2	2	-3	-2	-1
W1511	0	0	-1	0	0	0	-1
W1512	2	0	1	1	-2	0	0
w1513	9	12	9	10	9	10	39
W1615	12	3	24	-3	7	4	53
W1616	-1	-3	1	2	11	5	11
w1617	1	1	-6	2	3	4	1

TABLE 8: QSU – CHANGE IN URGE TO SMOKE (EXP-CONT.)

	Intention / Desire to Smoke	Relief of Neg. Affect	Total
W1505	0	0	0
w1506	-1	5	4
W1507	-1	4	-3
W1509	6	7	13
w1510	-6	-3	-9
W1511	11	4	15
W1512	-2	-2	-4
w1513	-1	0	-1

TABLE 9 CONTINUED

w1615	-9	-10	-19
W1616	5	-15	-10
w1617	-2	-8	-10

5.2.1 Experimental condition activity increase – Mood Improvement

There were three participants who increased their activity in the experimental condition. The average, standard deviation, and effect size of this sub-group is shown in Table 9, below. The MVPA increase ranged from 6.82 to 11.75 minutes and the change in number of steps ranged from 465 to 1676. This sub group completed an average of 19 more active sessions (Range= 11 to 34), and increased their percent of daily activity by .19% (range=-.53% to 1.13%) on average. One participant had MVPA sessions that lasted between eight to ten minutes. The positive mood change ranged from one to 37. Two of the participants decreased their average urge to smoke throughout the study (MPSS score) and one decreased their urge to smoke by at the conclusion of the study (QSU score). One participant had no difference in their QSU score. The effect sizes for each category of this sub group are all moderately meaningful using Cohen's d.

From this group, four participants had flexible jobs and work hours, or were on vacation. Two were male, one was female, and none of them exercised regularly. No general trends or patterns were apparent from their activity and smoking urge relationships.

TABLE 9: SUB-GROUP ACTIVITY INCREASE, MOOD IMPROVEMENT

	Active Sessions		MVPA		% Active		Steps	
	Control	Experimental	Control	Experimental	Control	Experimental	Control	Experimental
Average	50.33	69.33	37.01	46.39	4.46%	4.65%	5059.67	5997.00
Std. Dev.	17.50	17.00	2.18	3.26	0.95%	1.53%	302.00	405.00
Effect	-1.10		-3.39		-0.15		-2.62	

5.2.2 Experimental condition activity decrease – Mood improvement

There were four participants who decreased their activity in the experimental condition, but still had a positive mood change. The average, standard deviation, and effect size of this sub-group is shown in Table 10, below. The MVPA decrease from the control to the experimental condition ranged from 0 to 46.07 minutes and the change in number of steps ranged from 268 to 2282. This sub group completed 13.25 more active sessions (Range= -19 to 36), and 2.1% percent of daily activity (range=-.17% to 4.37%) on average in the control condition. One participant had MVPA sessions that lasted between eight to ten minutes. The POMS scores ranged from 11 to 53. All four of the participants decreased their average urge to smoke throughout in the experimental condition (MPSS score) (range= -.67 point to -1.75) and three decreased their urge to smoke in at the end of the experimental condition (QSU score) (-19 to 4). The effect sizes for each category of this sub group are all moderately and highly meaningful using Cohen's d.

From this group, three of the four participants had flexible jobs and work hours, or were on vacation. Two were male, two were female, and they all exercised once per week on average. However, three of them were classified as obese by BMI standards. No general trends or patterns were apparent from their activity and smoking urge relationships. Because this group walked less in the experimental condition, but still had less of an urge to smoke and improved their POMS scores in the experimental condition, this may indicate that walking with a purpose (to replace smoking with activity), that their goal oriented walking was more effective than their day to day walking that occurred in the control condition.

TABLE 10: SUB-GROUP ACTIVITY DECREASE, MOOD IMPROVEMENT

	Active Sessions		MVPA		% Active		Steps	
	Control	Exp.	Control	Exp.	Control	Exp.	Control	Exp.
Average	66.00	52.75	51.99	31.48	5.46%	3.36%	4991.00	3861.75
Std. Dev.	24.78	13.55	30.91	17.35	3.09%	1.91%	972.29	1672.54
Effect	0.66		0.82		0.82		0.83	

5.2.3 Experimental condition Activity decrease – Mood decrease

Those who walked more in the control condition and had a decrease or no change in their POMS score are shown in Table 11 below.

One was male and one was female. Both participants were the only two that had jobs that were very structured jobs and they spent more than 75% of their day on their feet. W1512 was also the only participant that exercised regularly. This sub-group not only had little control of how much daily activity their jobs required of them, but they also illustrate that short bouts of walking is not an effective method to reduce smoking urges and negative affect for active people.

TABLE 11: SUB-GROUP ACTIVITY DECREASE, MOOD DECREASE

	Active Sessions		MVPA		% Active		Rec PA Sessions		PA Min		Steps	
	Control	Experimental	Control	xperiment	Control	xperiment	Control	Experimental	Control	Experimental	Control	Experimental
W1507	83.00	68.00	38.30	29.87	3.20%	2.70%	0.00	0.00	0.00	0.00	6948	4746
W1512	113.00	88.00	191.63	73.08	15.57%	7.13%	2.00	1.00	23.20	15.90	18731	6793
Average	98.00	78.00	114.97	51.47	9.39%	4.91%	1.00	0.50	11.60	7.95	12840	5770
Std. Dev.	15.00	10.00	76.67	21.61	6.19%	2.21%	1.00	0.50	11.60	7.95	5892	1024
Effect size	1.57		1.13		0.96		0.63		0.37		1.67	

5.3 Discussion

The objective was to gather information on the effects of life-style based exercise on smoking urges during abstinence. In this preliminary, pilot study with 11 participants the qualitative data shows that more than the majority (73%) of the participants felt that the walking they did complete in the experimental condition completed could aid in smoking

cessation, despite whether the activity was associated to a smoking urge or not. It was hypothesized that during the 24-hour smoking abstinence, the participants urge to smoke would be less in the experimental condition by replacing the act of smoking with walking. The MPSS and QSU-Brief surveys quantified the participant's physical urge to smoke, while the ActiGraph measured the amount physical activity throughout the 24 hours. The POMS assessment quantified the effect of physical activity during the smoking abstinence. The user experience surveys provided qualitative data on the mental and physical effects of the treatment.

First, the average scores for the MPSS survey revealed that the urges to smoke were the same in both the experimental condition than in the control condition for a 24-hour abstinence period. For rate of urge increase, the difference in the 'amount of time with an urge', 'strength of an urge', and total urge score rates were not meaningful by the effect test. Although Taylor et al. (2005) and Falkner et al. (2010) revealed a decrease in smoking urges following self-paced walking, the MPSS in this study was only given every four hours, not immediately following an urge ensued bout of exercise. In accordance with the results of Taylor et al. (2005), unless participants in this study had walked within 20 minutes of taking the survey, the positive effect on smoking urges would not have been captured in the survey results. The survey was not provided more frequently throughout the abstinence period to avoid encouraging a cue-induced urge caused by the survey (Niaura et al., 1988).

The QSU-brief revealed that at the end of the 24 hours the 'Intention/Desire to smoke' (Factor 1) was the same for both conditions. Both Factor 2 and the Total scores revealed a small difference with higher scores in the control condition. The lower score in Factor 2 or

the 'relief of negative affect/ urgent desire to smoke' experimental condition discloses that participants had less of an urgent desire to smoke or a lesser need to relieve the negative affects of smoking withdrawal symptoms, though neither of these differences were meaningful, in accordance to the effect test. This survey was also given at the conclusion of the 24-hour abstinence and not only are reported smoking urges higher while enduring nicotine withdrawal (Shiffman & Jarvik, 1976), but participants have also reported stronger urges to smoke when they are anticipating a cigarette (Droungas et al., 1995; Juliano & Brandon, 1998; McBride et al., 2006). Participants knew that they could smoke at the end of each condition and therefore, no matter which condition they had participated in, they were anticipating a cigarette and had the intention to smoke immediately following the study. It is also important to note, that for those with a two-year smoking history, one day of smoking abstinence would not change their desire or intention to smoke. In fact, one in five smokers who had been abstinent for a minimum of five years claimed to still occasionally have a desire to smoke (Fletcher & Doll, 1969).

Finding no change in urge to smoke score for both the MPSS and the QSU is consistent with the study by Ho et al. (2009) that found no decrease in smoking urges using exercise for a 24-hour abstinence. Daley et al. (2004) and Arbour-Nicitopoulos et al. (2011) also failed to see an effect on smoking urges in exercise-based trials and had sample sizes of 16 participants or less.

The POMS assessment revealed a decrease in tension-anxiety, anger-hostility, confusion-bewilderment, and the TMD. This decrease was expected for the participants that increased their activity in the experimental condition and is supported by extensive research

that shows exercise relieves the negative affects of smoking withdrawal (Byrne & Byrne, 1993; Grove et al., 1993; Hughes et al., 1994; Bock et al., 1999; Ekkekakis & Petruzzello, 1999; Ussher et al., 2000; West et al., 2001; Taylor et al., 2007; Ussher et al., 2012).

A set of results emerged from five participants who had a positive change in mood, but decreased the number of steps or minutes of activity in the experimental condition. With changes in mood it is important to consider other psychological factors. Self-efficacy is the belief that a person has the ability to affect the events in their lives which is supported with motivation, accomplishments, and mental health (Bandura, 1994). A strong relationship has been determined between self-efficacy and health behavior change; meaning, the improvement of self-efficacy is a result of the improvement of that heath behavior change (Strecher et al., 1986). It has been shown that successful smoking interventions improve self-efficacy scores (Condiotte & Lichtenstein, 1981). All the participants included in the data analysis of this study successfully abstained from smoking for 24 hours straight, and although self-efficacy was not evaluated, it is reasonable to assume the participants improved their self-efficacy through that success. One participant continued to abstain from smoking for the next four days following his experimental condition. This is supported by a study that looked at relationships between self-efficacy and mood found linked changes in tension-anxiety, confusion/bewilderment, and total mood disturbance to self-efficacy (Stewart et al., 1994). Although participants did not increase their activity, their mood improvement may be attributed to the self-efficacy of successfully abstaining from smoking and making a positive health behavior change. It has been shown that motivation is a key component to cessation

success and combining measures of self-efficacy and motivation in future studies may contribute valuable information.

CHAPTER 6: CONCLUSIONS

This study aimed to validate the use of healthy alternatives designed to increase the long-term success rates of smoking cessation programs. It was hypothesized that self-paced walking would capture the mental and physical benefits of exercise in a 24-hour smoking abstinence, and reduce the participants urge to smoke. A group analysis revealed no change in smoking urges between the two conditions and a medium to small difference in negative affect. Further analysis of each individual participant revealed patterns that could improve the future direction of this study. First, because of the vast number of participants who had more MVPA in the control condition, it is apparent that participants did not have a means to gauge how much activity was being completed. Those who had physically active jobs and who exercised once per week were the primary demographic who completed more activity in the control condition. This study showed that while data is provided for how much MVPA was completed in each condition, it is unknown what activity was completed for daily activity and what activity was completed to replace smoking in the experimental condition. The time of day and strength of a smoking urge needs to be documented along with the amount of activity that was completed. Smoking urges were generally higher during non-work hours and should be a focus of MVPA in future studies. While incorporating MVPA for a purpose throughout 24-hour abstinence did not show a significant improvement in urges or negative affect, Tables 6, 7 and 8 show results that are trending green – meaning more participants improved their scores than worsened them. This study provides reasoning and key information for developing future research in this area and other alternative methods of smoking cessation.

CHAPTER 7: FUTURE WORK

This study had many limitations that could be addressed in future studies. First, in terms of the Black Box Model, to better understand the effect that walking has on the process occurring in the body during smoking abstinence, more inputs need to be controlled. Because this study was completed in the participant's real-world environment, the amount of sleep, or life events, stressors, and smoking cues cannot be controlled. The MVPA for daily activity also cannot be controlled or predicted. However, the amount of MVPA completed for smoking urges can be controlled. This can be done by setting a minimum amount of activity, including number of steps, number of activity sessions per day, amount of time spent walking, and walking pace, that should be completed throughout the course of the day, in each hour, or over the entire 24-hour abstinence. A major limitation of the current study was not having activity monitors that provided participants live feedback on their activity so an activity monitor that provides live, visual feed back to the participant would be necessary to make this a stipulation in a study. This would aid in potentially establishing a threshold of MVPA that reduces smoking urges and negative affect and provide more information relationships between MVPA and smoking urges and negative affect. Other factors outside of the black box model that were not controlled were how many times each participant completed the survey and at what times of the day they were completed. This can be improved by establishing a set amount of times every participant takes it either through EMA principals at random time intervals, or at the same time of the day for every person. This is an issue for many people who do not have flexible schedules or who cannot be available to their phone or survey device at all points of the day. Another key limitation was a small sample size. More participants,

along with previously mentioned improvements to control the amount of MVPA would create a better picture of the effectiveness of this approach to smoking cessation.

A noteworthy limitation of the current study is that it took place in winter when the weather was not conducive for extended walking outdoors. Future research should also address different types of life-style exercises that could be substituted for walking, like resistance bands, weights, or isotonic holds. These alternative exercises may produce a different hormonal response than self-paced walking that could not only address the negative affect of smoking withdrawal, but also reduce smoking urges. This would also open opportunities for those with life-styles, careers, and all seasons. The next step would be to increase the duration of the smoking abstinence. Nicotine withdrawal symptoms peak between 24-72 hours of abstinence (Hughes, 2007). Because this peak differs for each individual, increasing the abstinence period will capture a larger population experience with nicotine withdrawal and exercise. It is also of interest to prolong the entire experiment or to incorporate this method into a full cessation program lasting multiple weeks. It takes approximately 66 days to make a habit (Lally et al., 2010), so a prolonged study would then be able to determine the effectiveness of replacing the physical act of smoking with a new habit. This would also allow this method to capture more of the physical benefits of exercise and ward off unwanted weight gain. Altering the demographic to only test exercise as a smoking cessation tool on those who are specifically are interested in pursuing a healthier or active lifestyle should also be a component of future studies (Ward et al., 2003). Smoking cessation is an individualized experience and developing alternative methods increases the

likelihood of cessation success through by accommodating different lifestyles, personalities, and motivations.

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APPENDIX A: AVERAGE MPSS SCORES BY PARTICIPANT

TABLE 12: INDIVIDUAL MPSS SCORES

	Time		Strength		Total	
	Control	Exp.	Control	Exp.	Control	Exp.
w1505	1.97	2.12	1.60	1.67	3.57	3.80
w1506	2.70	1.90	2.62	1.50	5.32	3.40
w1507	0.04	2.66	0.19	1.88	0.22	4.54
w1509	-0.01	3.86	0.24	4.14	0.23	8.00
w1510	0.12	0.97	0.06	0.97	0.18	1.94
w1511	4.17	1.74	4.17	1.74	8.34	3.48
w1512	4.03	-1.74	1.74	-2.89	5.77	-4.63
w1513	1.02	-0.73	-2.40	3.00	-1.38	2.27
w1615	0.36	0.10	0.00	0.32	0.36	0.14
w1616	0.00	0.08	-0.21	0.08	-0.21	0.04
w1617	-0.45	-0.07	0.16	0.91	-0.10	0.84
Average	1.27	0.99	0.74	1.21	2.03	2.16
Std. Dev.	1.69	1.64	1.72	1.78	3.18	3.20
Effect size	0.17		-0.27		-0.04	

APPENDIX B: INDIVIDUAL ANALYSIS OF EACH PARTICIPANT

W1505 Results

This participant is a 24-year-old male, travelling, special education teacher. He does not exercise on a regular basis (within normal BMI range), has a smoking history of nine years and smokes between ten and 20 cigarettes per day. He was on winter break during each condition which provided him with a more stable schedule than on work days. He was surprised that replacing smoking with walking worked more than he thought it would, because it briefly got his mind off his urge. He did not have any recommendations to improve the method. In the control condition, he resorted to going to a bar and drinking to cope with his smoking urges. Through verbal feedback, participant iterated that he struggled more in his second condition (control), than he did in the first. He expressed that he counted down the minutes until it was over and he could smoke again.

Participant W1505 completed 28.62 minute of moderate to vigorous physical activity in the experimental condition and 21.8 minutes in the control condition; MVPA was 2.36% and 2.9% of his day, respectively. There was an increase of 1676 steps between the conditions (Table 12). While there were more physical activity sessions in the experimental condition, none of them lasted between 8-10 minutes. On average, his smoking urges scores increased in the experimental condition by 2.5 pts (Table 6). There was no difference between the urge to smoke at the end of both conditions (Table 8). While there was no improvement between conditions on W1505's smoking urges, there was an improvement in tension-anxiety, depression-dejection, anger-hostility, as well as the TMD scores on the POMS (Table 7). Figures X and Y illustrate the relation of physical activity to their smoking urges over the

course of each condition. The lowest smoking urges in the control condition occurred at the beginning of the study for the first two block of time, both with a total score of five and less than two minutes of MVPA. The lowest smoking urge in the experimental condition occurred in the second time block with a total score of two after completing seven minutes of activity in the past four hours and approximately 20 minutes total of MVPA. The experimental condition reveals an inverse relationship between the urge to smoke and amount of activity. Higher activity results in lower urges to smoke. The fourth MPSS survey was taken with-in three hours of the 24-hour mark in both conditions, revealing a spike in the urge to smoke score.

TABLE 13: W1505 ACTIVITY SUMMARY

W1505	Control	Experimental
Active Sessions	46	80
MVPA	21.80	28.62
% Active	2.90%	2.36%
Steps	3261	4937
Rec PA Sessions	0	0
PA Min	0	0

MPSS and Activity

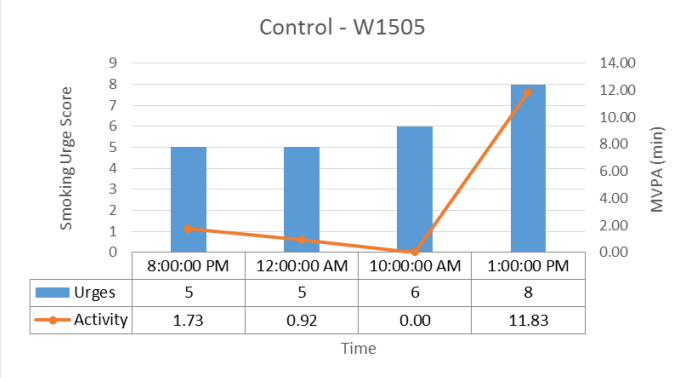

FIGURE 3: CONTROL – W1505

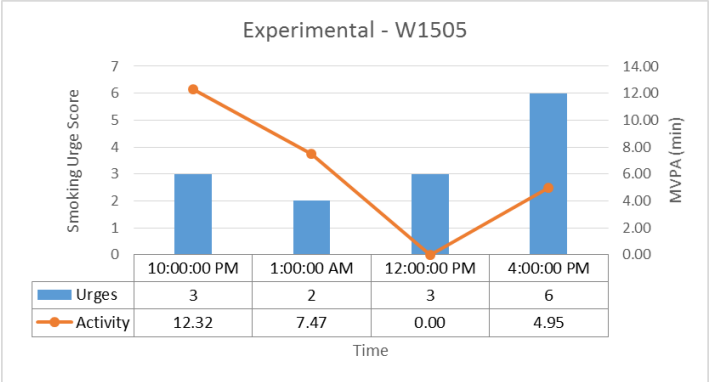

FIGURE 4: EXPERIMENTAL - W1505

W1506 Results

This participant is a female, 27-year-old elementary school teacher. She exercises once per week, within normal BMI range, smokes approximately 15 cigarettes per day and has a smoking history of ten years. She was also on winter break during both conditions. During the control condition, she used eating and counting down the hours until she could have a cigarette coping mechanisms for her smoking urges. She believed the method used in the experimental condition helped curb her urges to smoke, but also noted that walking was not always a possibility. Her experimental condition took place during a very large snowstorm and while her boyfriend was in town visiting, which led her to not leaving her apartment all day and watching movies to help distract her from her smoking urges.

W1506's narrative of her experience in the experimental condition explains why there is more activity in the control condition. She doubled the amount of time of MVPA and took 2282 more steps (Table 13) in the control condition. None of the activity sessions in either condition lasted 8-10 minutes. Her average smoking urge score decreased by 1.75 points in the experimental condition (Table 6) and her QSU score slightly increased (four points) in the experimental condition (Table 8). She had improvements in tension-anxiety, anger-hostility, fatigue-inertia, confusion-bewilderment, and TMD scores (Table 7). Figures 4 and 5 illustrate

the relationship between her activity and smoking urge throughout each condition. The lowest smoking urge score in both the control and experimental conditions were first thing in the morning when the participant woke up. The experimental condition activity and urge pattern may suggest that a combination of rest, distraction, and low stress is an ideal combination to lower this participant's smoking urges. The fourth MPSS survey was taken with-in two hours of the 24-hour mark in both conditions, revealing a spike in the urge to smoke score.

TABLE 14: W1506 ACTIVITY SUMMARY

W1506	Control	Experimental
Active Sessions	78	42
MVPA	23.05	10.47
% Active	2.55%	1.09%
Steps	3934	1652
Rec PA Sessions	0	0
PA Min	0	0

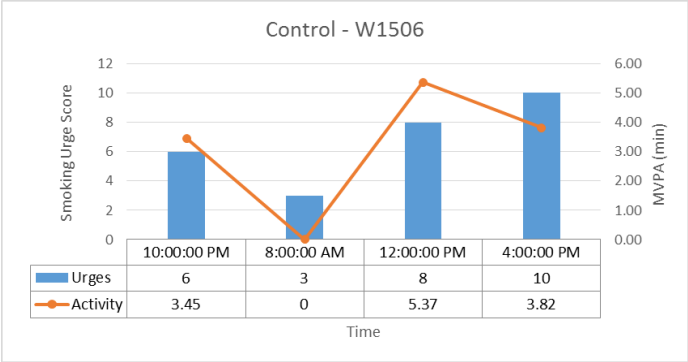

FIGURE 5: CONTROL - W1506

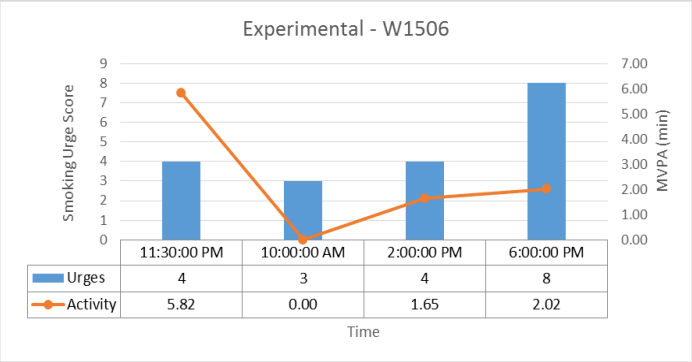

FIGURE 6: EXPERIMENTAL - W1506

W1507 Results

Participant W1507 is 29-year-old female, registered nurse. She does not exercise regularly (though the nature of her job has her on her feet for about 70% of her day), is within normal BMI range, smokes 12 cigarettes per day and has a smoking history of 14 years. She did not use any coping mechanisms in the control condition to manage her smoking urges. She believed the method used in the experimental condition helped curb her urge to smoke when she was able to walk - she noted that being in meetings or in the car was when she felt the most urge to smoke. She liked it because it is the healthier choice. In the last two hours of the experimental condition, she was at a doctor's appointment that was running late. She was extremely frustrated and stressed when she arrived at our meeting to conclude the condition.

W1507's job is extremely variable in terms of the schedule of each day, which also makes it restrictive. She completed eight more minutes of MVPA, 2202 more steps, and 15 more active sessions in the control condition which accounts for 3.2% of her day (Table 14). None of the activity sessions in either condition lasted 8-10 minutes. Her average smoking urge score decreased by .68 points in the experimental condition (Table 6) and her QSU score slightly increased (three points) in the experimental condition (Table 8). Her mood worsened in every factor, except confusion-bewilderment (Table 7), which may be explained by her doctor's office experience immediately prior to taking the POMS assessment. Figures 4 and 5 illustrate the relationship between her activity and smoking urge throughout each condition. The lowest smoking urge score in both the control and experimental conditions were first thing in the morning when the participant woke up at zero. Both conditions reveal an inverse relationship between activity and smoking urges. Higher activity results in lower urges to

smoke. This is most apparent in the first and fourth time block in each condition. The fourth time block is a period when increasing smoking urges is expected because of the increasing smoking withdrawal symptoms, however, in both conditions, increased activity either maintains the smoking urge or decreases it. The fourth MPSS survey was taken with-in two hours of the 24-hour mark in both conditions, revealing the highest urge to smoke scores.

TABLE 15: W1507 ACTIVITY SUMMARY

W1507	Control	Experimental
Active Sessions	83	68
MVPA	38.30	29.87
% Active	3.20%	2.70%
Steps	6948	4746
Rec PA Sessions	0	0
PA Min	0	0

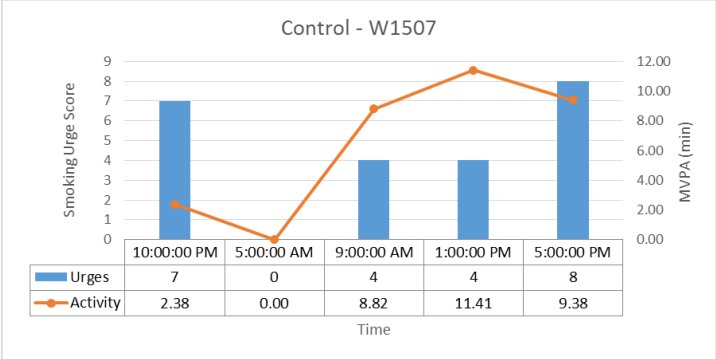

FIGURE 7: CONTROL - W1507

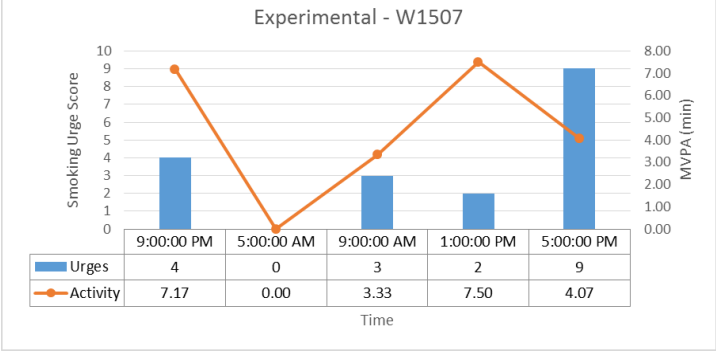

FIGURE 8: EXPERIMENTAL - W1507

W1509 Results

Participant W1509 is a 27-year-old female who works in retail. She does not exercise regularly, is with-in normal BMI range, smokes 12 cigarettes per day and has a smoking history of 9 years. She used chewing gum and drinking beverages as coping mechanisms in the experimental condition. She believed the method used in the experimental condition helped curb her urge to smoke because it kept her physically and mentally occupied. Because she commutes 40 minutes to work every day, and noted that she often has cravings while driving, she suggested finding an alternative that can be practiced while driving.

W1509 completed ten more minutes of MVPA, 671 more steps, and 11 more active sessions in the experimental condition. The MVPA in both conditions accounted for about 4.3% of her day. None of the activity sessions in either condition lasted 8-10 minutes (Table 15). Her average smoking urge score decreased by .60 points in the experimental condition (Table 6) and her QSU score worsened by 13% in the experimental condition (Table 8). Her mood improved in the experimental condition in every factor, except tension-anxiety and fatigue-inertia, which were constant in both conditions (Table 7). Figures 6 and 7 illustrate the relationship between her activity and smoking urge throughout each condition. The lowest smoking urge score in both the control and experimental conditions were first thing in the morning when the participant woke up. The fourth MPSS survey in the control condition was taken with-in one and a half hours of the 24-hour mark, and the fifth MPSS survey in the experimental condition was taken exactly at the 24-hour mark, revealing the highest urge to smoke scores for both conditions. However, in the final time block in both conditions, the participant completed over 6.5 minutes of MVPA and their urge to smoke only increased by one point.

TABLE 16: W1509 ACTIVITY SUMMARY

W1509	Control	Experimental
Active Sessions	70	81
MVPA	42.43	52.02
% Active	4.30%	4.26%
Steps	6261	6932
Rec PA Sessions	0	0
PA Min	0	0

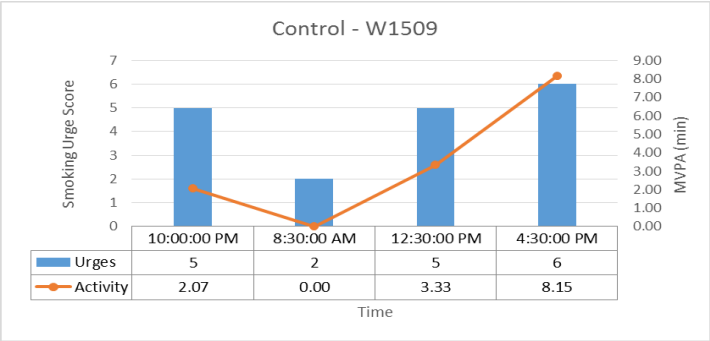

FIGURE 9: CONTROL - W1509

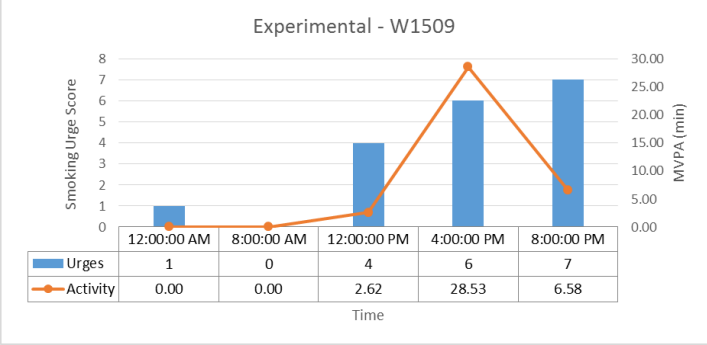

FIGURE 10: EXPERIMENTAL - W 1509

W1510 Results

W1510 is a 30-year-old male, high school teacher who was on winter break for both conditions. He does not exercise regularly, classified in the obese range for BMI, smokes ten cigarettes per day and has a smoking history of 12 years. He did not use any coping mechanisms in the control condition to curb his urge to smoke. He believed the method used in the experimental condition helped curb his urge to smoke a little bit and liked it because it

was an easy method to adopt, but did not enjoy walking. This participant is not looking to adopt a healthier lifestyle and noted that he would rather replace smoking with eating beef jerky instead of walking.

W1510 completed 12 more minutes of MVPA and 442 more steps in the experimental condition, increasing his daily activity by 1.5%. Two of the activity sessions in the experimental condition lasted 8-10 minutes (Table 16). His average smoking urge score increased by .25 points in the experimental condition (Table 6), though his QSU score improved by 9% in the experimental condition (Table 8). This may be explained by the six minutes of vigorous activity completed in the last two hours of the experiment (not shown in Figures 8 and 9). His mood improved in tension-anxiety and anger-hostility, and stayed the same for depression-dejection, and worsened for fatigue-inertia, confusion-bewilderment, and TMD by three, two, and one points, respectively, in the experimental condition (Table 7). Figures 8 and 9 illustrate the relationship between his activity and smoking urge throughout each condition. The lowest smoking urge score in the control condition was first thing in the morning when the participant woke up. The participants urge to smoke was the lowest, and remained the same for the first three time blocks in the experimental condition. Aside from immediately after waking up, the participants urge to smoke stayed the same throughout the control condition. The consistency of his smoking urge scores in both conditions reveals that the level of physical activity completed is not a suggested option to aid in smoking cessation for this participant.

TABLE 17: W1510 ACTIVITY SUMMARY

W1510	Control	Experimental
Active Sessions	50	49
MVPA	47.63	59.25
% Active	4.40%	5.94%
Steps	4105	4547
Rec PA Sessions	0	2
PA Min	0	30.93

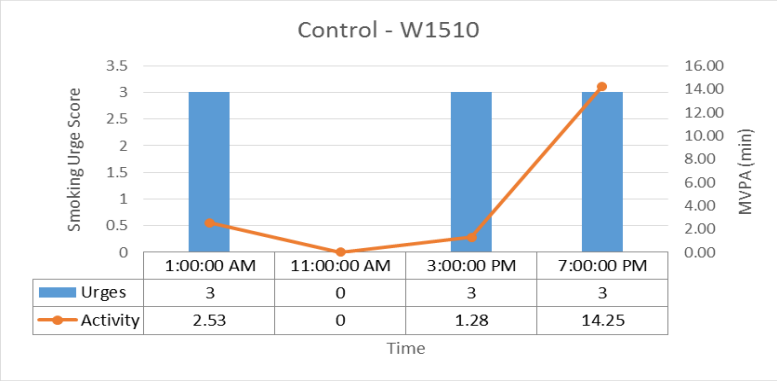

FIGURE 11: CONTROL - W1510

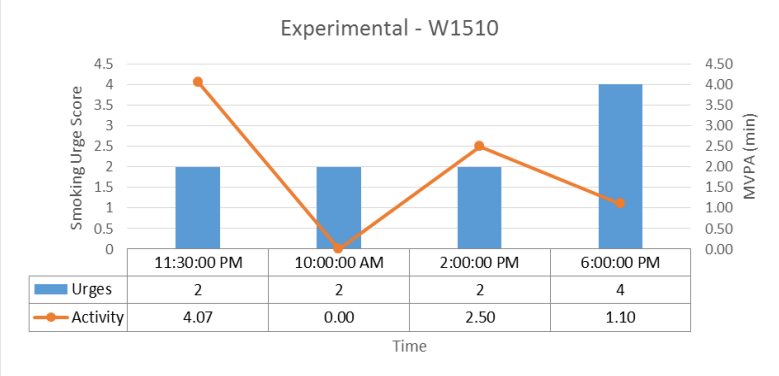

FIGURE 12: EXPERIMENTAL - W1510

W1511 Results

Participant W1511 is a 29-year-old male, carpenter. He does not exercise regularly (though his job has keeps him active 70% of the workday), classified in the obese range for BMI, smokes 11 cigarettes per day and has a smoking history of eight years. He did not use any coping mechanisms in the control condition to curb his urge to smoke, but primarily tried not to think about the fact that he could not smoke. He did not believe that the method used

in the experimental condition helped curb his urge to smoke, though he liked that it kept his mind busy. At the time, this participant made it clear he was not looking to adopt a healthier lifestyle.

W1511 completed 66 more minutes of MVPA and 4831 more steps in the experimental condition, increasing his daily activity by 4%. Five of the activity sessions in the experimental condition lasted 8-10 minutes compared to one in the control condition (Table 17). His average smoking urge score decreased by 1.00 point in the experimental condition (Table 6), though his QSU score worsened by 15% in the experimental condition (Table 8). His POMS score stayed the same in every factor except for anger-hostility and TMD, which both decreased by one point in the experimental condition (Table 7). Figures 10 and 11 illustrate the relationship between his activity and smoking urge throughout each condition. The lowest smoking urge score(zero) in both conditions was the first two time blocks, which included the morning when the participant first woke up, and the third and fourth time block in the experimental condition. The participants urge to smoke was the highest at 5:00 pm, or right after working hours, in both conditions, though in the experimental condition his score was half of that in the control condition. Although this participant did not like the experimental treatment and may not want a healthier life-style, his data shows that physical activity and keeping his mind busy are key components in decreasing his urge to smoke.

TABLE 18: W1511 ACTIVITY SUMMARY

W1511	Control	Experimental
Active Sessions	96	95
MVPA	122.62	188.50
% Active	9.22%	13.75%
Steps	8227	13058
Rec PA Sessions	1	5
PA Min	13.77	99.47

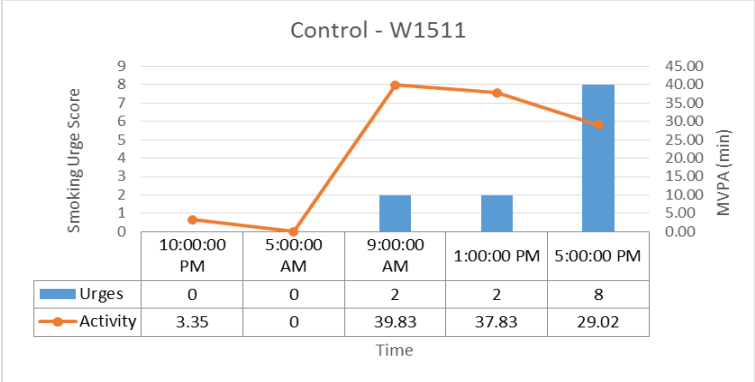

FIGURE 13: CONTROL - W1511

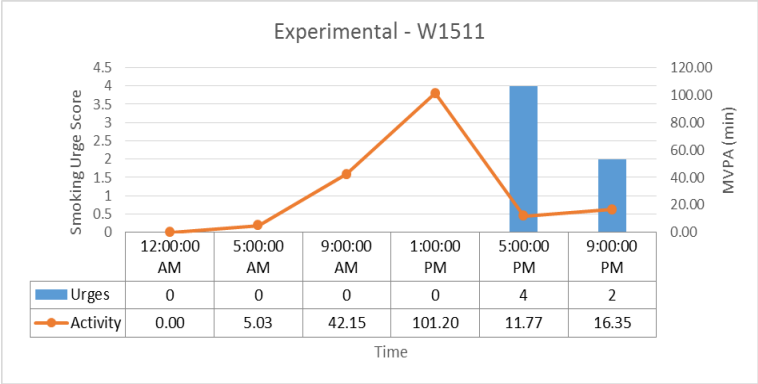

FIGURE 14: EXPERIMENTAL - W1511

W1512 Results

Participant W1512 is a 28-year-old male, who does public works. He lifts weights four to five times per week, spends 80% of his workday on his feet, is classified as overweight by BMI standards, smokes 10 cigarettes per day and has a smoking history of three years. He did not use any coping mechanisms in the control condition to curb his urge to smoke. He believed the method used in the experimental condition helped curb his urge to smoke a little

bit and liked it because it involved physical activity, but also felt the urge to smoke when he walked.

W1512 completed 118 more minutes of MVPA and 11938 more steps in the control condition, increasing his daily activity by 9%. One of the activity sessions in the experimental condition lasted 8-10 minutes compared to two in the control condition (Table 18). His average smoking urge score increased by two points in the experimental condition (Table 6), though his QSU score improved by 4% in the experimental condition (Table 3). His POMS score improved for tension-anxiety, depression-dejection, and anger-hostility and worsened by two points for fatigue-inertia, and stayed the same for confusion-bewilderment and TMD (Table 2). Figures 12 and 13 illustrate the relationship between his activity and smoking urge throughout each condition. This participant had constant smoking urges for the first two time blocks, and the final time block. Smoking urges remained low during working hours, but increased throughout the day. In the control condition, higher MVPA kept smoking urges one point lower than the experimental condition in the second and third time blocks.

TABLE 19: W1512 ACTIVITY SUMMARY

W1512	Control	Experimental
Active Sessions	113	88
MVPA	191.63	73.08
% Active	0.16	0.07
Steps	18731	6793
Rec PA Sessions	2	1
PA Min	23.20	15.90

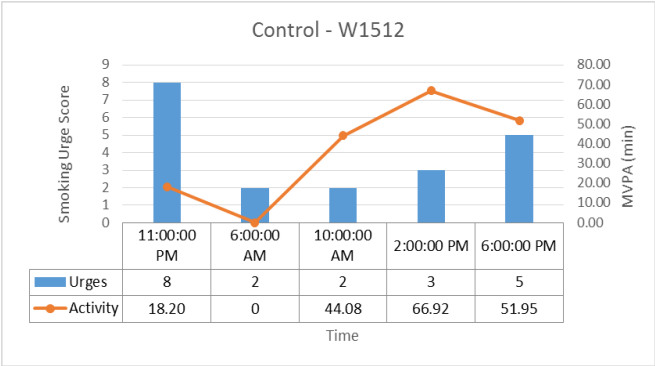

FIGURE 15: CONTROL - W1512

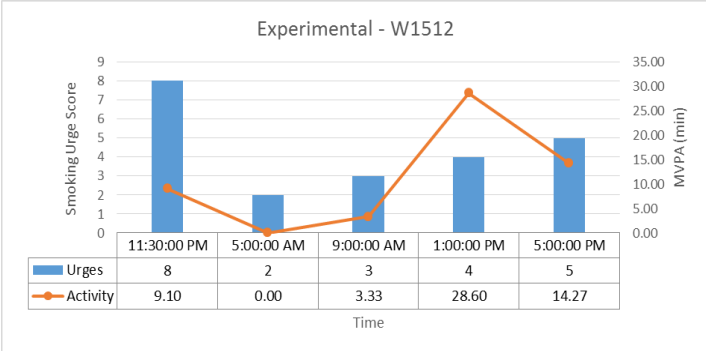

FIGURE 16: EXPERIMENTAL - W1512

W1513 Results

W1513 is a 24-year-old male, who works as a flavorist. He exercises twice a week on average and spends 75% of his day on his feet, is classified in the obese range for BMI, smokes ten cigarettes per day and has a smoking history of 2 years. He used chewing on a pen in the control condition to curb his urge to smoke. He did not believe the method used in the experimental condition helped curb his urge to smoke. He noted that he associated getting up to walk with getting up to go smoke. At the end of his control condition, he got lost in a snow storm for two hours in attempts to meet up with the PI. He was extremely upset and frustrated when taking the final three surveys.

W1513 completed 24 more minutes of MVPA and 1538 more steps in the control condition, increasing his daily activity by 3%. None of the activity sessions in either condition

lasted 8-10 minutes (Table 19). His average smoking urge score increased by .75 points in the experimental condition (Table 6), though his QSU score improved by 1% in the experimental condition (Table 3). His POMS score improved for every factor with the TMD improving by 39 points (Table 2). This vast improvement may be a product of the negative state he was in when taking the POMS in the control condition. Figures 12 and 13 illustrate the relationship between his activity and smoking urge throughout each condition. This participant's lowest urges occurred in the second and third time blocks in the control, which included immediately before bed and first thing in the morning. The lowest urge in the experimental condition occurred in the first time block. The highest urges occurred at the beginning of the control condition and in the second and third time blocks of the experimental conditions.

TABLE 20: W1513 ACTIVITY SUMMARY

W1513	Control	Experimental
Active Sessions	50	40
MVPA	46.33	22.95
% Active	5.07%	2.32%
Steps	4876	3338
Rec PA Sessions	0	0
PA Min	0	0

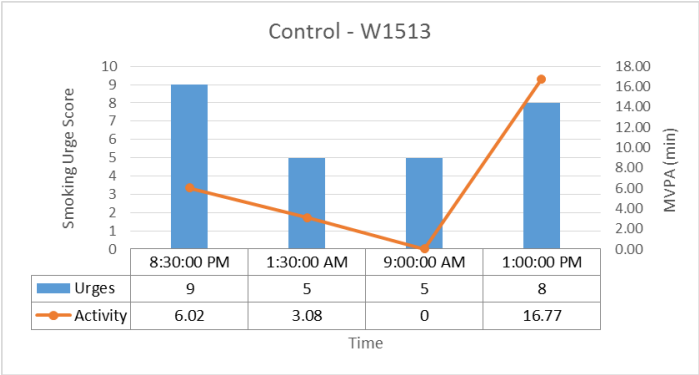

FIGURE 17: CONTROL - W1513

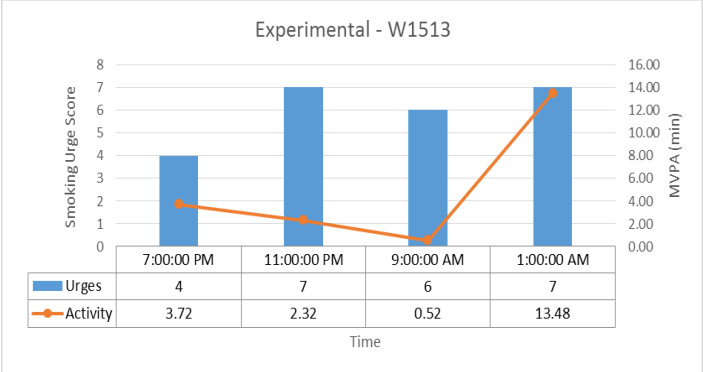

FIGURE 18: EXPERIMENTAL - W1513

W1615 Results

W1615 is a 24-year-old male, graduate student. He exercises once a week on average, is classified in the obese range for BMI, smokes ten cigarettes per day and has a smoking history of 7 years. He did not use any coping mechanisms in the control condition to curb his urge to smoke. He was surprised that the method used in the experimental condition helped curb his urge to smoke and liked it because it encouraged him to get up and move. However, he iterated that it was hard to do with the cold weather. This participant was suffering from a cold during the experimental condition.

W1615 completed the exact same amount of MVPA that accounted for 3% of his day in both conditions, though he completed 429 more steps in the control condition. None of the activity sessions in either condition lasted 8-10 minutes (Table 20). His average smoking urge score decreased by one point in the experimental condition (Table 6) and his QSU score improved by 19% in the experimental condition (Table 3). His POMS score improved for every factor (Table 2). Figures 14 and 15 illustrate the relationship between his activity and smoking urge throughout each condition. This participant's lowest urges occurred in the second time block, or first thing in the morning, in both conditions. The highest urge occurred in the final

time block in the control condition, and in the third time block in the experimental condition. In both conditions, the time blocks with the highest amount of MVPA resulted in the second lowest urge scores.

TABLE 21: W1615 ACTIVITY SUMMARY

W1615	Control	Experimental
Active Sessions	36	55
MVPA	34.98	34.98
% Active	3.64%	3.81%
Steps	4586	4157
Rec PA Sessions	0	0
PA Min	0	0

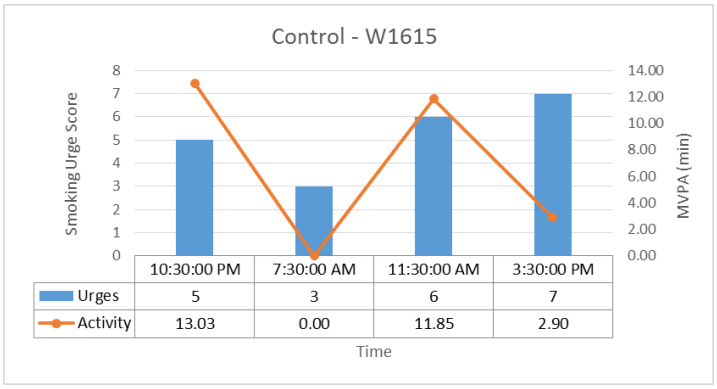

FIGURE 19: CONTROL - W1615

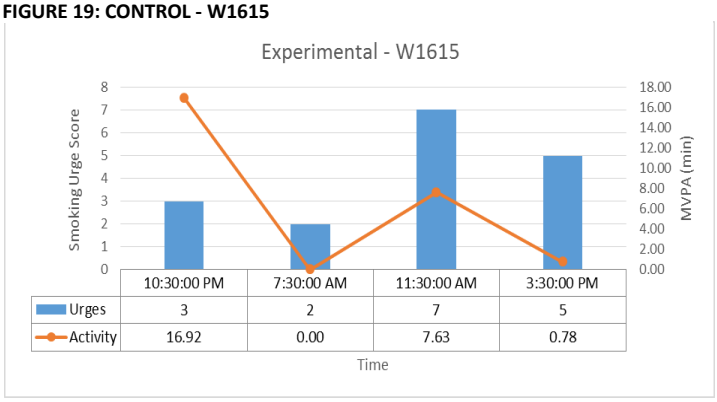

FIGURE 20: EXPERIMENTAL - W1615

W1616 Results

Participant W1616 is 24-year-old female, recruiter. She exercises once per week, is classified as obese by BMI standards, smokes 10 cigarettes per day and has a smoking history

of 2 years. She used vocal exercises that made her laugh as a coping mechanism in the control condition. She believed the method used in the experimental condition 'somewhat' helped curb her urge to smoke. She liked it because it temporarily took her mind off her urges, though she mentioned that it is not an ideal tactic for an office setting. As a recruiter, her schedule is very restrictive. She performs interviews for the entirety of most afternoons, which eliminates the freedom to walk when an urge ensues. This participant was also suffering from a cold during the experimental condition.

W1616 completed 46 more minutes of MVPA, 268 more steps, and 26 more active sessions in the control condition, which increased her daily activity by 4% (Table 21). One activity session in the control condition lasted 8-10 minutes. Her average smoking urges score decreased by .67 points in the experimental condition (Table 6) and her QSU score improved by 10% in the experimental condition (Table 3). Her POMS score improved in every factor, except tension-anxiety and depression-dejection (Table 2. Figures 16 and 17 illustrate the relationship between her activity and smoking urge throughout each condition. The lowest smoking urge score in both the control and experimental conditions were first thing in the morning when the participant woke up, and in the final time block of the control condition. Highest smoking urges occurred in the first time block of the control condition and in the final time block of the experimental condition. Unlike most participants, W1616's urges to smoke decreased in the final time block of the control condition where the MVPA was the highest from either condition.

TABLE 22: W1616 ACTIVITY SUMMARY

W1616	Control	Experimental
Active Sessions	100	74
MVPA	103.58	57.52
% Active	10.59%	6.21%
Steps	6568	6300
Rec PA Sessions	1	0
PA Min	10.53	0

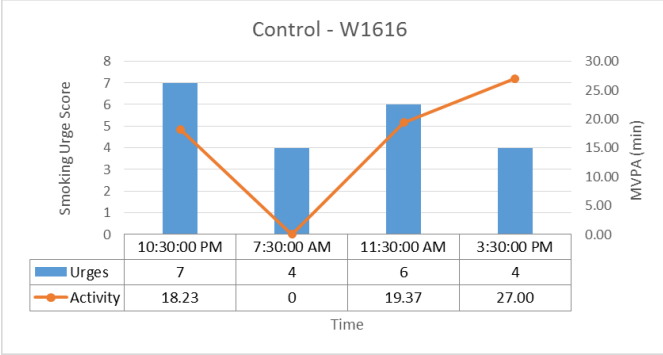

FIGURE 21: CONTROL - W1616

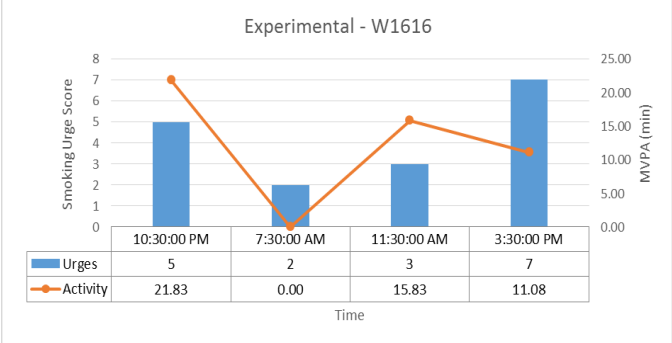

FIGURE 22: EXPERIMENTAL - W1616

W1617 Results

W1615 is a 24-year-old male, under graduate student and deli counter worker. He does not exercise regularly, is classified in the normal range for BMI, smokes ten cigarettes per day and has a smoking history of 4 years. He did not use any coping mechanisms in the control condition to curb his urge to smoke. He believed that the method used in the experimental condition helped curb his urge to smoke and liked it because there was a small

rush of adrenaline and helped keep his mind off smoking. The most challenging part of both conditions was missing the social aspect of both of his roommates smoking.

W1617 completed 12 more minutes of MVPA, 465 more steps, and 13 more active sessions in the experimental condition, which increased his daily activity by 1% (Table 22). One activity session in the control condition lasted 8-10 minutes. His average smoking urge score decreased by 1.67 in the experimental condition (Table 6) and his QSU score improved by 10% in the experimental condition (Table 3). His POMS score improved for every factor, except anger-hostility which decreased by six points (Table 2). Figures 14 and 15 illustrate the relationship between his activity and smoking urge throughout each condition. This participant's lowest urges occurred in the second time block in the control condition and in the first and third time block in the experimental condition – this included his urge immediately upon waking up in the morning. The highest urge occurred in the first time block in the control condition, and in the second time block in the experimental condition.

TABLE 23: W1617 ACTIVITY SUMMARY

W1617	Control	Experimental
Active Sessions	35	47
MVPA	46.78	58.53
% Active	6.19%	7.33%
Steps	5657	6122
Rec PA Sessions	1	0
PA Min	11.95	0

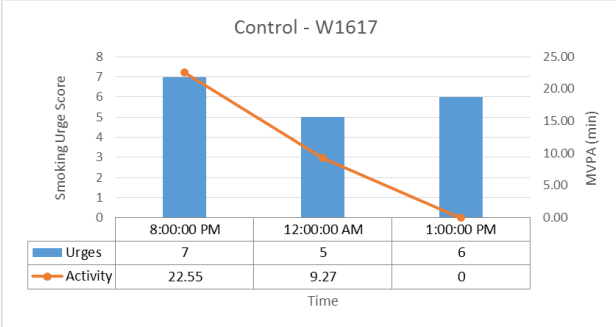

FIGURE 23: CONTROL - W1617

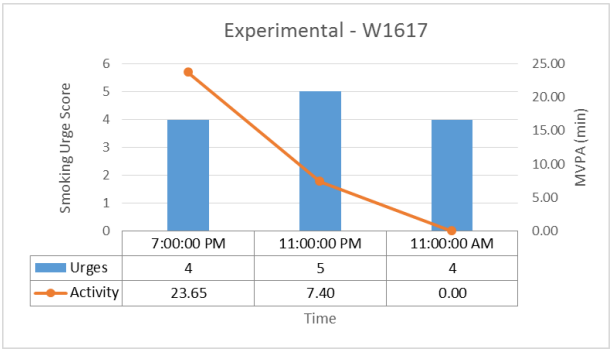

FIGURE 24: EXPERIMENTAL - W1617

W1508 Results

Participant W1508 is a 30-year-old male, construction project manager. He does not exercise regularly, is classified in the normal range for BMI, smokes 25 cigarettes per day and has a smoking history of 13 years. He participated in the control condition, where he used chewing tobacco to cope with his smoking urges. This participant also smoked ten cigarettes throughout the course of the condition. He spends a majority of his day driving, which is when his urges are the strongest. Of all the participants, he smoked the most cigarettes per day and was the most addicted.

W1502 Results

Participant W1502 is 30-year-old female who is unemployed. She does not exercise regularly, is classified as obese by BMI standards, smokes 10 cigarettes per day and has a smoking history of 5.5 years. This participant completed the experimental condition, but

smoked six cigarettes during the control condition. She believed that the experimental treatment helped curb her smoking urges a little. She liked that it forced her to move around, which helped clear her head. She didn't like that there was not the immediate relaxing effect that smoking has, which forced her to handle her stress differently. She iterated that she was extremely stressed about completing the second condition for the study and almost canceled. Aside from stress, her primary reason for smoking during the control was that she was in her apartment with all her smoking triggers, including her boyfriend who also smokes.

APPENDIX C: IRB APPROVAL

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515 294-4566
FAX 515 294-4267

Date: 6/23/2015

To: Kellie Ann McGrath
150 Campus Ave Unit 10
Ames, IA 50015

CC: Dr. Iris V Rivero
3004 Black Engineering
Dr. Richard T Stone
3004 Black Engineering

From: Office for Responsible Research

Title: Low Intensity Activity Affects on Smoking Urges During Prolonged Smoking Abstinence

IRB ID: 15-286

Approval Date:	6/22/2015	**Date for Continuing Review:**	6/1/2016
Submission Type:	New	**Review Type:**	Full Committee

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- **Use only the approved study materials** in your research, **including the recruitment materials and informed consent documents that have the IRB approval stamp.**
- **Retain signed informed consent documents for 3 years after the close of the study,** when documented consent is required.
- **Obtain IRB approval prior to implementing any changes** to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.
- **Immediately inform the IRB of** (1) **all serious and/or unexpected adverse experiences** involving risks to subjects or others; and (2) **any other unanticipated problems involving risks** to subjects or others.
- **Stop all research activity if IRB approval lapses,** unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
- **Complete a new continuing review form** at least three to four weeks prior to the **date for continuing review** as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. **Approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **IRB approval in no way implies or guarantees that permission from these other entities will be granted.**

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.

APPENDIX D: IRB MODIFICATION APPROVAL

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515 294-4566
FAX 515 294-4267

Date: 10/9/2015

To: Kellie Ann McGrath
150 Campus Ave Unit 10
Ames, IA 50015

CC: Dr. Iris V Rivero
3004 Black Engineering
Dr. Richard T Stone
3004 Black Engineering

From: Office for Responsible Research

Title: Low Intensity Activies on Smoking Urges During Prolonged Smoking Abstinence

IRB ID: 15-286

Approval Date:	10/8/2015	**Date for Continuing Review:**	6/1/2016
Submission Type:	Modification	**Review Type:**	Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- **Use only the approved study materials** in your research, **including the recruitment materials and informed consent documents that have the IRB approval stamp.**
- **Retain signed informed consent documents for 3 years after the close of the study,** when documented consent is required.
- **Obtain IRB approval prior to implementing any changes** to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.
- **Immediately inform the IRB of** (1) **all serious and/or unexpected adverse experiences** involving risks to subjects or others; and (2) **any other unanticipated problems involving risks** to subjects or others.
- **Stop all research activity if IRB approval lapses,** unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
- **Complete a new continuing review form** at least three to four weeks prior to the **date for continuing review** as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. **Approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **IRB approval in no way implies or guarantees that permission from these other entities will be granted.**

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.