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Effects of two types of exercise on cravings to smoke

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Effects of Two Types of Exercise on Cravings to Smoke

by

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ABSTRACT

Becoming more physically active is associated with increased confidence to maintain smoking abstinence as well as success at stopping smoking. The purpose of the current study was to assess the effects of two different types of exercise (cardiovascular and Hatha yoga) on general and cue-elicited craving for a cigarette. Participants were 76 smokers ages 18-45 (mean=29) who smoked at least 10 cigarettes per day (mean=20) for at least one year. Participants were randomly assigned to engage in 30 minutes of cardiovascular activity (walking on a treadmill), yoga, or to view a video about exercise (control). Participants completed a self-report measure of craving (Questionnaire of Smoking Urges-Brief [QSU-brief]; Cox, Tiffany, & Christen, 2001) and a brief mood form, as well as a picture-based cue reactivity assessment before and approximately five minutes after the activity. Results demonstrated that participants in both exercise groups reported a significant decrease in anticipation of pleasure from smoking following exercise as compared to the control group, as measured by Factor 1 of the QSU-brief ($p <$ .05) up to 20 minutes following exercise. Participants in both exercise groups also reported significant decrease in smoking to relieve negative affect or withdrawal only 20 minutes after exercising, as measured by Factor 2 of the QSU-brief ($p < .05$). There was also a trend toward a significant group x time interaction effect for the QSU-brief Global

scale (p = .053) immediately following exercise and a significant decrease in craving 20 minutes after exercise (p = .040). These effects were fully mediated by both an increase in positive mood and a decrease in negative mood following exercise (p's < .05) and a decrease in negative mood 20 minutes after exercise. Following activity, the cardiovascular group had a significant decrease in craving towards smoking pictures and an increase in craving towards neutral pictures, the yoga group demonstrated a significant decrease towards both smoking and neutral cues, and the control group had an increase in craving over time for both types of cues (ps < .05). Overall, these findings suggest that both cardiovascular activity and yoga may reduce urges to smoke following exercise, but that cardio exercise may be specifically associated with reduced cue-elicited craving. Future studies should examine the relationship between acute and long-term effects of exercise on cravings and smoking behavior. This can inform the potential application of exercise regimens within smoking cessation programs.

Introduction

An estimated 46 million people (22.5% of all adults) smoke cigarettes in the United States (Centers for Disease Control, 2002). Cigarette smoking remains the foremost preventable cause of death in the United States (US Department of Health and Human Services, 2000). It accounts for approximately one of every five deaths or 440,000 deaths each year, 30% of which are cancer deaths (Centers for Disease Control, 2002). An estimated $157 billion in annual health-related economic losses are also accredited to smoking (Centers for Disease Control, 2002). It is thus crucial to continue to investigate the factors related to various aspects of smoking with the aim of increasing smoking cessation rates and preventing millions of smoking-related deaths.

It is widely accepted that physical activity promotes health and successful functioning (US Department of Health and Human Services, 2000). In addition to its preventative effects on a number of disease processes, exercise has been shown to reduce sleep disturbance (O'Connor & Youngstedt, 1995), mood disturbance (Byrne, 1993), subjective stress (King, Taylor, & Haskell, 1993), feeling tense (Devries, 1987), and weight gain (Kawachi et al., 1996). Additionally, exercise has a positive effect on self-esteem (McAuley, Mihalko, & Bane, 1997) and perceived coping ability (Steptoe, Edwards, Moses, & Mattews, 1989).

As compared to non-smokers, smokers are less likely to participate in health-promoting activities such as exercise (Boyle, O'Connor, Pronk, & Tan, 2000). Smokers

are also significantly less active than non-smokers (Eriksen, Natvig, Rutle, & Bruusgaard, 1999), they are less likely to increase their physical activity over time (Blair, Goodyear, Wynne, & Saunders, 1984), and they have a greater decline in physical activity over a period of years (Lazarus, Kaplan, Cohen, & Leu, 1989). This is unfortunate because, aside from the aforementioned benefits of physical activity, becoming more physically active is positively associated with confidence to maintain smoking abstinence (King, 1996) as well as success at stopping smoking (Derby, 1994; Paavola, 2001; Sedgwick, 1988). For instance, a 15 year longitudinal study demonstrated that those who engaged in more physical activity during their leisure time had higher rates of smoking cessation over time (Paavola, Vartiainen, & Puska, 2001).

A number of studies have investigated the effects of exercise in the context of smoking cessation treatment, with mixed results. For example, Bock, Marcus, King, Borrelli and Roberts (1999) reported that vigorous exercise produced acute reductions in withdrawal symptoms, cigarette craving, and negative affect among sedentary women attempting to quit smoking. These authors concluded that exercise may be an effective complement to the process of smoking cessation due to these positive acute effects. However, no long-term effects of exercise on affect or smoking related symptoms were observed, and cessation rates were not significantly different between the exercise group and the non-exercise control group. Similarly, Jonsdottir and Jonsdottir (2001) reported that adding an 80-minute regimen of aerobic training, weight lifting, and stretching three times a week to a standard smoking cessation intervention (nicotine replacement therapy, health education, behavioral modification, and counseling) was associated with a non-significant trend, in which the continuous abstinence rate at one year post intervention

was higher in the usual intervention plus exercise group (39.4%) than in the usual intervention group (20.6%). The authors concluded that a multi-component smoking cessation program that includes physical exercise might be an effective intervention, but that further studies with larger sample sizes are needed. Ussher et al. (2007) combined exercise counseling sessions with standard smoking cessation counseling, which occurred three times a week. This less intensive approach did not increase abstinence at 12 months as compared to the control group who received health education advice along with smoking cessation counseling. The physical activity increases observed at six weeks in the exercise group were not observed at 12 months. The authors concluded that more intensive exercise interventions may be needed. Ussher (2005) reviewed eleven studies in which the specific effects of exercise on smoking abstinence were examined. Of those eleven studies, only two found a positive effect for exercise on smoking abstinence. The other studies were reported as having inadequate sample sizes, insufficient measurement, or poor control of exercise adherence. The author concluded that there is some evidence for exercise aiding smoking cessation and that future studies are needed to examine possible psychological and physiological mechanisms underlying these effects. Finally, Taylor and Katomeri (2007) concluded that physical activity may be a useful aid to quitting, although only a few studies involving exercise have shown enhanced long-term cessation (e.g., Marcus et al., 1999). This result may be related to a predominant focus on weight management and structured exercise with less concern for promoting exercise to self-regulate cravings and withdrawal symptoms.

Acute Effects of Exercise

Several recent studies have examined the acute effects of exercise on the withdrawal and craving aspects of smoking following approximately 15 hours of smoking abstinence. The types of exercise that have been examined include a short bout (5 and 10 minutes) of pedaling on a stationary bicycle, a one mile self-paced walk, and 5 minutes of seated isometric exercise. Overall, these studies found that participants who engaged in some form of physical exercise reported decreased craving and withdrawal symptoms for up to 20 minutes post-exercise as compared to control groups who sat passively (Daniel, Cropley, Ussher, & West, 2004; Ussher, Nunziata, Cropley, & West, 2001; Ussher, West, Doshi, & Sampuran, 2004; & Taylor, Katomeri, & Ussher, 2005).

An additional study examined the acute effects of a 15-minute brisk walk on in vivo cue-elicited cigarette cravings and withdrawal symptoms and ad libitum smoking (Taylor & Katomeri, 2007). Participants abstained from smoking for two hours prior to participation. Following exercise or passive sitting, participants were presented with a lit cigarette and craving and withdrawal symptoms were measured multiple times. Craving was measured using a single item. Time to first cigarette was determined by a text message the participant sent to the researchers via cell phone. The researchers concluded that 15 minutes of exercise reduced cue-elicited cravings and some withdrawal symptoms, and led to a delay to ad libitum smoking. They state that further research is needed, however, to further examine the effects of exercise on cue-elicited cravings.

Taylor, Ussher, & Faulkner (2007) conducted a review of 14 studies that examined the acute of effect of exercise on smoking variables. The authors concluded that a single session of exercise has an acute effect on smoking behavior, cravings,

withdrawal symptoms, and affect, particularly in experimental settings. The authors also noted that further research is needed to explore the acute effects of exercise on smoking-related cues, including imagining smoking situations and the use of visually presented smoking images in order to understand how exercise may serve as an aid to smoking cessation.

There are several limitations in these previous studies concerning acute exercise effects in smokers. First, the majority of these studies used a single item measure of craving with unknown reliability and limited information regarding the domains of craving affected by exercise. The current study will utilize a multi-item measure of smoking urges that provides a multi-dimensional assessment with good psychometric properties. This multi-dimensional measure will provide a more refined analysis of the specific components of craving decreased by exercise. Second, there is only use of self-report measures of craving in prior studies, which may lead to demand effects. We will extend the evaluation by including subjective and psychophysiological responses to smoking cues. Third, all measurements were of high levels of craving that occurred during acute withdrawal, whereas the present study will measure responses to exercise in a mildly deprived state, which is a moderate level of baseline craving that is more typical during a quit attempt and during cue-elicited craving. Fourth, the one study that examined cue reactivity did so using an in vivo cue only at post exercise and did not compare responses to a neutral cue. The current study will examine cue reactivity both before and after exercise and will incorporate neutral cues, which will extend the previous findings. This will expand the research across studies to include the effects of exercise on cravings at different stages of abstinence and provide a more naturalistic study. Finally, there are

many types of physical activity that range in terms of general intensity and specific physical characteristics. It is unclear if the type of exercise employed has differential effects on cigarette craving as studies have not yet directly compared forms of exercise. The proposed research will directly compare a moderately high level of cardiovascular exercise to non-cardiovascular Hatha yoga exercise.

Hatha Yoga

Yoga is an ancient and widely practiced form of meditation and relaxation, with approximately 20 million regular yoga practitioners in the U.S. and Europe (Feuerstein, 1998). Hatha yoga consists of gentle stretching and strengthening exercises done slowly with the attention focused on breathing and sensations that are experienced as the participants assume various yoga postures. Participants are guided through the sequence of postures, with their awareness focused on moving their bodies and limbs. Participants are grounded in the present moment by constantly refocusing on how their bodies are feeling (Lavey et al., 2005).

The effects of yoga on smoking behavior have received little research attention. To our knowledge, only one study has examined this area (McIver, O'Halloran, & McGartland, 2004). This study consisted of a one-group, pretest-posttest design of substance abusing smokers who were not motivated to quit smoking. The yoga intervention consisted of 5 weekly 60-minute yoga sessions and resulted in a statistically significant positive shift towards an intention to stop smoking as measured by the Stages of Change/Transtheoretical Model Questionnaire. However, there was little evidence of smoking cessation. This is not surprising due to the very small sample size (20) and the fact that participants were not initially motivated to quit.

Hatha yoga is an alternative form of physical activity that may have similar advantageous effects as cardiovascular exercise for smokers, such as regulating mood, stress, tension, and weight gain. Furthermore, yoga may have practical advantages over cardiovascular exercise in regards to smoking cessation. For instance, as Hatha yoga is less strenuous than cardiovascular exercise, sedentary smokers may be more compliant to a yoga program than to a cardiovascular program. Also, smokers may find Hatha yoga to be more acceptable and enjoyable due to its meditative and relaxation components. Accordingly, the present study will provide an initial direct comparison of Hatha yoga and cardiovascular exercise for their effects on self-report measures of craving for a cigarette and reactions to smoking cues.

Cue Reactivity

The cue-reactivity paradigm, which monitors addicts' reactions to various drug-related stimuli, has been used widely in the laboratory to explore the relationship between addicts' drug use and the environments and stimuli associated with prior drug use (Drummond, Tiffany, Glautier, & Remmington, 1995; Carter & Tiffany, 1999). Under this paradigm, it is thought that external stimuli, such as drug paraphernalia and situations, and internal stimuli, such as cognition and affect, become classically conditioned stimuli due to frequent pairings with drug intake. Over repeated pairings, these conditioned stimuli can elicit conditioned responses, including self-reported craving, drug self – administration, as well as physiological indices that reflect autonomic arousal (e.g., heart rate and skin conductance) or motivational processes (e.g., startle eye blink).

In a meta-analysis conducted by Carter and Tiffany (1999) it was found that significant heart rate increases were observed when smokers were exposed to drug-related stimuli. These psychophysiological effect sizes are small, on average. There were also significant increases (with a large effect size) in self-report of craving when exposed to drug-related versus drug-neutral stimuli across all drugs of abuse. The current study will include both psychophysiological (heart rate) and self-reported (craving) measures of cue reactivity.

The heart rate curve is triphasic, consisting of the initial deceleration (D1), initial acceleration (A1), and second deceleration (D2), measured as change from zero. The initial deceleration is associated with the cognitive processes of focusing attention and orienting to the stimulus; the initial acceleration is related to emotional aspects of the stimulus, as in a classical conditioning situation; and the second deceleration is related to anticipation or expectancy of a second stimulus, which may not be applicable to the current study (Hugdahl, 1995).

In addition, several recent studies have shown that the startle eyeblink reflex is sensitive to drug cue manipulations (e.g., Elash, Tiffany, & Vrana, 1995; Mucha, Geier, Stuhlinger, & Mundle, 2000; Saladin, Drobes, Coffey, & Libet, 2002). Startle eyeblink measures the affective state of an individual, in that the response is enhanced in the presence of unpleasant stimuli and suppressed in the presence of pleasant cues (Lang, Bradley & Cuthbert, 1990). Startle reflex will be included as a secondary cue reactivity variable in the proposed study, as it can provide unique information about the affective response to smoking cues following two forms of exercise.

Mechanisms

The mechanism whereby exercise may lead to reduced cigarette craving is unclear based on existing research. One possible mediator of the effects of exercise on craving is a reduction of negative affect and anxiety. Negative affect is associated with both failure to quit smoking and smoking relapse (Brandon, 1994), thus utilizing exercise to reduce negative affect may, in turn, aid in quitting smoking. Yoga, for example, has been found to increase positive mood (Berger & Owen, 1992) and research evidence suggests that cardiovascular exercise has affect regulatory properties (Morgan, 1994). Previous research has suggested that enhanced exercise-related affect may reduce the need to enhance affect by smoking (Taylor et al., 2005). The present study aims to determine if effects of exercise on craving and cue reactivity are mediated by affective changes.

Another possible mechanism is that exercise acts as a distraction, and that any distracting activity will lead to reduced craving. Taylor et al. reported that at higher intensities, exercise may induce greater cognitive demand than at lower intensities (2007). They also reported that there may be some low-intensity 'mindful' exercise (e.g. yoga, Tai Chi) that demands increased cognitive focus (i.e. distraction from smoking). Most previous studies compared an active exercise group to a control group who sat passively (e.g. Daniel et al., 2004; Taylor, Katomeri, & Ussher, 2005; & Ussher & West, 2004). The present study will attempt to remove distraction as a possible confound by having the control group watch an educational video about exercise, which will also serve as a distraction. This will also be examined more directly to ensure that the three groups are equally distracted by including the concentration subscale of the Wisconsin Smoking

Withdrawal Scale and a 1 item questionnaire to assess amount of distraction each condition produced.

Finally, neuroendocrine changes may be an additional pathway by which exercise functions to reduce craving. Cortisol and beta-endorphin are hormones that are released to modulate central nervous system activity during times of stress (McEwen & Sapolsky, 1995). Both hormone resting levels are also greater among smokers than nonsmokers (al'Absi, Wittmers, Erickson, Hatsukami, & Crouse, 2003; del Arbol et al., 2000). Previous research has shown that cardiovascular exercise significantly increases cortisol (in any intensity of exercise) as well as beta-endorphin levels (in high intensity exercise) (Meeusen et al., 2004). The increase in hormones during cardiovascular exercise mimics the hormonal increase caused by nicotine ingestion, which could be one possible mechanism to explain how cardiovascular exercise reduces craving. Exploring this mechanism is beyond the scope of this initial study and is planned for future research.

The Current Study

The main purpose of the current study is to assess the effects of two different types of exercise (cardiovascular exercise and Hatha yoga) on craving for a cigarette. The effects of yoga on craving have not been assessed in past research, nor has any past study compared different types of exercise in one cohesive experiment. Improving upon past research, the current study used a well-validated, multi-dimensional self-report measure of craving, and we examined the effects of exercise on subjective and physiological reactions to smoking cues.

A secondary aim is to evaluate whether effects of exercise on craving are mediated by affective changes (e.g., increased positive affect, decreased negative affect)

that are produced by exercise, or moderated by gender, exercise habits, and smoking level. Berger and Owen (1992) found a greater beneficial effect for yoga on mood among males. Based on this finding, we will examine whether exercise effects on craving or cue reactivity are different for males and females. It is also important to examine whether smokers would be likely to benefit from a specific form of physical activity as part of their smoking cessation effort as a function of their baseline level of physical activity, or baseline smoking-related variables such as smoking amount and nicotine dependence.

Specific Aim 1: To compare groups of smokers who are randomly assigned to receive an acute bout of cardiovascular exercise, Hatha yoga, or no activity, on self-reported craving, as well as subjective and physiological reactivity to smoking cues.

Hypothesis 1a: The two active exercise groups will have reduced craving following exercise, as compared to the control group.

Hypothesis 1b: The two active exercise groups will have reduced reactivity to smoking cues, as compared to the control group.

Specific Aim 2: To examine potential mechanisms by which each type of exercise may reduce cigarette craving. This is an exploratory aim because there is no prior research in the area of yoga's effect on craving. Mediators (positive and negative affect) and moderators (gender, exercise habits, and smoking level) will be examined. However, no specific directional hypotheses are stated due to the exploratory nature of this aim.

Methods

Overview

This study draws upon cue reactivity and exercise research utilizing well-defined methodology within these fields. Prior to exercise, participants completed a multi-item craving questionnaire, a mood questionnaire, and they were exposed to smoking and neutral stimuli. Heart rate and eyeblink startle data, as well as self-reported craving, were recorded during cue trials. Participants were then randomly assigned to one of three groups: cardiovascular exercise, Hatha yoga exercise, or a no-exercise control group. Level of distraction was assessed after each intervention via self-report. This was followed by a second self-reported craving, mood, and cue reactivity assessment. This allowed us to test whether either type of exercise had an effect on self-reported craving or cue reactivity and to evaluate potential mediators and moderators of these effects.

Participants

Participants consisted of 76 smokers recruited via flyers posted throughout the community and the University of South Florida campus, newspaper advertisements, internet advertising, and previous screenings. The inclusion criteria was as follows: 1) a smoking rate of 10 cigarettes per day for at the least the past year, 2) expired carbon monoxide greater than or equal to 8ppm, 3) not currently engaged in a quit attempt, 4) between the ages of 18 and 45, 5) normal or corrected-to-normal hearing and vision, and 6) willing and able to endure 20 minutes of moderately intense exercise. Participants were excluded from the study if they met any of the following criteria: 1) history of

cardiovascular disease, joint or muscle pain, or asthma, 2) taking medication from the following classes: benzodiazepines, antidepressants, neuroleptics, stimulants, anti-convulsants, and beta agonists, 3) presence of a neurological or cardiovascular disorder that might interfere with the collection of psychophysiological data, 4) current or past medical conditions that would interfere with their ability to exercise for 20 minutes, or 5) a body mass index (BMI) of 35 or greater to avoid "very obese" individuals.

All potential participants were screened on the telephone to ensure they met the inclusion criteria. The telephone screening included questions from the Physical Activity Readiness Questionnaire, which has been extensively used in exercise research to detect potential risk factors that might be exacerbated by acute exercise participation. The Principal Investigator reviewed each telephone screening form prior to the participant taking part in the research study to ensure ability to exercise safely. Eligible participants attended a single 2-hour laboratory session. Participants received $10 per hour of participation.

Sample size estimates for the proposed study were based on power analysis, using methods from Cohen (1988). Recent studies (Taylor et al., 2005; Ussher & West, 2005) have shown medium (effect size f = .29) to large (effect size f = .81) effect sizes for group differences (between exercise and non-exercise control groups) in reduced cravings to smoke during, and for up to 20 minutes following a single bout of exercise conducted after overnight smoking-deprivation. The effect size of f = .29 was based on seated isometric exercise, which is a much lower level of exercise than all of the other studies reviewed and also as compared to the proposed study. Large effect sizes were obtained in all of the other studies in which cardiovascular exercise was used. We have chosen to

adopt a relatively conservative effect size based on the fact that the previous studies did not employ cue reactivity, which is generally associated with a range of effect sizes for different dependent variables; small effect sizes for psychophysiological measures and large effect sizes for subjective craving measures (Carter & Tiffany, 1999). Accordingly, a sample size of 25 per group would provide acceptable power (1-beta) = .81 to detect post exercise group differences of effect size (f) = .37 with an alpha level of .05.

Measures

Demographic-related Measures

Demographic Questionnaire. Single items assessed the age, education, marital status, ethnicity, occupation, and income of participants, as well as current medication and medical history.

Smoking-related Measures

Smoking Status Questionnaire. This form was administered to assess participants' smoking status and level of nicotine dependence. This questionnaire contains items from the Fagerström Test for Nicotine Dependence (FTND), which is a valid and reliable measure of nicotine dependence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991).

Questionnaire of Smoking Urges (QSU-Brief; Cox, Tiffany, & Christen, 2002). This is a 10-item questionnaire, which is a shortened version of the original 32-item measure (Tiffany & Drobes, 1991) that consists of a two factor evaluation of self-reported craving for cigarettes. The two factors are desire to smoke because of the anticipation of pleasure and desire to smoke to relieve negative affect or withdrawal. The reported Cronbach's alpha coefficients are .92 or greater.

Wisconsin Inventory of Smoking Dependence Motives (WISDM-68; Piper et al., 2004). The WISDM-68 is a multidimensional questionnaire measure of smoking dependence. It includes 13 subscales, all of which have acceptable internal consistency. Participants rate their level of agreement with 68 statements about smoking dependence on a seven-point Likert scale. This instrument was used to determine whether specific motivations moderate the effects of the exercise interventions on craving, mood, and cue reactivity.

Affect-related Measures

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS measured the positive and negative affect of the participant at baseline. It includes two mood scales, each consisting of ten items. The participant rated the general level of their mood on a five-point Likert scale. This provides a measure of trait affect. The Positive Affect Scale and the Negative Affect Scale have Cronbach alpha levels that range from .86 to .90 and from .84 to .87, respectively.

Mood Form (Diener & Emmons, 1984). The mood form is a self-report 9-item questionnaire that is an assessment of positive and negative mood states. The participant completed this form multiple times, including at baseline and following exercise, to determine if their state mood changed as a result of the exercise, and whether these mood changes mediate the effects of exercise on craving and cue reactivity indices.

Distraction-related Measures

Wisconsin Smoking Withdrawal Scale (WSWS; Welsch et al., 1999). Participants were administered the three-item Concentration subscale of the WSWS at the end of each intervention. The coefficient alpha for the total scale is .91 and the coefficient alpha

reliability for the Concentration subscale ranges from .86 to .90. The WSWS has been shown to have good construct validity. Because the WSWS was originally constructed to assess withdrawal symptoms over the course of several hours or days, the directions were reworded so that they would assess current concentration levels (e.g., "Please answer the following questions based on how you felt during the activity.").

Distraction Form. Level of distraction was measured at the end of each intervention with a one-item Likert-scale with 11 gradations. The item read "How much was your mind focused on the activity you were doing?" and was anchored by "not at all" and "extremely" at either end of the scale. This instrument was used to measure distraction level as a manipulation check to ensure group equivalence.

Evaluation Measures

Activity Evaluation Form. At the completion of the cardiovascular exercise and the Hatha yoga exercise, participants evaluated the activity to provide initial data regarding the acceptability and feasibility of these activities. This information will be useful for potential future smoking cessation efforts incorporating exercise. Participants rated how enjoyable they found the activity, how difficult they found the activity, and how likely it is that they will do this activity again in the future on a 1 – 4 Likert scale.

Video Evaluation Form. At the completion of viewing the video, participants in the control group evaluated the video. Participants rated how enjoyable they found the video, how entertaining they found the video, and how informative they found the video on a 1 – 4 Likert scale.

Exercise-related Measures

Seven Day Physical Activity Recall Interview (Sallis, Haskell, & Wood, 1985). This brief semi-structured interview was used as a measure of physical activity. The interview estimates time spent in physical activity, strength, and flexibility activities for the previous seven days. It has been used extensively in sport, exercise, and health research (Morgan, 1997). This instrument was used to examine the potential moderating effects of exercise habits.

Godin Leisure-Time Exercise Questionnaire (Godin & Shepard, 1985). This self-administered questionnaire was used to assess amount and type of exercise a participant performs during an average seven day period. This instrument was used to examine the potential moderating effects of exercise habits.

*Physical Activity Readiness Questionnaire (*PAR-Q; British Columbia Ministry of Health, 1978; Thomas, Reading, & Shephard, 1992). The PAR-Q is a questionnaire which is used to screen potential participants by telephone in order to detect potential risk factors that might be exacerbated by acute exercise participation. It has been used extensively in exercise research.

Borg Rating of Perceived Exertion Scale (Noble et al., 1983; Borg, 1998). The Borg is a measure of subjective exertion, which was given orally two times during each intervention, once 15 minutes after the intervention began and once 25 minutes after the intervention began. The scale ranges from 6 (no exertion) to 20 (maximum exertion). It has been found to be a reliable and valid test of perceived exertion (Whaley et al., 1997). This instrument was used as a manipulation check to ensure that the groups differ on the amount of reported subjective exertion.

Cue Reactivity

Subjective Ratings. Craving level was obtained following each smoking and neutral cue using a visual computerized scale with 21 gradations, with the anchors "none" and "extremely strong" at either end of the scale. In addition, a computerized version of the Self-Assessment Manikin (SAM; Bradley & Lang, 1994) was utilized to assess participants' self-reported valence, arousal, and dominance in response to each cue. SAM is a cartoon figure with 21 gradations that the participant manipulates with a computer trackball to represent their current affective state.

Heart Rate. Heart rate is a measure of cardiovascular function that varies in response to cognitive effort or emotional arousal (Schwartz, Weinberger, & Singer, 1981). It was measured using a Coulbourn bioamplifier (model V75-01) with bandpass filter settings of 8 Hz (high pass) to 40 Hz (low pass). Electrodes were attached according to established guidelines, with one 8mm Ag-AgCl electrode filled with saline electrode gel placed on each forearm and one ground electrode placed on the non-dominant forearm. Inter-beat intervals were detected from the amplified signal using a Schmitt trigger, and stored on computer for offline editing and averaging.

Startle Eyeblink. The startle eyeblink reflex provides an index of one's affective reaction to a stimulus (Lang, Bradley, & Cuthbert, 1990). Brief bursts of white noise (50 msec, 100dB) were presented during 20 of 24 cue reactivity trials and the resulting eyeblink was measured with a Coulbourn bioamplifier (model V75-01) with bandpass filter settings of 90 Hz (high pass) and 150 Hz (low pass). Two small (4 mm) Ag-AgCl electrodes filled with saline electrode gel were attached in the orbicularis oculi muscle region located just below the left eye. EMG activity in response to each startle probe was

sampled at 1,000 Hz from 50 msec prior to probe onset until 250 msec following probe offset. Eyeblink magnitude and latency was manually scored offline.

Materials

Smoking and Neutral Cues. Smoking cues consisted of 12 pictures involving smoking a cigarette, and were selected from several sets that are currently in use in our laboratory and that have been shown to elicit smoking urges. Neutral cues consisted of 12 pictures that are devoid of anything smoking-related (e.g. furniture, automobiles), were non-affective, and were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1996).

Carbon monoxide (CO) monitor. CO level in parts per million (ppm) was assessed following informed consent of each participant utilizing a BreathCO carbon monoxide recorder (Vitalograph, Inc.). Each participant held his/her breath for 20 seconds and blew into a cardboard tube inserted into the device. Expired CO must be at least 8 ppm to be included in the study.

Alcohol Breathalyzer. Alcohol breath levels were assessed utilizing an Alcosensor IV (Intoximeters, Inc.). Alcohol level must be 0 for inclusion in the study.

Computers. One Pentium-type computer was used to display timed images and rating scales and an additional computer recorded physiological data.

Television. One television/VCR combination unit was used to show participants an educational exercise video or a yoga video, if assigned to one of these groups.

Exercise Equipment. A treadmill with the capacity to change the level of incline and to change the speed settings was utilized in the exercise condition.

Videotapes. A yoga instructional video, which was developed specifically for the study, was used in the Hatha yoga condition. A registered yoga teacher from the Moffitt Integrative Medicine Program demonstrated various Hatha yoga techniques on the videotape and the participant was told to follow along with each technique. The specific details were developed by a yoga expert. Additionally, portions of two educational videos about exercise available from the Educational Video Network, which discussed the health benefits of exercise were employed during the control condition.The videos were entitled "Strength and Fitness Training Quiz" and "Training for Strength and Fitness" and viewing time totaled 30 minutes.

Heart Monitor. A portable heart monitor (Polar Electro, Inc., Lake Success, NY) was used to monitor heart rate of participants during each exercise or control condition. The monitor consisted of an elastic chest strap, which detects heart rate continuously and transmits it to a wrist receiver for display.

Procedure

Participants who met qualifications for the study as determined by a telephone screening were scheduled for an appointment at the Tobacco Research and Intervention Program at the H. Lee Moffitt Cancer Center & Research Institute. All sessions took place in the afternoon or early evening to control for diurnal variations in craving. Participants were instructed to smoke their last cigarette one hour prior to their appointment in order for everyone to be at a similar smoking status for the study. In addition, this minimal level of nicotine deprivation allowed us to focus on whether exercise suppresses craving induction rather than withdrawal reduction. They were also instructed that the study requires completion of several questionnaires, a picture viewing

task, and that they may be asked to exercise at a mild to moderate intensity level for 30 minutes.

Consent and Initial Assessment

Upon arrival, the purpose of the study was described as studying the effects of exercise in smokers. Informed consent was obtained from the participant, following an opportunity to have any questions answered by the experimenter. Next, recent alcohol intake was determined by breath analysis, and smoking status was verified via breath carbon monoxide. The participant must have had a CO output of at least 8ppm and a breathalyzer reading of zero for inclusion in the study. The participant then completed several self-report questionnaires including: Demographic Questionnaire, Smoking Status Questionnaire, WISDM-68, PANAS, and the Godin Leisure-Time Exercise Questionnaire. The Seven Day Physical Activity Recall Interview was also conducted at this time. Intake assessment and questionnaire completion took approximately 30 minutes.

Electrode Placement and Instructions

The participant was then seated in a comfortable chair and electrodes for measuring heart rate and startle eyeblink response were applied to the arms and face. The heart rate electrodes measured arousal and the startle eyeblink electrodes measured the participant's affective reaction to the smoking and neutral cues. The participant next completed the Mood Form and the QSU-brief to obtain "state" mood and smoking urge data. Scripted instructions for the picture viewing procedure were provided, and then headphones were placed over the participant's ears for the delivery of acoustic startle probes.

Cue Reactivity: Baseline

The participant remained still for two minutes in order to acclimate to the surroundings. During this time, their baseline heart rate was recorded. Next, the experimenter guided the participants through two neutral sample pictures and then left the room. The participant viewed 12 smoking-related images and 12 neutral images in one of several randomized sequences, with the provision that no more than 2 pictures from each category were presented in sequence.

Images were shown on a 20-inch high resolution computer monitor located on a table directly in front of the participant. The image sequence consisted of a 2-second baseline period, followed by 6 seconds of picture viewing, and then subjective ratings. Heart rate was measured continuously throughout the picture viewing. The startle eyeblink reflex was elicited by a binaural acoustic stimulus (50 msec white noise, 100dB, instantaneous rise time) during ten of the twelve images in each category, and during 10 of the inter-trial intervals that range from 12-20 seconds. The baseline cue reactivity assessment took approximately 15 minutes.

Exercise

Following picture-viewing, the heart rate and startle eyeblink electrodes were removed and the participant completed another Mood Form and QSU-brief. The participant was then escorted into another testing room for the exercise portion of the procedure. The exercise condition was determined randomly and in each condition (cardiovascular, Hatha yoga, or educational video) the researcher had a similar amount of contact with the participant. This portion of the procedure took approximately 30 minutes.

In the cardiovascular exercise group, the participant had a portable heart rate monitor attached to them. They were told that they needed to keep their heart rate at a level determined by the researcher using the formula: (220 – age) * 70%. A range of 65% to 75% was acceptable. This corresponds to a moderate intensity level of physical activity. The participant either changed the incline or the speed of the treadmill in order to keep their heart rate in the acceptable range. There was a five minute warm up period, followed by 20 minutes at the prescribed heart rate level, and finally exercise concluded with a five minute cool down period. Two times during exercise (15 minutes after the start of exercise and 25 minutes after the start of exercise) the researcher held up a sign with the BORG printed in large letters. The participant pointed to the number that corresponded to their subjective exertion level. The researcher recorded their ratings at this time. The researcher recorded the participant's heart rate every five minutes during the exercise. At the completion of exercise participants completed a brief activity evaluation questionnaire containing items measuring how enjoyable they found the activity, how difficult they found the activity, and how likely it is that they will do the activity in the future. The participant rated their level of distraction to the activity using the WSWS Concentration subscale and an additional 11 point Likert scale.

In the Hatha yoga condition, the participant had a heart rate monitor attached to them. They were given brief instructions by the researcher on how to follow the videotape. The participant followed the video for a total of 30 minutes to correspond to the cardio group. The video also included a five-minute warm up and a five minute cool down period to correspond to the cardiovascular condition. The tape included simple Hatha yoga stretching and breathing exercises that can be easily learned and utilized by a

relatively healthy person. Two times during yoga, the researcher performed the BORG assessment as previously described. Heart rate was also recorded as previously described. After the yoga, participants completed a brief activity evaluation questionnaire containing items measuring how enjoyable they found the activity, how difficult they found the activity, and how likely it is that they will do the activity in the future. Level of distraction was also rated in the same manner as in the cardiovascular condition.

In the control condition, the participant watched an educational video about exercise. To keep the procedure as uniform as possible, they also had a polar heart rate monitor attached to them, received brief instructions, and watched a 30 minute video with the researcher performing the BORG assessment and heart rate recording in the same manner as previously described. Prior to viewing the video, participants were told they will be evaluating it after it finishes. This is in order to maximize the level of attention that is paid to the video. After the video, participants completed a brief video evaluation questionnaire containing items measuring how entertaining they found the video, how informative they found the video, and how enjoyable the found the video. Finally, level of distraction was rated in the same manner as the other conditions.

Cue Reactivity: Post Exercise

Following the exercise condition, the participant was escorted back into the picture viewing room. As with the pre-exercise cue reactivity, the participant remained still for two minutes to acclimate to the surroundings. Heart rate was measured at this time in order to determine if heart rate was at or near the participants' baseline level due to the timing of the procedure. The startle eyeblink electrodes were re-attached and they filled out another Mood Form and QSU-brief. They were then reminded of the

instructions, the headphones were placed on their ears, and the experimenter left the room. The participant viewed a second set of smoking-related and neutral images that were parallel to the pre-assessment images following the procedure previously described. Finally, headphones were removed, the Mood Form and QSU-brief were completed, and electrodes were removed.

Upon completion of the study, participants were debriefed and they had the opportunity to ask any questions. They were compensated $10 per hour. Table 1 outlines the procedure of the study.

Table 1

Summary of Procedure

Event	Time (min)	Cumulative Time (min)
Informed Consent	5	5
Questionnaires and Interview	30	35
Electrodes Attached	10	45
Craving/Mood Forms (Time 1)	5	50
Acclimation	2	52
Cue Reactivity (Pre)	15	67
Electrodes Removed	5	72
Craving/Mood Forms (Time 2)	5	77
Exercise/Video	30	107
Distraction Forms	2	109
Electrodes Re-Attached	5	114
Craving/Mood Forms (Time 3)	5	119
Cue Reactivity (Post)	15	134
Craving/Mood Forms (Time 4)	5	139
Electrodes Removed	10	149
Debriefing	5	**Total: 154**

Data Processing

Startle reflex data was scored for peak amplitude (the maximum EMG activity following each probe) and onset latency (the length of time from probe onset to eyeblink initiation). To minimize differences among individuals, magnitude scores were transformed to *T* scores. Heart rate data was scored offline to remove artifacts, and then the difference from the 2-second baseline for each trial was taken. Based on an evident triphasic heart rate waveform (e.g., Bohlin & Kjellberg, 1979), we scored the initial deceleration (D1) as the peak downward deflection during the first 3 seconds after picture onset, the initial acceleration (A1) as the peak increase during seconds 2 and 5 following picture onset, and the secondary deceleration (D2) as the peak negative deflection during the final 2 seconds. Physiological and subjective cue reactivity data was averaged over trials within each picture category (smoking and neutral) and within each assessment (pre-exercise and post-exercise).

Startle data were not able to be analyzed. Overall, 80% of the startle data were not usable due to technical difficulties. There was not enough power in the remaining sample to detect differences between the groups.

Results

Participant Characteristics

The final sample included 76 participants (48 males, 28 females) who met inclusion criteria. A summary of participants' demographic characteristics is presented in Table 2 and a summary of smoking-related and baseline characteristics is presented in Table 3. A series of one-way analyses of variance (ANOVA) and chi-square analyses (for categorical variables) indicated that the groups were equivalent on all demographic, baseline, and smoking-related variables (all *p*'s >.05). Participants were an average of 29 years old (SD = 8.4), 37% female, 79% White, smoked an average of 20 cigarettes per day (SD = 8.7), and had a mean FTND score of 4.62 (SD = 2.46), which is equivalent to being moderately dependent.

Table 2

Participant Demographic Characteristics

		Experimental Condition		
Characteristic	Total (N = 76)	Cardio (N = 25)	Yoga (N = 26)	Control (N = 25)
Demographics				
% Female	37	32	35	44
Age				
M	28.89	28.36	30	28.28
SD	8.4	7.44	9.2	8.66
Education (yrs)				
M	13.34	13.32	13.88	12.8
SD	2.1	2.06	1.95	2.26
Race				
%White	79	80	81	76
%Black/African American	14	8	15	20
%Asian	3	0	4	4
%Native Hawaiin/ Other Pacific Islander	1	4	0	0
%American Indian/ Alaskan Native	3	8	0	0
Ethinicity				
%Hispanic/Latino	11	8	15	8

Table 3

Participant Smoking-Related and Baseline Characteristics Mean (SD)

	Experimental Condition			
Characteristic	Total (N = 76)	Cardio (N = 25)	Yoga (N = 26)	Control (N = 25)
Cigarettes per day	19.73 (8.67)	19.94 (8.44)	18.33 (8.04)	20.98 (9.62)
Years Smoking	12.49 (8.19)	12.66 (7.25)	13.13 (9.07)	11.64 (8.38)
Fagerström Test for Nicotine Dependence	4.62 (2.46)	5.12 (2.76)	4.08 (2.19)	4.68 (2.39)
Carbon Monoxide	21.76 (12.54)	20.6 (9.73)	21 (12.84)	23.72 (14.8)
WISDM-Affiliative Attachment	14.16 (8.8)	12.72 (8.34)	14.31 (8.62)	15.44 (9.59)
WISDM-Automaticity	19.89 (8.46)	18.96 (7.68)	19.73 (8.44)	21 (9.39)
WISDM-Loss of Control	16.3 (6.81)	16.4 (6.12)	16.65 (7.21)	15.84 (7.27)
WISDM-Behavioral Choice	23.45 (11.17)	21.16 (10.45)	24.92 (11.46)	24.2 (11.65)
WISDM-Cognitive Enhancement	18.12 (9.26)	15.76 (9.23)	18.92 (8.35)	19.64 (10.07)
WISDM-Craving	18.48 (6.18)	18.16 (5.52)	18.08 (6.57)	19.24 (6.57)
WISDM-Cue Exposure	34.14 (9.11)	34.2 (8.24)	33.35 (9.61)	34.92 (9.7)
WISDM-Negative Reinforcement	27.43 (8.84)	25.16 (8.54)	28.04 (9.13)	29.08 (8.71)
WISDM-Positive Reinforcement	19.87 (8.1)	16.92 (8.19)	21.38 (7.5)	21.24 (8.13)
WISDM-Social Environment	20.21 (7.08)	19.84 (6.45)	18.12 (7.7)	22.76 (6.45)
WISDM-Taste	25.55 (10.32)	24.32 (9.81)	25.81 (10.26)	26.52 (11.14)
WISDM-Tolerance	21.86 (7.73)	20.68 (8.62)	21.46 (7.26)	23.44 (7.31)
WISDM-Weight	15.37 (9.07)	16.16 (9.37)	14.38 (9.04)	15.6 (9.07)
Godin Leisure Time	43.66 (32.18)	42.1 (29.12)	39.08 (30.56)	50.61 (37.14)
7-Day Recall (kcal/kg/day)	567.03 (712.52)	821.74 (1002.99)	415.04 (412.74)	466.38 (539.75)
PANAS-Positive Mood	33.33 (7.61)	33.44 (8.21)	33.46 (7.11)	33.44 (8.21)
PANAS-Negative Mood	20.82 (7.1)	20.44 (6.76)	20.62 (6.6)	21.4 (8.13)

Note. WISDM = Wisconsin Inventory of Smoking Dependence Motives; PANAS = Positive and Negative Affect Schedule

Manipulation Check: Heart Rate, BORG Assessment, and Distraction Level

As expected, participants in the cardiovascular exercise group had a significantly greater average heart rate (M = 125.99, SD = 19.38) during the activity as compared to participants in the yoga (M = 80.67, SD = 13.72) and control (M = 77.14, SD = 9.75) groups ($F[2, 72] = 84.50$, $p < .001$) as measured by the polar heart rate monitor. Heart rate was recorded every five minutes during activity and subsequently averaged to obtain mean heart rate.

Participants in the cardiovascular exercise group also had a significantly greater average BORG rating (M = 12.4, SD = 2.02) as compared to participants in the yoga (M = 8.54, SD = 2.22) and control (M = 7.98, SD = 3.94) groups, $F(2, 73) = 23.20$, $p < .001$.

A one-way analysis of variance (ANOVA) was run to determine if there was a difference in distraction level between the three groups as measured by the WSWS Concentration subscale and the one-item distraction measure. No differences were found, $F(2,72) = 2.22$, $p = .116$ (Cardio: M = 4.08, SD = 2.25, Yoga: M = 3.19, SD = 2.62, Control: M = 4.83, SD = 2.80), so distraction level was not included as a covariate upon examining the main hypotheses.

Similarly, a one-way ANOVA was run to determine if there was a group difference in baseline heart rate during the post-exercise cue reactivity assessment. For each image, heart rate was recorded during a 2-second baseline period, followed by the 6 seconds of picture viewing. Participants in the cardio group demonstrated a trend to significantly higher post-cue reactivity baseline heart rate as compared to participants in

the yoga group for the first third of the cues, $F(2,72) = 2.58$, $p = .083$. Follow-up tests of least squares difference indicated that participants in the cardio group had a significantly higher heart rate (M = 81.14, SD = 10.99) as compared to participants in the yoga group (M = 73.65, SD = 15.08), $p = .043$. Thus, heart rate analyses should be interpreted with caution.

Primary Analyses

Smoking Urge. To test for the effect of exercise on self-reported urge to smoke, we initially conducted a 3 x 3 repeated measures ANOVA, with group (3 levels- cardio, yoga, control) as the between subjects factor, time (3 levels- prior to exercise, immediately following exercise, 20 minutes following exercise) as the within subjects factor, and QSU-brief Global and factor scores as the dependent variables. Analyses indicated a significant time effect, $F(2, 72) = 14.00$, $p < .001$, in which the two exercise groups reported decreased urge following exercise, and equivalent time 1 level urge 20 minutes after exercise. However there were no significant group effects. As there were no significant differences between the cardiovascular and yoga groups on any QSU-brief factor scores at any time point (t's > .369), no differential effects between the groups were hypothesized, and cardio and yoga are two subsets of the general exercise intervention, these two groups were collapsed into one "exercise" group, which was subsequently utilized for analyses.

Accordingly, a series of 2 x 2 repeated measures ANOVAs were conducted, with group (2 levels-exercise, yoga) as the between subjects factor and time (2 levels- prior to exercise, following exercise) as the within subjects factor. Separate ANOVAs were run with times 2 (immediately following exercise) and 3 (20 minutes following exercise) as

the post-exercise time point, respectively. Figures 1-6 summarize QSU-brief scores across all three assessments for all three groups and for the collapsed exercise vs. control groups. Means and standard deviations for all urge measures are presented in Table 4.

For the QSU-brief Global scale, a main time effect was found at time point 2, $F(1, 73) = 15.85$, $p < .001$. The main time effect at time 3 was not significant. There was also a trend toward a significant group x time interaction effect for the QSU-brief Global scale at time 2, $F(1, 74) = 3.86$, $p = .053$, and significance at time 3, $F(1,74) = 5.45$, $p = .022$. Simple effects analyses were run to examine time effects for each group. At time 2, significance was revealed for the exercise group, $F(1, 50) = 17.39$, $p < .001$, indicating that exercise decreased overall cravings immediately following exercise. No significance was revealed for the exercise group at time 3. For the control group, no significance was revealed at time 2, however there was a significant time effect at time 3, $F(1, 24) = 4.73$, $p = .040$, in which urge increased 20 minutes after the activity.

For the QSU-brief Factor 1 scale (anticipation of smoking producing pleasure or reward), a significant main time effect was revealed at time 2, $F(1, 73) = 15.41$, $p < .001$. No main time effect was found for time 3. For time points 2 and 3, there were significant group x time interactions, F's $(1, 74) = 4.61$ and 4.33, p's $< .05$. Simple effects analyses were run to examine time effects for each group. There was a significant time effect for the exercise group for time 2, $F(1, 50) = 17.02$, $p < .001$, indicating that urges were decreased immediately following exercise. No significance was revealed for the exercise group at time 3. For the control group, no significance was revealed at time 2, however there was a significant time effect at time 3, $F(1, 24) = 5.27$, $p = .031$, in which urge increased 20 minutes after the activity.

For the QSU-brief Factor 2 scale (desire to smoke to relieve negative affect or withdrawal), a main time effect was found at time point 2, $F(1, 73) = 9.32$, $p = .003$. The main time effect at time point 3 was not significant. The group x time interaction effect for QSU-brief Factor 2 scale at time 2 was not significant $F(1, 74) = 2.57$, $p = .113$. However, there was a significant group x time interaction effect for the QSU-brief Factor 2 scale at time 3, $F(1, 74) = 4.90$, $p = .030$. Simple effects analyses were run to examine time effects for each group. At time 3, no significance was demonstrated for the exercise group. A trend to significance was revealed for the control group at time 3, $F(1, 24) = 4.21$, $p = .051$, in which urge increased 20 minutes after the activity.

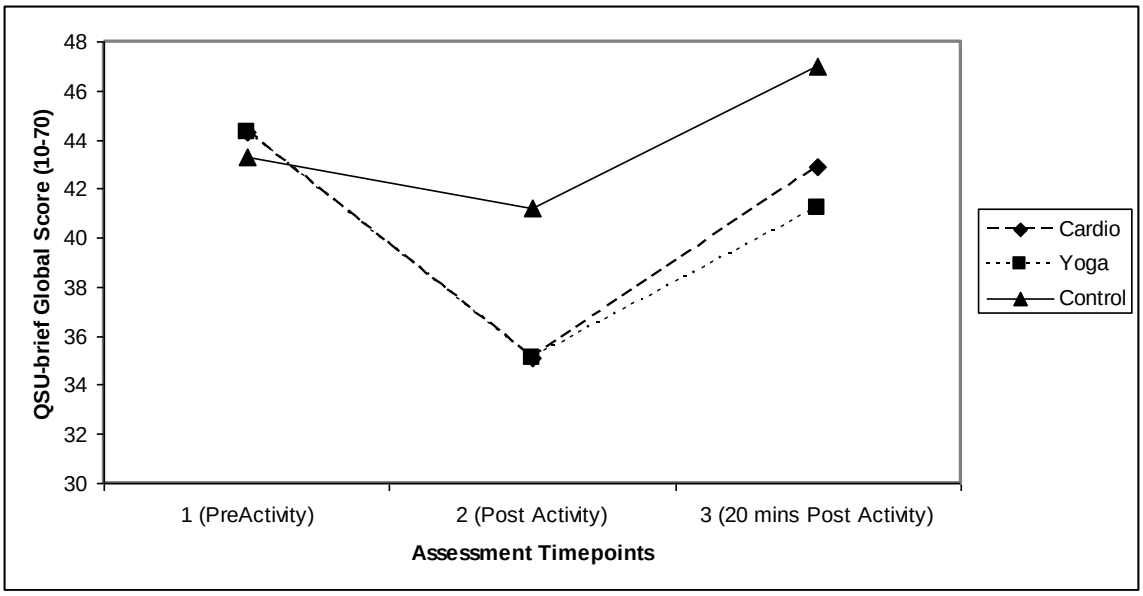

Figure 1. **QSU-brief Global Scores for Cardio, Yoga, and Control Groups**

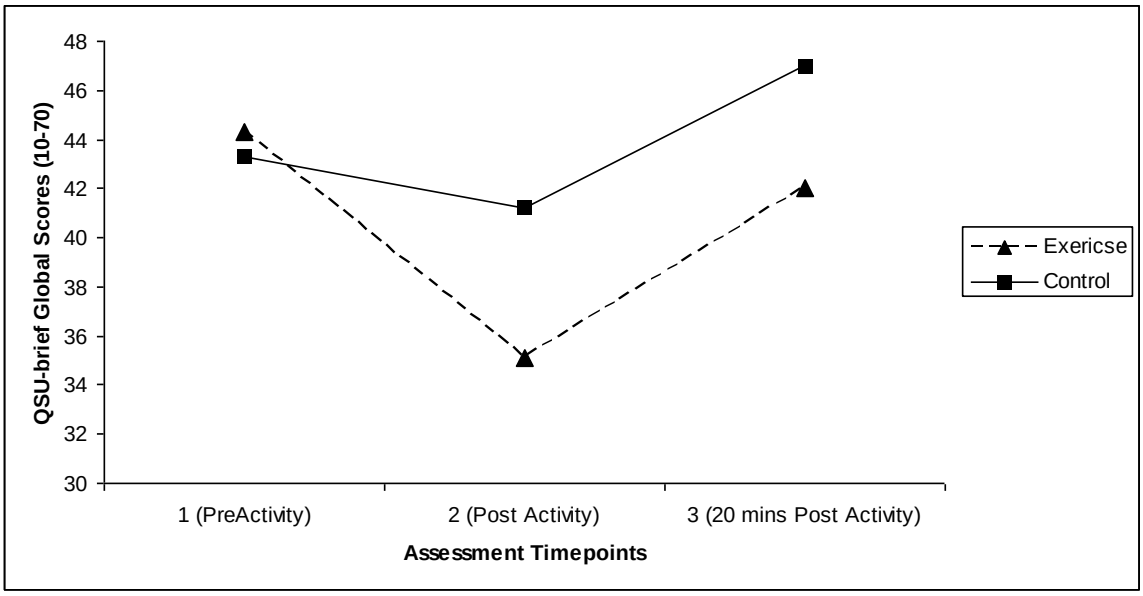

Figure 2. **QSU-brief Global Scores for Exercise and Control Groups**

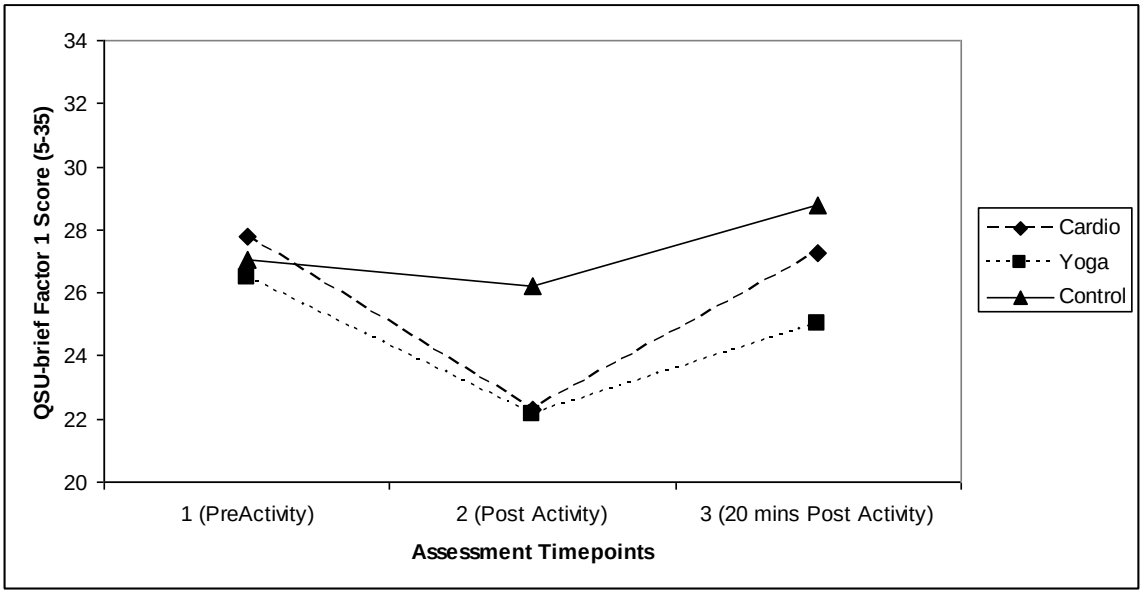

Figure 3. **QSU-brief Factor 1 Scores for Cardio, Yoga, and Control Groups**

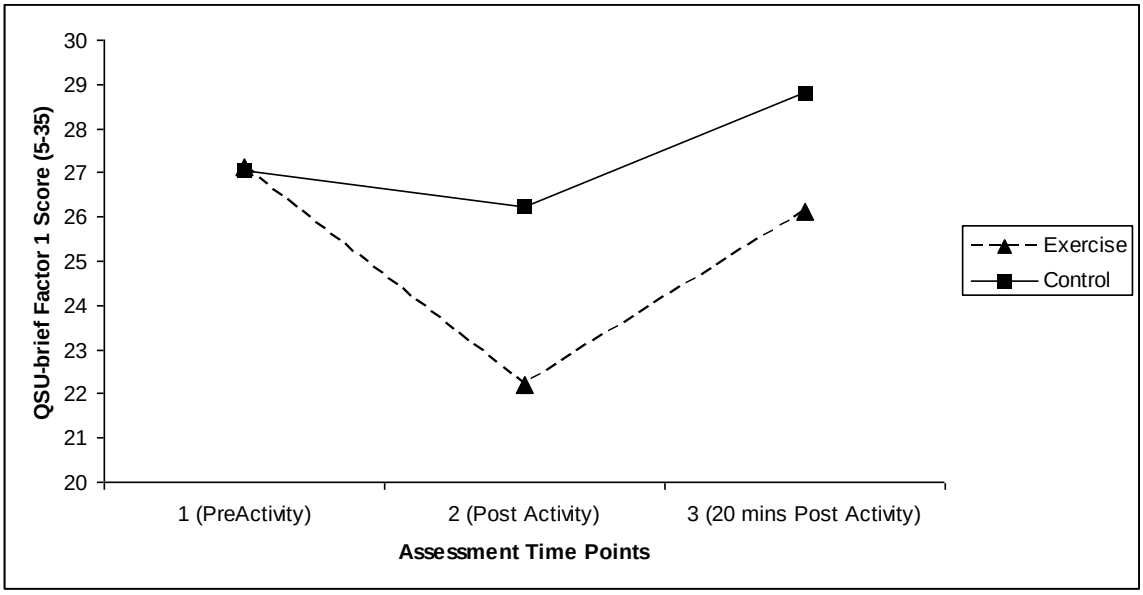

Figure 4. **QSU-brief Factor 1 Scores for Exercise and Control Groups**

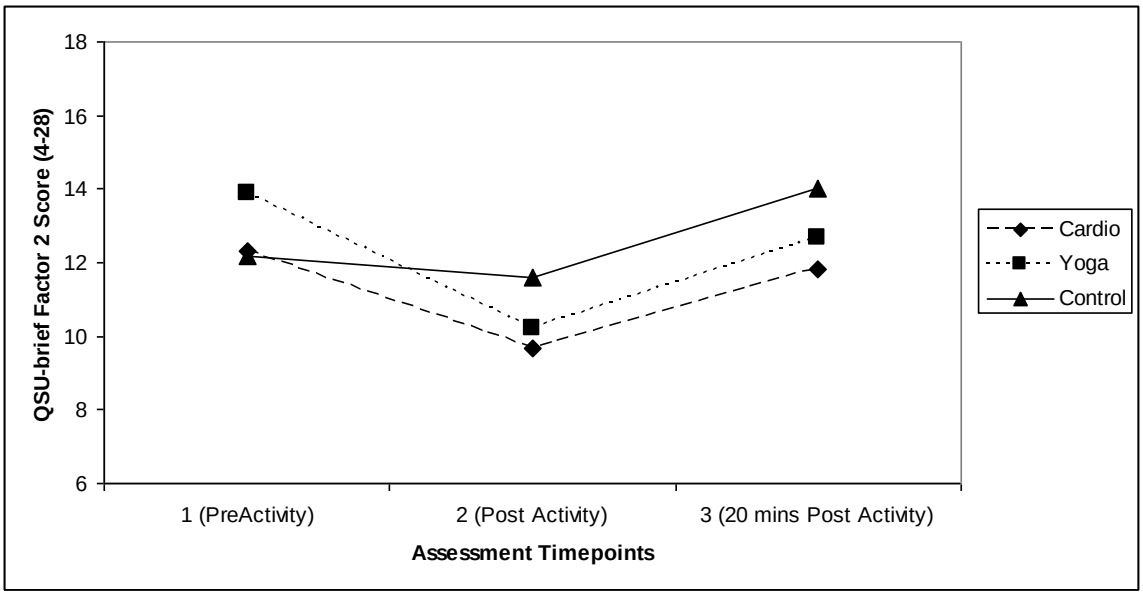

Figure 5. **QSU-brief Factor 2 Scores for Cardio, Yoga, and Control Groups**

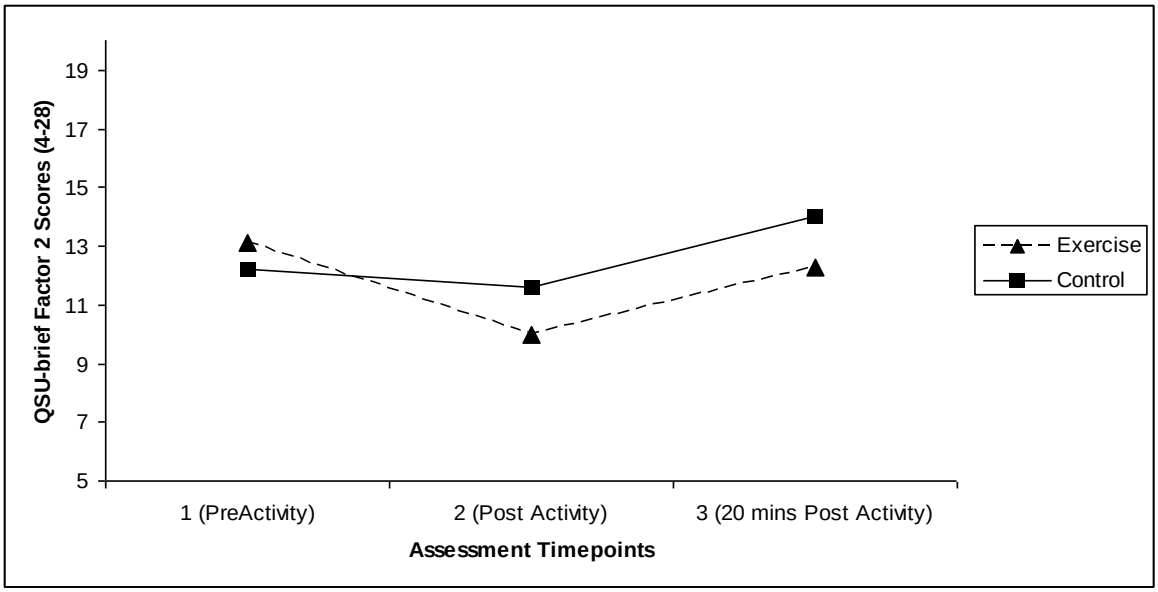

Figure 6. **QSU-brief Factor 2 Scores for Exercise and Control Groups**

Table 4

QSU-brief Urge Ratings

	Assessment Time Mean (SD)			
QSU-brief Scale	Time 1 (Baseline)	Time 2 (Pre Activity)	Time 3 (Post Activity)	Time 4 (20 mins Post Activity)
Factor 1				
Exercise Group (N = 51)	23.12 (8.45)	27.12 (8.53)	22.22 (9.89)	26.12 (8.66)
Control Group (N = 25)	24.28 (9.30)	27.04 (8.27)	26.24 (8.33)	28.80 (7.93)
Factor 2				
Exercise Group	10.16 (5.91)	13.12 (6.86)	9.96 (6.23)	12.27 (6.81)
Control Group	10.20 (6.51)	12.20 (7.95)	11.60 (7.90)	14.00 (8.59)
Global				
Exercise Group	36.71 (14.42)	44.29 (15.97)	35.10 (16.36)	42.04 (15.62)
Control Group	37.84 (15.99)	43.32 (16.30)	41.24 (15.70)	47.00 (16.87)

Mood. State positive and negative mood was analyzed via 3 x 3 repeated measures ANOVAs, with group (3 levels- cardio, yoga, control) as the between subjects factor, time (3 levels- prior to exercise, immediately following exercise, 20 minutes following exercise) as the within subjects factor, and positive and negative mood as the dependent variables. Means and standard deviations for positive and negative mood measures are presented in Table 5, and shown in Figures 7 and 8, respectively. Positive mood analyses indicated a significant main time effect, $F(2, 71) = 10.15$, $p < .001$ and a significant group x time interaction effect, $F(4, 144) = 5.00$, $p = .001$. Similarly, negative mood analyses indicated a significant main time effect, $F(2, 71) = 19.11$, $p < .001$ and a significant time x group interaction effect, $F(4, 144) = 3.36$, $p = .012$. Simple effects analyses were run to examine the time effect for each group separately.

Significant time effects were found for the cardio group for both positive, $F(2,23) = 5.15$, $p = .014$, and negative mood, $F(2,23) = 8.43$, $p = .002$. Similarly, significant

effects were found for the yoga group for both positive, $F(2,23) = 8.09$, $p = .002$, and negative mood, $F(2,23) = 11.73$, $p < .001$. Finally, significance was not demonstrated for the control group for either positive, $F(2,23) = .76$, $p = .480$ or negative mood, $F(2,23) = .41$, $p = .670$. Thus, both forms of exercise were associated with increased positive mood and decreased negative mood.

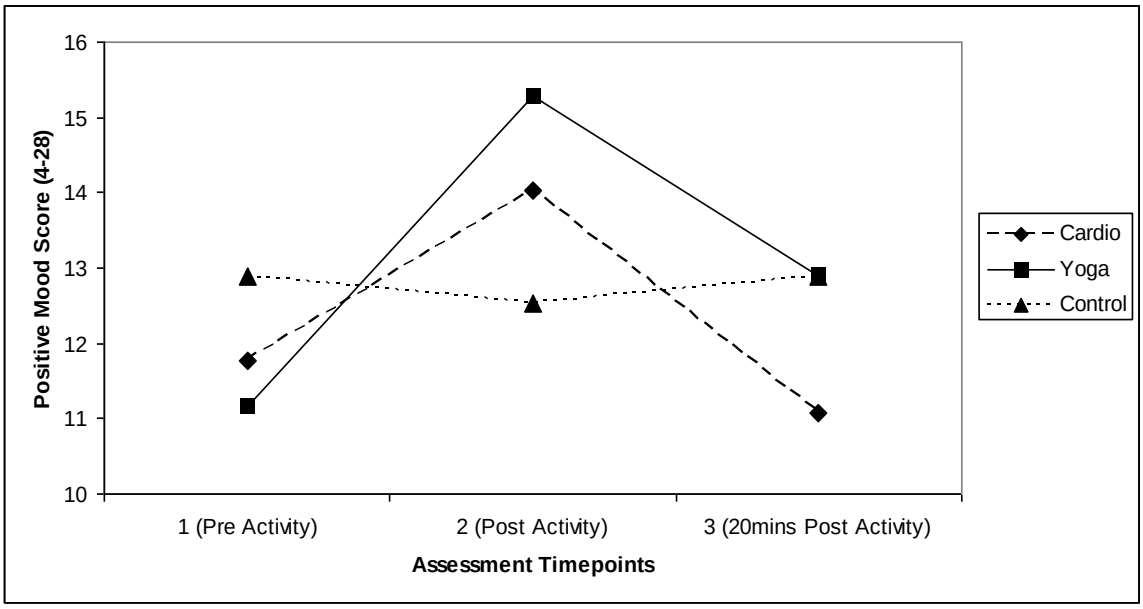

Figure 7. **Positive Mood for Exercise and Control Groups**

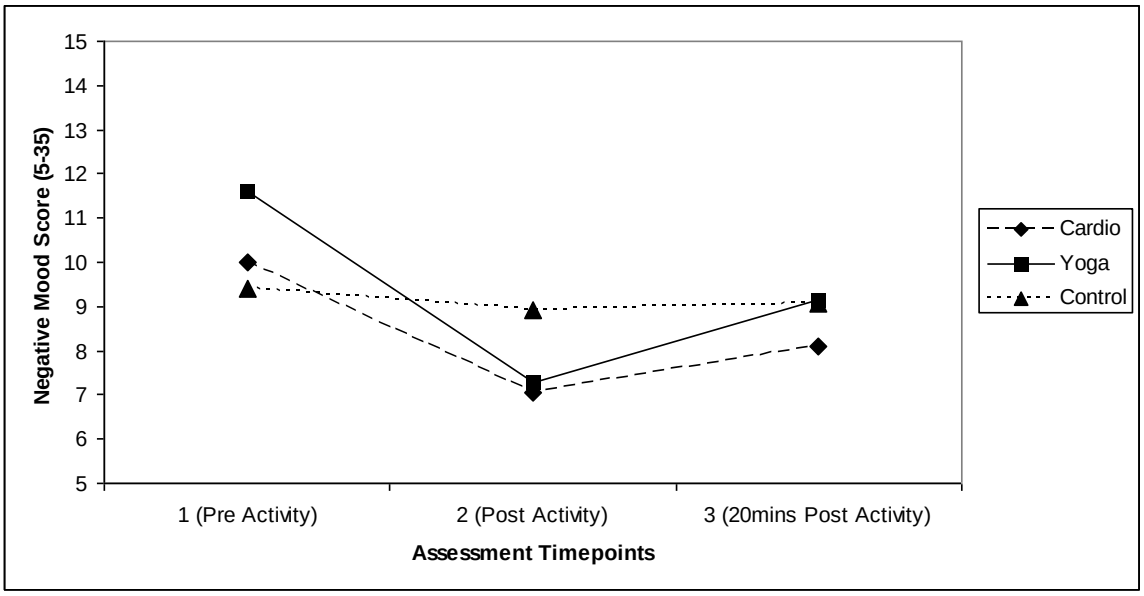

Figure 8. **Negative Mood for Exercise and Control Groups**

Table 5

Participant Positive and Negative Mood Ratings

Mood Scale	Time 1 (Pre Activity)	Time 2 (Post Activity)	Time 3 (20 mins Post Activity)
Positive Mood			
Cardio Group	11.76 (4.76)	14.04 (5.64)	11.08 (4.99)
Yoga Group	11.16 (5.47)	15.28 (6.39)	12.92 (6.17)
Control Group	12.88 (6.35)	12.52 (7.37)	12.88 (7.42)
Negative Mood			
Cardio Group	10.00 (4.60)	7.04 (2.67)	8.08 (3.76)
Yoga Group	11.60 (6.05)	7.28 (3.46)	9.16 (5.29)
Control Group	9.40 (6.68)	8.92 (7.12)	9.08 (6.31)

Cue Reactivity

Hypothesis 1b, which states that the two active exercise groups will have reduced reactivity to smoking cues following exercise, as compared to the control group, was analyzed using a 3 x 2 x 2 repeated measures ANOVA, with group (3 levels- cardio, yoga, control) as the between subjects factor and time (2 levels- pre, post) and cue

category (2 levels- smoking, neutral) as within subjects factors. The primary dependent variables were craving and heart rate. We also examined affective reactivity to the cues, utilizing valence, arousal, and dominance ratings.

Craving. For cue-elicited craving, a trend - level three way interaction was found F (2, 66) = 2.93, $p = .060$. Thus, the time x cue category effects were examined separately for each group, utilizing 2 x 2 repeated measures ANOVAs, with cue category (2 levels- neutral, smoking) and time (2 levels- pre, post) as the within subjects factors. Mean urge ratings are provided in Table 6 for each exercise group, cue type and time point.

For the cardiovascular group, significant cue category F(1,22) = 14.82, $p = .001$ and time x cue category F(1,22) = 5.83, $p = .025$ effects were found. The main effect for time was not significant. Follow-up tests examined cue effects at each time. There was a significant difference between smoking and neutral cues both at pre $t(24) = 4.2$, $p < .001$ and at post $t(23) = 2.2$, $p = .036$, with effect sizes of .66 and .29, respectively. Although both significant, there was a specific reduction in reactivity to smoking cues following cardio exercise.

For the Hatha yoga group, significant time F(1, 24) = 5.27, $p = .031$ and cue category F(1,24) = 20.55, $p < .001$ effects were found, but there was no time x cue interaction. These effects indicate that participants in the Hatha yoga group experienced a general decrease in cue elicited craving following exercise, but that differences between smoking and neutral cues were maintained at both time points

Finally, for the control group, a significant cue category effect was found F(1,20) = 41.90, $p < .001$, but no time or time x cue category effects were revealed. Thus, these

participants reported higher cue elicited cravings to the smoking pictures, and these ratings did not change appreciably over time.

Table 6

Cue Elicited Urge Ratings

(Range 0-20)

		Urge Mean (SD)	
		Pre	Post
Cardio	Smoking Cues	12.14 (5.98)	11.92 (6.21)
	Neutral Cues	8.36 (5.31)	10.13 (5.92)
Yoga	Smoking Cues	13.09 (6.35)	11.64 (5.86)
	Neutral Cues	8.60 (5.20)	6.97 (5.77)
Control	Smoking Cues	13.62 (6.17)	14.54 (5.69)
	Neutral Cues	5.83 (4.52)	6.52 (4.58)

Valence, Arousal, and Dominance

Valence, arousal, and dominance were also examined via 3 x 2 x 2 repeated measures ANOVAs with Group (3 levels- cardio, yoga, control) as the between subjects factor, and time (2 levels- pre, post) and cue category (2 levels- smoking, neutral) as the within subjects factors. No significant effects were found for either valence or arousal. However, significant cue category, $F(1,65) = 7.44$, $p = .008$, and group x cue category, $F(2,65) = 6.83$, $p = .002$, effects were found for dominance. Mean dominance ratings are provided in Table 7 for each exercise group, cue type and time point. Follow-up paired samples t-tests were utilized to further examine the cue category effects for each group. For the cardio and yoga groups, there were no significant differences between the smoking and neutral cues. For the control group, however, significant differences were revealed between smoking and neutral cues, $t(24) = -4.66$, $p < .001$. This indicates that these effects were driven by differences between cue types in the control group.

Table 7

Participant Dominance Ratings

(Range 0-20)

		Dominance Mean (SD)	
		Pre	Post
Cardio	Smoking Cues	11.66 (4.91)	11.46 (5.12)
	Neutral Cues	10.76 (4.21)	10.59 (4.21)
Yoga	Smoking Cues	10.77 (4.84)	10.81 (4.53)
	Neutral Cues	11.96 (3.57)	12.06 (3.13)
Control	Smoking Cues	8.30 (4.83)	7.96 (5.54)
	Neutral Cues	11.68 (3.76)	12.25 (3.61)

Heart Rate. 3 x 2 x 2 repeated measures ANOVAs were employed to examine initial deceleration (D1), initial acceleration (A1), and secondary deceleration (D2) components of the heart rate wave form, with group (3 levels- cardio, yoga, control) as the between subjects factor, and time (2 levels- pre, post) and cue category (2 levels- smoking, neutral) as the within subjects factors. For the initial deceleration, no cue, time, or group main effects were revealed. However, a significant group x time x cue category interaction was found, $F(2,71) = 3.17$, $p = .048$.

Following the same strategy as with cue-elicited craving, we first examined time x cue type effects separately for each group. None of these effects were significant. Thus, the 3-way interaction was broken down to examine group x cue category effects separately for each time point. Again, no significance was found when examining initial deceleration at pre or post.

In addition, a series of 3 x 2 repeated measures ANOVAs were used to examine group x time interactions for each cue type. For neutral cues, a significant group x time interaction was revealed, $F(2, 70) = 4.61$, $p = .013$, with participants in the cardio group experiencing less deceleration at post (pre M = -3.47, SD = 1.71; post M = -2.97, SD = 1.87) and participants in both the yoga and control groups experiencing greater deceleration at post (yoga: pre M = -2.86, SD = 2.03, post M = -3.49, SD = 2.04; control: pre M = -2.25, SD = 1.55, post M = -3.41, SD = 2.27). There was no effect of exercise on initial heart rate deceleration at post on smoking pictures.

Finally, there were no significant main or interaction effects for either initial acceleration (A1) or secondary deceleration (D2) heart rate components.

Secondary Analyses

Mediation. Mediation analyses were conducted to examine whether change in positive and negative affect mediated the relationship between exercise condition and change in urge to smoke. Formal significance tests of the indirect effect of positive and negative affect change were conducted by means of a bootstrapping approach (Efron & Tibshirani, 1993), as described by Preacher & Hayes (2004). Results indicated that the indirect effect of exercise condition on change in urge to smoke through change in positive and negative affect was significantly different from zero ($p < .05$). To further examine the degree of mediation, a four-step, ordinary least squares approach was employed (Baron & Kenny, 1986). According to Baron and Kenny, there are four steps to determine if mediation is indicated. First, it needs to be demonstrated that the initial variable is correlated with the outcome variable; second, the initial variable needs to be correlated with the mediator variable; third, the mediator variable needs to affect the

outcome variable while controlling for the predictor variable; and fourth, the effect of the initial variable on the outcome variable controlling for the mediator variable needs to be reduced to zero. If all four steps are met, the data are consistent with the hypothesis that variable M completely mediates the X – Y relationship, and if the first three steps are met but the fourth step is not, then partial mediation is indicated.

Analyses revealed the following for the relationship between group condition, QSU Global, and positive and negative affect: Step 1 indicated a significant total effect of exercise condition on urge to smoke change between times 1 and 2 (QSU Global: ß = 7.12, R^2 = .050, *p* = .053) and between times 1 and 3 (QSU Global: ß = 6.02, R^2 = .069, *p* = .022). Step 2 indicated a significant effect of exercise condition predicting both positive and negative affect change between times 1 and 2 (Positive affect: ß = -3.48, R^2 = .130, *p* = .001; Negative affect: ß = 3.09, R^2 = .142, *p* = .001) as well as negative affect only between times 1 and 3 (Negative affect: ß = 1.86, R^2 = .181, *p* = .025). The effect of exercise condition on positive affect change between times 1 and 3 was not significant. Thus mediation was not supported for this variable. Step 3 indicated significant effects for both positive and negative affect change between times 1 and 2 on Global urge change, while controlling for exercise condition (Positive affect and QSU Global: ß = -2.01, p < .001; Negative affect and QSU Global: ß = 1.86, p < .001), as well as between times 1 and 3 for negative affect change (Negative affect and QSU Global: ß = 1.21, p < .001). The first three steps in establishing mediation were satisfied, indicating at least partial mediation. Step 4, revealed non-significant effects of exercise condition on urge change between times 1 and 2 while controlling for both positive and negative affect change (Positive affect and QSU Global: ß = .126, *p* = .969; Negative affect and QSU

Global: ß = 1.37, p = .698), indicating that positive and negative affect change fully mediated this relationship. Also, step 4 revealed non-significant effects of exercise condition on urge between times 1 and 3 while controlling for negative affect (Negative affect and QSU Global: ß = 3.77, p = .131), indicating that negative affect change fully mediated this relationship.

Analyses revealed the following for the relationship between group condition, QSU Factor 1, and positive and negative affect: Step 1 indicated a significant total effect of exercise condition on urge to smoke change between times 1 and 2 (QSU Factor 1: ß = 4.10, R^2 = .059, p = .035) and between time 1 and 3 (QSU Factor 1: ß = 2.82, R^2 = .055, p = .038). Step 2 indicated a significant effect of exercise condition predicting both positive and negative affect change between times 1 and 2 (Positive affect: ß = -3.48, R^2 = .130, p = .001; Negative affect: ß = 3.09, R^2 = .142, p = .001) and between times 1 and 3 for negative affect only (Negative affect: ß = 1.86, R^2 = .135, p = .025). The effect of exercise condition on positive affect change between times 1 and 3 was not significant. Thus mediation was not supported for this variable. Step 3 indicated significant effects for both positive and negative affect change between times 1 and 2 on QSU Factor 1 while controlling for exercise condition (Positive affect and QSU Factor 1: ß = -.956, $p < .001$; Negative affect and QSU Factor 1: ß = .914, $p < .001$), as well as between times 1 and 3 for negative affect (Negative affect and QSU Factor 1: ß = .536, p = .005). The first three steps in establishing mediation were satisfied, indicating at least partial mediation. Step 4 revealed non-significant effects of exercise condition on urge between times 1 and 2 while controlling for both positive and negative affect (Positive affect and QSU Factor 1: ß = .776, p = .660; Negative affect and QSU Factor 1: ß = 1.28, p = .499), indicating

that positive and negative affect change fully mediated this relationship. Also, step 4 revealed non-significant effects of exercise condition on urge between times 1 and 3 while controlling for negative affect (Negative affect and QSU Factor 1: ß = 1.82, p = .171), indicating that negative affect change fully mediated this relationship.

QSU Factor 2 urge change was only significant at time point 3, thus mediation was analyzed only for time 3. Analyses revealed the following for the relationship between group condition, QSU Factor 2, and positive and negative affect: Step 1 indicated a significant total effect of exercise condition on urge to smoke change between times 1 and 3 (QSU Factor 2: ß = 2.66, R^2 = .062, p = .031). Step 2 indicated a significant effect of exercise condition predicting negative affect change between times 1 and 3 (Negative affect: ß = 1.86, R^2 = .067, p = .025). The effect of exercise condition on positive affect change was not significant. Thus mediation was not supported for this variable. Step 3 indicated significant effects for negative affect change between times 1 and 3 on QSU Factor 2 change between times 1 and 3 while controlling for exercise condition (ß = .502, p = .003). The first three steps in establishing mediation were satisfied, indicating at least partial mediation. Step 4 revealed non-significant effects of exercise condition on urge between times 1 and 3 while controlling for negative affect (ß = 1.73, p = .149), indicating negative affect change fully mediated this relationship.

Finally, analyses revealed no evidence that positive or negative affect mediated the effect of exercise condition on cue elicited craving or other cue reactivity indices.

Moderation. Exploratory analyses were conducted to examine potential moderators of the relationship between group condition and craving/cue reactivity indices. In particular, these analyses focused on gender, exercise habits, and smoking

indices (amount, nicotine dependence) as potential moderators using procedures described by Baron and Kenny (1986). Gender was entered as an additional group factor in the above ANOVA models to determine whether this factor interacts with group. Exercise habits, such as the amount and type of exercise typically performed, smoking amount (cigarettes per day), and nicotine dependence (FTND score) were included within regression models to determine whether these variables interact with group in predicting the craving and cue reactivity outcomes. Additional continuous moderators included baseline levels of craving or mood as well as smoking motives (WISDM). Analyses revealed no significant moderators of the relationship between group condition and any craving or cue reactivity indices.

Discussion

The principal aim of this study was to conduct a comprehensive, multimodal assessment of cigarette craving and subjective/physiological reactivity to smoking cues following different types of acute exercise. These analyses indicate mixed support for a reduction in self-reported craving for up to 20 minutes following exercise. Thus, the hypothesis that the two exercise groups would have reduced craving following exercise was supported for the QSU Factor 1 scale, for the time period immediately following exercise, for QSU Factor 2 only after a delay of approximately 20 minutes after exercise, and for the QSU Global scale immediately following exercise. Additionally, we found that participants in both exercise groups experienced increased positive mood and decreased negative mood following exercise as compared to the control participants. This is consistent with previous studies (Byrne, 1993, Bock et al., 1999, Berger & Owen, 1992, Morgan, 1994), which demonstrated the mood enhancing effects of exercise. Exercise may reduce the need to enhance affect by smoking and the desire to remove negative affect associated with smoking abstinence. Enhanced exercise-related affect may act as a buffer for this response and may provide coping resources during smoking cessation (Taylor et al., 2005). Furthermore, we found that the reduction in urge to smoke and anticipation of pleasure from smoking was fully mediated by an increase in positive mood and a decrease in negative mood immediately following exercise, and that relief of negative affect from smoking was fully mediated by a decrease in negative mood 20 minutes after exercise. Interestingly, for reduction in urge to smoke and anticipation of

pleasure from smoking, 20 minutes after exercise, positive mood no longer mediated this relationship, but change in negative mood remained a significant mediator. As far as the authors are aware, this is the first time a finding of this nature has been described in this area of research, thus replication in future studies is warranted.

Participants in the exercise groups also reported decreased cue elicited craving after exercise as compared to the control group. Particularly, for participants in the cardiovascular group, the cue reactivity effect size decreased following exercise. Thus, the effects of cardiovascular exercise on cue elicited cravings were targeted specifically to smoking cues. Participants in the Hatha yoga group, however, experienced a general decrease in cue elicited craving following exercise for both smoking and neutral cues. This finding speaks to the overall relaxing effect of Hatha yoga and thus the observed benefit of Hatha yoga for reducing cue elicited craving may be partly due to relaxation. Further studies are needed to compare the effects of Hatha yoga versus standard relaxation tasks (meditation, progressive muscle relaxation, etc.) on desire to smoke. These findings indicate that both Hatha yoga and cardiovascular exercise have the potential to provide immediate relief from urges to smoke, and may be useful for smokers during cessation or during temporary abstinence. Hatha yoga may be particularly useful when aerobic exercise is not practical.

Cue-elicited heart rate was also examined in the current study. No main cue effect was found, indicating that the cues may not have been salient enough to reveal a significant difference between groups. Results also indicated that for neutral cues at post, participants in the cardio group experienced decreased deceleration and participants in the yoga and control groups experienced increased deceleration. These findings do not

support the hypothesis that participants in the exercise groups would experience reduced heart rate reactivity to smoking cues. Although heart rate has been used in numerous smoking cue reactivity studies, this is the first time physiological indices of cue reactivity have been examined following an acute bout of exercise.

During the activity, as expected, participants in the cardio group experienced heart rate increases and participants in the yoga group experienced heart rate decreases. These differences may have affected the analyses. Accordingly, relatively subtle group differences in cue reactivity may have been masked by more substantial heart rate changes during and following exercise. More research is needed to determine the proper procedure for measuring physiological responding when examining exercise effects on cue reactivity. Additionally, future research could also examine heart rate via alternative analyses. For example, future research could examine habituation effects. It is possible that the exercise group participants' heart rate response to smoking cues would dissipate more quickly than control group participants' heart rate response to smoking cues. As a measure of cue reactivity, heart rate across all trials may not be sensitive to group differences, however, habituation may be sensitive to these differences, thus this is an example of an additional paradigm deserving of future research.

Due to technical difficulties, the current study failed to gather enough usable data to be able to analyze startle reflex. This variable could be an important indicator of affective response to smoking cues and should be included in future studies.

Although several potential moderators of the relationship between exercise and urge to smoke were explored, no significant interactions were revealed. The most plausible reason for this is that the sample size of 76 was not large enough to detect significant

differences. Additionally, it is possible that more frequent and/or more intense exercise would have lead to the detection of moderators. The effects of varying the dose of exercise need to be examined in future studies.

To our knowledge, no previous studies examined the effects of Hatha yoga on cravings to smoke, nor has any previous study compared different types of exercise on cravings to smoke. Also, prior studies were mainly interested in overnight withdrawal relief, whereas the current study focused on the effect of exercise on craving induction in non-abstinent smokers. The results of this study extend findings for the beneficial effects of exercise on desire to smoke (Ussher et al., 2001 & Taylor et al., 2005) and suggest that the effects are not limited to cardiovascular exercise. Both cardiovascular exercise and Hatha yoga may reduce both general and cue-elicited cigarette cravings for up to 20 minutes post-exercise.

Limitations and Future Directions

There were several limitations of the current investigation that should be considered when interpreting its results. In this study participants may have been aware of the expected psychological benefits of exercise (Berger et al. 1992). Thus, a limitation of this study is that some of the psychological benefits reported by those in the exercise groups may have been due to expectancy. Future studies could take precautions to mask the true goal of the experiment. Another limitation is the potential influence of demand effects. It is conceivable that participants recognized that self-reported urges to smoke were hypothesized to decrease following exercise, which may have affected their behavior.

The current study relied on past research to set its exercise framework of 30 minutes of activity immediately followed by craving assessment, which may not be the most advantageous. Future research is needed to address issues such as optimal duration and type of exercise, as well as the time course of effects on smoking-related variables following exercise.

Due to the limited scope of the current study, not all possible mechanisms are explored. For instance, it is feasible that exercise acts to reduce cigarette cravings through mimicking certain neurobiological effects of nicotine. Future research should explore this issue by incorporating measurement of relevant hormones as potential mediators of exercise effects on cravings to smoke. Also, the effects of cardiovascular exercise and yoga on smoking behavior should be addressed in future studies. This could entail measurement of smoking topography following exercise, as well as the use of ecological momentary assessment to measure real world effects of exercise on smoking behavior.

An additional mechanism that could be examined further is distraction. In the present study, the three groups were equivalent on distraction level, as measured immediately after the activity. Distraction, however, was not assessed post-activity. It is possible that participants in the exercise groups were distracted post-exercise by such things as bodily sensations produced by the exercise, or perhaps by exercise-related cognitions. Future studies should assess distraction level post activity. Also, in the current study, the construct of distraction was defined as the level of concentration the participant reported during the activity. Distraction can also be considered as a construct of attention and therefore, can be assessed via different measures than in the current study.

It is important to consider if the observed effects would be generalizable to other settings and populations. For instance, smokers trying to quit may be more motivated to utilize exercise as a smoking cessation aid. In addition, the effects of exercise on smoking have not been examined in older smokers or adolescents in previous research. This is important when considering cessation treatment, because although nicotine replacement therapy (NRT) is the most widely used and studied form of pharmacotherapy for managing nicotine dependence and withdrawal (Henningfeld, Fant, Buchhalter, & Stitzer, 2005), most NRT studies exclude adolescent and geriatric populations. Exercise could be a safer smoking cessation aid for these populations. Although, in the current study, participants were recruited from the community and were fairly representative of the smoking population of the area, they were required to be currently smoking and be between the ages of 18 and 45 years old.

Lastly, the relationship between acute and long-term effects of exercise on craving and smoking behavior needs to be explored in future studies. This can inform the potential application of exercise regimens within smoking cessation programs. Future studies need to examine withdrawal throughout the hours following exercise, as this is important in determining the role of exercise during smoking cessation. Also, further research is needed to investigate the effects of exercise on cravings and withdrawal at different stages of abstinence. Further naturalistic studies, with real-time assessment (Shiffman et al. 1996), are needed to understand how different types and durations of exercise can be used to manage craving and withdrawal symptoms over days and weeks of abstinence.

The results of this study have important implications for the treatment of tobacco dependence. A single session of exercise can be recommended for reducing cigarette cravings and for reducing negative affect, and thus may be useful as a smoking cessation aid. Exercise may also be one strategy for reducing cigarette consumption, which can lower health risks for those unwilling or unable to quit, or for reducing the risk of progressing to regular smoking. A relatively small dose of exercise appears to be sufficient; a level that most people can easily and conveniently carry out. This line of research is in its initial stages. Further research is needed to determine if exercise is effective in natural environments during actual quit attempts, and to enhance our understanding of the mechanisms involved in order to develop better practice guidelines for promoting exercise for smokers.

In summary, this study adds to existing evidence that exercise can have an acute effect on reducing urges to smoke. This is also the first study to formally demonstrate that an increase in positive affect and a decrease in negative affect is a mechanism by which this urge reduction occurs. The internal and external validity of such evidence has been extended by inclusion of multi-item and multi-dimensional measures, use of cue reactivity, comparison of different types of exercise in the same study, and observations of effects up to 20 minutes post-exercise. This study indicates that smokers have a choice as to what type of exercise is most agreeable to them, and that either moderate cardiovascular exercise or yoga are convenient forms of exercise that may provide popular, low-effort, and inexpensive options to reduce urges to smoke.

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Appendices

Appendix A: Demographic Questionnaire

1. Age _____ Date of Birth __ __ / __ __ / __ __ __ __

2. What is your gender? Female Male

3. Which of the following best describes your ethnic background?

__Hispanic or Latino __Not Hispanic or Latino

4. What is your race? (check only one)

__White __Asian __Black or African American

__Native Hawaiian or Other Pacific Islander __American Indian or Alaska Native

5. What is your marital status:

__Single, never married __Married __ Divorced

__Widowed __Separated __Living in marriage-like relationship

6. What is your usual pattern of employment over the past 3 years?

__Full time (40 hours/ week)
__Part time (regular hours)
__Part time (irregular hours)
__Student
__In controlled environment
__Military Service
__Retired/disability
__Homemaker
__Unemployed

7. What is your current job title, description?

_____

_____

8. What is the highest level of education you have completed?

__No formal education __Some high school __Some graduate work
__Some grade school __Some college __ A graduate degree
__Completed grade school __Completed college

9. How many years of education have you completed?
(High School=12, College and Graduate school add one for each year completed.)
__ __ (# of years)

10. Are you currently taking any medications? _____Yes _____No

Medication	Dosage/Frequency	Start Date	Reason
1)			
2)			
3)			
4)			
5)			

11. Surgery, hospitalizations or injuries:

date	diagnosis	treatment	hospital/doctor's name
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

12. Habits: (please circle either yes or no and indicate how often and amount)

Do you drink coffee?	Yes	No	How often?_____	Amount_____
Do you drink alcohol?	Yes	No	How often?_____	Amount_____
Do you smoke cigars?	Yes	No	How often?_____	
Do you use snuff?	Yes	No	How often?_____	
Do you smoke a pipe?	Yes	No	How often?_____	

13. Past medical history (give approximate age you had any of the following):

__heart disease	__asthma	
__kidney disease	__head injury	__loss of consciousness
__stroke	__glaucoma	__neurological disorder
__thyroid trouble	__high blood pressure	__bronchitis
__heart trouble	__diabetes	__seizure

14. Do you have any problems with your hearing? If so, please give a brief description_____

_____

15. Do you have any problems with your vision? If so, please give a brief description_____
_____

Appendix B: Smoking Status Questionnaire

After reading each statement carefully, place a check next to the answer that best fits the question. Be sure to check one answer for each question.

1. How soon after you wake up do you smoke your first cigarette?

   __ Within 5 minutes
   __ 6-30 minutes
   __ 31-60 minutes
   __ After 60 minutes

2. Do you find it difficult to refrain from smoking in places where it is forbidden, e.g. in church, at the library, or in a movie theater, etc.?

   __ Yes
   __ No

3. Which cigarette would you hate most to give up?

   __ The first one in the morning
   __ All others

4. How many cigarettes a day do you smoke?

   __ 10 or less
   __ 11-20
   __ 21-30
   __ 31 or more

5. Do you smoke more frequently during the first hours after waking than during the rest of the day?

   __ Yes
   __ No

6. Do you smoke if you are so ill that you are in bed most of the day?
   __ Yes
   __ No

Appendix C: Questionnaire of Smoking Urges

Indicate how much you agree or disagree with each of the following statements by placing a single checkmark along each line between STRONGLY DISAGREE and STRONGLY AGREE. The closer you place your checkmark to one end or the other indicates the strength of your agreement or disagreement. We are interested in how you are thinking and feeling right now as you are filling out the questionnaire.

1. I have a desire for a cigarette right now.

   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

2. Nothing would be better than smoking a cigarette right now.

   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

3. If it were possible, I probably would smoke now.

   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

4. I could control things better right now if I could smoke.

   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

5. All I want right now is a cigarette.

   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

6. I have an urge for a cigarette.

   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

7. A cigarette would taste good right now.

   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

8. I would do almost anything for a cigarette now.

   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

9. Smoking would make me less depressed.

   STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

10. I am going to smoke as soon as possible.

    STRONGLY DISAGREE ___: ___: ___: ___: ___: ___: ___STRONGLY AGREE

Appendix D: Wisconsin Inventory of Smoking Dependence Motives

Below are a series of statements about cigarette smoking. Please rate your level of agreement for each using the following scale:

1	2	3	4	5	6	7
Not true of me at all						*Extremely true of me*

1. I enjoy the taste of cigarettes most of the time.	1	2	3	4	5	6	7
2. Smoking keeps me from gaining weight.	1	2	3	4	5	6	7
3. Smoking makes a good mood better.	1	2	3	4	5	6	7
4. If I always smoke in a certain place it is hard to be there and not smoke.	1	2	3	4	5	6	7
5. I often smoke without thinking about it.	1	2	3	4	5	6	7
6. Cigarettes control me.	1	2	3	4	5	6	7
7. Smoking a cigarette improves my mood.	1	2	3	4	5	6	7
8. Smoking makes me feel content.	1	2	3	4	5	6	7
9. I usually want to smoke right after I wake up.	1	2	3	4	5	6	7
10. Very few things give me pleasure each day like cigarettes.	1	2	3	4	5	6	7
11. It's hard to ignore an urge to smoke.	1	2	3	4	5	6	7
12. The flavor of a cigarette is pleasing.	1	2	3	4	5	6	7
13. I smoke when I really need to concentrate.	1	2	3	4	5	6	7
14. I can only go a couple hours between cigarettes.	1	2	3	4	5	6	7
15. I frequently smoke to keep my mind focused.	1	2	3	4	5	6	7
16. I rely upon smoking to control my hunger and eating.	1	2	3	4	5	6	7
17. My life is full of reminders to smoke.	1	2	3	4	5	6	7
18. Smoking helps me feel better in seconds.	1	2	3	4	5	6	7
19. I smoke without deciding to.	1	2	3	4	5	6	7
20. Cigarettes keep me company, like a close friend.	1	2	3	4	5	6	7
21. Few things would be able to replace smoking in my life.	1	2	3	4	5	6	7
22. I'm around smokers much of the time.	1	2	3	4	5	6	7
23. There are particular sights and smells that trigger strong urges to smoke.	1	2	3	4	5	6	7
24. Smoking helps me stay focused.	1	2	3	4	5	6	7
25. Smoking helps me deal with stress.	1	2	3	4	5	6	7
26. I frequently light cigarettes without thinking about it.	1	2	3	4	5	6	7
27. Most of my daily cigarettes taste good.	1	2	3	4	5	6	7
28. Sometimes I feel like cigarettes rule my life.	1	2	3	4	5	6	7
29. I frequently crave cigarettes.	1	2	3	4	5	6	7
30. Most of the people I spend time with are smokers.	1	2	3	4	5	6	7
31. Weight control is a major reason that I smoke.	1	2	3	4	5	6	7
32. I usually feel much better after a cigarette.	1	2	3	4	5	6	7
33. Some of the cigarettes I smoke taste great.	1	2	3	4	5	6	7
34. I'm really hooked on cigarettes.	1	2	3	4	5	6	7
35. Smoking is the fastest way to reward myself.	1	2	3	4	5	6	7
36. Sometimes I feel like cigarettes are my best friends.	1	2	3	4	5	6	7
37. My urges to smoke keep getting stronger if I don't smoke.	1	2	3	4	5	6	7

38. I would continue smoking, even if it meant I could spend less time on my hobbies and other interests.	1	2	3	4	5	6	7
39. My concentration is improved after smoking a cigarette.	1	2	3	4	5	6	7
40. Seeing someone smoke makes me really want a cigarette.	1	2	3	4	5	6	7
41. I find myself reaching for cigarettes without thinking about it.	1	2	3	4	5	6	7
42. I crave cigarettes at certain times of day.	1	2	3	4	5	6	7
43. I would feel alone without my cigarettes.	1	2	3	4	5	6	7
44. A lot of my friends or family smoke.	1	2	3	4	5	6	7
45. Smoking brings me a lot of pleasure.	1	2	3	4	5	6	7
46. Cigarettes are about the only things that can give me a lift when I need it.	1	2	3	4	5	6	7
47. Other smokers would consider me a heavy smoker.	1	2	3	4	5	6	7
48. I feel a strong bond with my cigarettes.	1	2	3	4	5	6	7
49. It would take a pretty serious medical problem to make me quit smoking.	1	2	3	4	5	6	7
50. When I haven't been able to smoke for a few hours, the craving gets intolerable.	1	2	3	4	5	6	7
51. When I do certain things I know I'm going to smoke.	1	2	3	4	5	6	7
52. Most of my friends and acquaintances smoke.	1	2	3	4	5	6	7
53. I love the feel of inhaling the smoke into my mouth.	1	2	3	4	5	6	7
54. I smoke within the first 30 minutes of awakening in the morning.	1	2	3	4	5	6	7
55. Sometimes I'm not aware that I'm smoking.	1	2	3	4	5	6	7
56. I'm worried that if I quit smoking I'll gain weight.	1	2	3	4	5	6	7
57. Smoking helps me think better.	1	2	3	4	5	6	7
58. Smoking really helps me feel better if I've been feeling down.	1	2	3	4	5	6	7
59. Some things are very hard to do without smoking.	1	2	3	4	5	6	7
60. Smoking makes me feel good.	1	2	3	4	5	6	7
61. Smoking keeps me from overeating.	1	2	3	4	5	6	7
62. My smoking is out of control.	1	2	3	4	5	6	7
63. I consider myself a heavy smoker.	1	2	3	4	5	6	7
64. Even when I feel good, smoking helps me feel better.	1	2	3	4	5	6	7
65. I reach for cigarettes when I feel irritable.	1	2	3	4	5	6	7
66. I enjoy the sensations of a long, slow exhalation of smoke.	1	2	3	4	5	6	7
67. Giving up cigarettes would be like losing a good friend.	1	2	3	4	5	6	7
68. Smoking is the easiest way to give myself a lift.	1	2	3	4	5	6	7

Appendix E: Positive and Negative Affect Schedule

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you generally feel this way, that is, how you feel on the average. Use the following scale to record your answers.

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

_____ interested

_____ distressed

_____ excited

_____ upset

_____ strong

_____ guilty

_____ scared

_____ hostile

_____ enthusiastic

_____ proud

_____ irritable

_____ alert

_____ ashamed

_____ inspired

_____ nervous

_____ determined

_____ attentive

_____ jittery

_____ active

_____ afraid

Appendix F: Mood Form

Please indicate how much you are experiencing each of the following moods **right now** by placing a checkmark on EACH line.

	Not at all	Very slight	Some what	Moderate amount	Much	Very much	Extremely much
Happy							
Depressed/Blue							
Joyful							
Unhappy							
Pleased							
Enjoyment/Fun							
Frustrated							
Worried/Anxious							
Angry/Hostile							

Appendix G: Wisconsin Smoking Withdrawal Scale

Please answer the following questions by circling one number from 0 – 4 based on how you have felt or what you have noticed during the exercise or video.

0	1	2	3	4
Strongly Disagree	Disagree	Feel Neutral	Agree	Strongly Agree

1.	My level of concentration is excellent.	0	1	2	3	4
2.	It is hard to pay attention to things.	0	1	2	3	4
3.	It has been difficult to think clearly.	0	1	2	3	4

Appendix H: Activity Evaluation/Distraction Form

Please answer the following questions evaluating the activity you participated in.

1. Please rate how enjoyable you found the activity.

1) Not at all
2) Slightly
3) Moderately
4) Very Much

2. Please rate how difficult you found the activity.

1) Not at all
2) Slightly
3) Moderately
4) Very Much

3. Please rate how likely it is that you will do this activity in the future.

1) Not at all
2) Slightly
3) Moderately
4) Very Much

4. Rate how much you were pre-occupied by this activity by circling one number from 0-10.

Not at all *Extremely*

0	1	2	3	4	5	6	7	8	9	10

5. Please provide any additional comments about the activity.

_____
_____
_____
_____
_____

Appendix I: Video Evaluation/Distraction Form

Please answer the following questions evaluating the video you just watched.

1. Please rate how enjoyable you found the video.

1) Not at all
2) Slightly
3) Moderately
4) Very Much

2. Please rate how entertaining you found the video.

1) Not at all
2) Slightly
3) Moderately
4) Very Much

3. Please rate how informative you found the video.

1) Not at all
2) Slightly
3) Moderately
4) Very Much

4. Rate how much you were pre-occupied by this video by circling one number from 0-10.

Not at all *Extremely*

0	1	2	3	4	5	6	7	8	9	10

5. Please provide any additional comments about the video.

_____
_____
_____
_____
_____

Appendix J: Seven Day Physical Activity Recall Interview

1. Were you employed during the last seven days? 0. No (skip to Q4) 1. Yes

2. How many days of the last seven did you work? _____days

3. How many total hours did you work in the last seven days? _____hours

4. What two days do you consider your weekend days? _____ _____
(mark days below with a squiggle)

WORKSHEET	DAYS							
	SLEEP	1__	2__	3__	4__	5__	6__	7__
MORNING	Moderate							
	Hard							
	Very Hard							
AFTERNOON	Moderate							
	Hard							
	Very Hard							
EVENING	Moderate							
	Hard							
	Very Hard							
Total Min Per Day	Strength							
	Flexibility							

4a. Compared to your physical activity over the past three months, was last week's physical activity more, less, or about the same?

1. More
2. Less
3. About the same

Worksheet Key:
An asterisk (*) denotes a work-related activity.
A squiggly line through a column (day) denotes a weekend day.

Rounding
10-22 min. = 25
23-37 min. = 50
38-52 min. = .75
53-1:07 hr/min = 1.0
1:08-1.22 hr/min = 1.25

Appendix K: Godin Leisure Time Exercise Questionnaire

Considering a **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your **free time** (write on each line the appropriate number).

	Times Per Week
a) STRENOUS EXERCISE **(HEART BEATS RAPIDLY)** (i.e. running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller blading, vigorous swimming, vigorous long distance bicycling)	_____
b) MODERATE EXERCISE **(NOT EXHAUSTING)** (i.e. fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, dancing)	_____
c) MILD EXERCISE **(MINIMAL EFFORT)** (i.e. yoga, archery, fishing, bowling, horseshoes, golf, snow-mobiling, easy walking)	_____

2. Considering a 7-Day period (a week), during your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)? Circle one:

OFTEN SOMETIMES NEVER/RARELY

How hard do you feel you are working right now?

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat Hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	