

STATE-SPECIFIC EFFECTS OF WITHDRAWAL IN SMOKERS

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

The Department of Psychology

by

Carla J. Rash

B. A., University of Central Florida, 2001

May 2004

Table of Contents

List of Tables	iii
Abstract.....	iv
Introduction.....	1
Literature Review.....	3
The Relapse Process	3
Cue-reactivity.....	8
State-specific Effects	11
State-specific Effects and Smoking	13
Statement of Problem and Hypotheses	15
Method	18
Power Analysis	18
Participants.....	18
Materials	19
Smoking Status Questionnaire.....	19
Positive and Negative Affect Schedule.....	19
Questionnaire of Smoking Urges.....	20
Minnesota Nicotine Withdrawal Scale	21
Physiological Measures	21
Learning Task	21
Free Recall Task	23
Procedure	23
Results.....	26
Discussion.....	31
References.....	35
Appendix A: Smoking Status Questionnaire	40
Appendix B: PANAS.....	41
Appendix C: Smoking Urges (QSU)	42
Appendix D: MNWS	46
Appendix E: Consent Form	47
Vita.....	49

List of Tables

1. Comparison of Physiological Responses of Smokers to Reported Cravings in the Presence of Cues and Withdrawal.....10

2. Study Design.....16

3. Learning Task Word Lists in Three Rotations.....22

4. Summary of Measures at Given Timepoints23

5. Means of Physiological Measurements by Condition at Each Assessment Point27

6. Mean Corrected Number of Words Recalled.....28

7. Correlations Among Heart Rate and Select Variables.....28

8. Correlations Among Withdrawal and Select Variables29

Abstract

Comparisons of responses to a free-recall task were made in withdrawal and non-withdrawal states of 41 smokers. A 2 x 2 design was used to investigate state-specific learning effects in smokers during nicotine withdrawal using a list of 20 common words. Nicotine withdrawal was defined as a minimum of 12 hours abstinence from smoking. Physiological measures of heart rate and blood pressure were examined for drug-compensatory responses. No significant decreases in physiological responding were found. Additionally, no interaction was found between reported urge and withdrawal. The primary hypothesis regarding state-specific effects on recall was not supported. These findings are to be interpreted with caution, as sample-size was not sufficient to detect differences among groups.

Introduction

Approximately 23% of adults currently smoke cigarettes in the United States (CDC, 2002). Despite a desire to quit among 70% of smokers, only a small percentage is successful in permanently quitting (CDC, 1994). Long-term abstinence rates among smokers wanting to quit are low, ranging from 20 to 40% for treatment programs, and only 5% for those quitting without the aid of a treatment program (Stitzer, 1998). Many feel the best approach to treating smokers, and the one to produce higher rates of abstinence, is one that is comprehensive and provides pharmacological treatment in combination with cognitive and behavioral coping skills (USDHHS, 2000). Despite the improvement over single approach therapies, the success rates for smokers remain low even with various combinations of mood management, cessation skills training, contingency management, nicotine replacement therapy, and weight control treatment programs (Hall, Wasserman, & Havassay, 1991).

What makes smoking cessation so difficult even with the aid of a treatment program, therapist, and/or pharmacological therapy? One explanation lies in the relationship between relapse and environmental cues. The sight and smell of others smoking become triggers for urges to smoke. In addition to these environmental cues, affect plays a large role in relapse amongst smokers. Unlike most drugs, smokers use cigarettes to produce varied emotional states- to relieve anxiety, stress, tension, or boredom, to calm down, to celebrate, or as a “pick-me-up.” Treatment, then, must encompass all of these aspects. The use of coping skills training is a common approach (Hall et al., 1991), providing the smoker with skills to be applied as an environmental or affect-related cue elicits an urge to smoke.

With the poor abstinence rates in treatment programs, investigating and improving the efficacy of treatment is necessary. The current study investigated the memory of smokers in

withdrawal and smoking states. Additionally, urges were considered as they reflect an important aspect of the relapse process. If relapse is connected to a failure to effectively utilize coping skills, and the problem is one of a retrieval failure, consideration of the state-dependent learning (SDL) theory in treatment of smokers may improve success by increasing likelihood of accessing necessary coping skills when needed. During initial learning of coping skills, according to the SDL theory, the state should be similar to that at which recall is expected in order to achieve optimal performance.

Literature Review

The Relapse Process

Relapse, or returning to use following cessation, remains a problem for drug users. Studies focusing on the pattern of relapse find those who have used following cessation to be at risk for increased usage over time. A follow-up study of smokers' relapse patterns found that most relapses occur in the first three months following cessation (Brandon, Tiffany, Obremski, & Baker, 1990). Smoking even one cigarette puts an individual at high risk for relapse. In the Brandon et al. (1990) study, 88% of participants who had even one cigarette post cessation relapsed during the 2-year period studied. Only 29% of the participants in this study reported using coping skills following post cessation cigarette use, despite the fact that 85% of participants received coping response skills training during treatment.

Agreement determining when a person is to have relapsed has not been reached, and may change for different drugs depending on patterns of use (Hall et al., 1991). A distinction between a 'slip' (lapse) and relapse can also be made. Hall et al. (1991) identify three stages of the relapse process. The (1) 'slip' refers to the first lapse following cessation, and is distinct from (2) return to continuous use, or relapse. Additionally, the authors note the (3) process between the 'slip' and full relapse as separate from the previously mentioned stages. This distinction between slip and relapse is not always recognized in treatment programs. Programs such as Alcoholics Anonymous, which advocate a 'one drink makes a drunk' philosophy shape the 'slip' as a failure rather than merely a mistake or stumble on the path to sobriety. This may encourage a person who uses following cessation to perceive the event in a more negative view, potentially causing them to 'give up' and fully relapse. Rather, Marlatt (1985) presents the slip in terms of a 'fork in

the road', a choice of continuing toward positive behavior change or toward the previous problem, emphasizing the role of personal choice.

A component of the model proposed by Marlatt (1985), the abstinence violation effect (AVE), provides a possible explanation for the third stage, the process between slip and relapse. For smokers, as well as other drug users, negative affect plays a large role in high-risk situations and relapse. When an individual is unsuccessful after encountering a high-risk situation, the AVE may occur, particularly when the individual allows only for complete abstinence. AVE refers to the response of the individual to the initial 'slip', and involves (1) an attribution for cause of lapse with internal, global, stable, and uncontrollable features, and (2) an affective reaction. Regarding the initial slip as failure generates negative affect that was previously paired with drug use, where drug use served as a coping method for handling negative affect. The individual then may use drugs to alleviate negative affect created by their perception of failure as they have in past situations. However, continued use spurns additional negative statements regarding lack of success, until full relapse has occurred. Indeed, Marlatt poses the idea that slips may actually be beneficial, providing useful information that can be used in future situations.

An emphasis of Marlatt's model is the role of the 'high risk situation' in relapse. A high-risk situation refers to a situation where drug use is expected, or commonly occurred. Examples differ from one individual to another, but common high-risk situations include social pressures (while drinking, being around drug-using friends), negative affect (anger, depression, anxiety), and interpersonal conflict. The effective use of coping skills during high-risk situations contributes to increasing the individual's self-efficacy and mastery for remaining drug-free, reducing likelihood of future relapse. Conversely, when encountering high-risk situations with ineffective coping skills, a reduction in self-efficacy is experienced along with a rise in positive

expectancies (beliefs about the immediate positive consequences of drug use, i.e., alleviation of negative affect). Motivation to use the drug increases as positive expectancies outweigh negative expectancies, and the slip occurs. The AVE follows the slip, defined by a loss of self-control and sense of guilt, increasing the likelihood of full relapse.

In contrast to the cognitive-behavioral models such as that proposed by Marlatt (1985), conditioning models attempt to explain the relapse process by emphasizing the role of craving. Siegel (1979) describes the process of tolerance development through anticipatory compensatory responses that are created by recurring drug use. First use of a drug creates an expected physical response (e.g., stimulant use causes increased heart rate) and can be regarded as an unconditioned response (UCR). Tolerance to the drug occurs following subsequent use in the presence of the same pre-drug cues. The explanation put forth by Siegel for the development of tolerance is that the reactivity to the drug is diminished as these cues begin to elicit a compensatory conditioned response (CCR). This secondary, adaptive conditioned response (CR) ultimately decreases the effect of the drug by eliciting a reverse physiological reaction. The development of the CCR begins with central nervous system (CNS) activity following drug ingestion. CCR's begin as an unconditioned physical response to the CNS activity. Following repeated pairings of the CNS activity after drug ingestion and environmental drug cues, the CCR becomes a conditioned response, and will occur in the presence of the environmental cues. The environmental cues then can elicit the CCR when no drug is present.

The CCR is opposite in effect from the pharmacological properties of the drug (decreasing the heart rate in the case of stimulants), decreasing the overall effect of the drug even at same dosage. However, when change occurs in the cues (or conditioned stimuli (CS)), the CCR fails to be elicited, thereby eliminating the tolerance effect. This results in a more intense

experience for the user and can sometimes result in what is commonly referred to as drug overdose. Siegel and Ramos (2002) point out that these overdoses do not usually involve more than typical amounts of the drug, but instead use occurred in the presence of a novel environment. Therefore, a consistent amount of a drug can have very different effects given a change in the environment.

Siegel (1979) stresses the importance of the environmental cues (i.e., time of expected use) in the development of tolerance. “Tolerance does *not* result simply from the organisms experiencing repeated pharmacological stimulation. Rather it *does* result from repeated administration of the drug in the context of environmental cues that reliably signal the impending pharmacological stimulation (p. 151).” Once tolerance is established and drug-compensatory responses initiated in response to environmental cues, lack of drug administration will result in full compensatory responses without the moderating effect of the drug. These effects may comprise withdrawal symptoms and craving (Siegel).

In applying the conditioning model to treatment and prevention of relapse, importance must be placed on environmental cues. Simple maintenance of abstinence without attention to environmental cues will not produce adequate treatment of drug-dependence (Siegel, 1979). Particularly, in-patient drug treatment facilities lack exposure to drug-related environmental stimuli, and upon release to his/her natural environment, the individual may experience withdrawal symptoms and craving leading to potential relapse, as drug use alleviates negative physical symptoms experienced by the individual. The craving and withdrawal symptoms (CCRs unmet by drug administration) following exposure to the pre-cessation environment must be addressed by treatment. Extinction, or repeated pairing of the conditioned stimulus (i.e., drug paraphernalia) without the unconditioned stimulus (drug) until the conditioned response no

longer occurs, has been demonstrated in rats with morphine tolerance. Compared to rats in a control condition (simulating physical withdrawal only), rats in the extinction condition (repeated injections of saline rather than morphine) responded with effects typical before drug-compensatory CRs are established (Seigel, 1978). Thereby providing evidence that attention to environmental cues in regards to treatment may improve prolonged abstinence following cessation.

While Marlatt's cognitive-behavioral approach and the conditioning model operate out of different frameworks and principles, they are not necessarily mutually exclusive. The importance of environmental cues (and cravings generated from the cues) in the conditioning model could be interpreted to be the high-risk situations of Marlatt's model. Without specific training in regards to post-cessation drug cues, individuals are left without proper defenses to maintain positive behavior change. This view can be conceptualized as a layering of processes. At the most basic level, individuals respond to stimuli in the environment. This reaction (to a high-risk situation), if met by effective coping strategies, will not lead to drug use. However, when coping strategies are not used, or used ineffectively, mental processes are engaged (changing of expectancies, or anticipation of symptom relief) and the risk of drug use increases.

As specified by the conditioning model, the environmental cues associated with drug use generate reactions in individuals upon exposure. Cue-reactivity studies have investigated the effects of presentation of drug-related cues in differing modes (i.e., in vivo, imagery). Additionally, applications of the findings in cue-reactivity studies have been examined as a possible treatment strategy in the form of cue-exposure.

Cue-Reactivity

Cue-reactivity studies attempt to manipulate cravings through exposure to drug-related cues. Studies using in vivo manipulation typically have the participant take a cigarette out of a favored brand pack, hold, and light the cigarette (Sayette & Hufford, 1994). Video cues have demonstrated similar effects to in vivo cues, allowing the participant to view an individual performing the same tasks on video tape (Shadel, Niaura, & Abrams, 2001). Another approach includes the use of personalized or standardized imagery scripts (Conklin & Tiffany, 2001; Drobos and Tiffany, 1997), delivered through headphones. Personalization of scripts has not been shown to be an improvement over use of standardized scripts in generating urges (Conklin & Tiffany). Imagery studies have also investigated the effect of affective content, finding that negative affect scripts produce cravings even without urge content (Tiffany & Drobos, 1990), possibly reflecting the importance of negative affect in the relapse process.

Cravings, or urges, are often measured by use of visual analogue scale (VAS; Tiffany & Drobos, 1990) where participants rate their craving according to anchors (no urge at all to worst urge ever experienced), Likert-type scales (Niaura et al., 1999; Shadel, Niaura, & Abrams, 2001), ratings (Sayette & Hufford, 1994), or questionnaires (Conklin & Tiffany, 2001; Drobos & Tiffany, 1997; Taylor et al., 2000). Other measures of cue reactivity concern the physiological changes occurring in withdrawal and may include heart rate, skin conductance, finger temperature, facial EMG, or arterial blood pressure.

Reaction to urges has been shown to predict relapse in cue-exposure studies (Abrams et al., 1988; Doherty, Kinnunen, Militello, & Garvey, 1995). In a study assessing predictors of relapse at 4 time points (days 1, 7, 14, and 30) following cessation, participants with greater reported urges were more likely to have relapsed by the next time point (Doherty et al., 1995).

Strongest urges were reported one day following cessation, a sensitive period as many relapses occur in the first week of abstinence (33% relapsed in first 7 days in this study). The study also investigated predictors of urges to smoke. Previous reported urges were the best predictors of future urge; negative affect and stress also demonstrated a correlation with reported urge.

Abrams et al. (1988) were able to demonstrate this relationship between reactivity to in vivo smoking cues (presence of a smoking confederate in the room with the participant) and relapse by examining relapsers, long-term quitters, and a control group that had never smoked. The researchers found relapsers to demonstrate greater anxiety and urge to smoke upon exposure to a smoking cue than the quitters or control. Additionally, heart rate in relapsers was significantly higher than the control group. These studies further underscore the importance of addressing exposure to drug-related cues following cessation.

A meta-analysis of cue-reactivity studies conducted by Carter and Tiffany (1999) addressed several questions of physiological responding with regards to the incentive and withdrawal models. The withdrawal model, similar to the conditioning model of relapse (Seigel, 1979), would predict exposure to drug-related cues elicits drug-compensatory conditioned responses, that is, in opposite direction of the response expected by the pharmacological properties of the drug (e.g., decreased heart rate during nicotine withdrawal) for urges as well as withdrawal. However, physiological response patterns closely related to the pharmacological properties of the drug (e.g., increase in heart rate during nicotine use) have also been found (see Table 1). Due to inconsistent results, the model has not been fully accepted. Results of the meta-analysis of cue-reactivity studies showed patterns more consistent with reactions mimicking the effects of the drug than those predicted by the withdrawal model. Specifically, for nicotine users, heart rate and sweat gland activity increased during cue-reactivity exposure (Carter & Tiffany,

1999). The authors advise caution with this finding as several physiological responses showed no significant effect, and several alternative explanations are available. Further, Niaura et al. (1992)

Table 1

Comparison of Physiological Responses of Smokers to Reported Cravings in the Presence of Cues and Withdrawal

	Heart Rate	Sweat Gland	Skin Temp.	Skin Conductance
	Activity			
<i>Cue-Reactivity Studies</i>				
Abrams et al. (1988)	+			
Carter & Tiffany (1999)	+	+	NS	
Meta-analysis results				
Conklin & Tiffany (2001)	+			NS
Drobes & Tiffany (1997)*	+		-	+
Elash, Tiffany, & Vrana (1995)**	+			
Shadel et al., (1998)	-			
Tiffany, Cox, & Elash (2000)	+			-
<i>Withdrawal Studies</i>				
Fagerstrom (1978)***			-	
Hatsukami, Hughes, Pickens, & Svikis (1984)	-		NS	
Hughes, Hatsukami, Pickens, & Svikis (1984)	-			
Hughes & Hatsukami (1986)	-			

Notes: NS= No significant change *Drobes & Tiffany, 1997 also reported findings for abstinent participants (12 hours), differences included less positive result in abstinent Ss in skin conductance, larger increases in skin temp. of abstinent Ss. **In positive affect content scripts only. ***Effect shown only in more physically dependent smokers

found physiological responding changes during exposure. Heart rate, urge, and blood pressure have been found to increase while watching another hold an unlit cigarette, but when watching someone else smoke a cigarette, participants experience a decrease in blood pressure and urge rating, reflecting the complex nature of cue-response and making interpretation more difficult.

Considering heart rate, which was the most consistently investigated physiological measure in the studies included, a clear disparity emerges between withdrawal and urge states. The withdrawal studies consistently reported a decrease in heart rate, a response that could be interpreted as a drug-compensatory reaction unmet by the drug, providing support for the conditioning model. In contrast, the majority of the cue-reactivity studies report an increase in heart rate, a response pattern resembling the pharmacological properties of the drug. This could provide evidence for the distinction between withdrawal and urge/craving states, and explain inconsistent results. As such, the present study will include a measure of urge as the level of reported urge may affect physiological measures of withdrawal.

State-specific Effects

Context-dependent memory effects, memory deficits found when context at recall is changed from the context at which learning occurred, have been demonstrated in diverse areas including times of day and place of learning (Neath, 1998). A further area of study concerns state-specific learning effects, or a manipulation of a person's affective or pharmacological state different from the state at which material was learned. Specifically, the conditions in which the state is similar at both learning and recall exhibit less detriment in recall scores than conditions where state is altered from learning to recall. These effects have been investigated in numerous drugs including marijuana (Rickles, Cohen, Whitaker, & McIntyre, 1973), alcohol (Lowe, 1982; 1983), amphetamines (Bustamente et al., 1970), and combinations of alcohol with nicotine and

caffeine (Lowe, 1987; 1986; 1988). Commonly used medications such as antihistamines have also been examined, and SDL effects identified (Carter & Cassaday, 1998).

The implications of SDL effects in clinical settings has been proposed by several researchers (Reus, Weingartner, & Post, 1979; Ross & Schwartz, 1974), in reference to clinical states (see Reus et al., 1979 for review of research), pharmacotherapy, and treatment. Ross and Schwartz (1974) point out that particularly in the treatment of drug abusers, “knowledge or skills acquired when drug-free may be inaccessible when the individual ingests drugs (p. 369)”. It is with this implication for treatment that the current study is most concerned. That is, can treatment success be improved by consideration of SDL theory?

Hodgeson (2001) encourages the use of SDL in the treatment of alcohol abusers, particularly exposure to drinking related cues (including taste and smell). This allows the participant to practice coping skills for high-risk situations under supervision. Shealy and Shen (1973) presented a case study of an alcohol abuser whose treatment included the principles of SDL. Conflict situations were simulated while the participant was highly intoxicated, and continued until the participant utilized conflict management skills or left the situation. The authors also point out that confidence increased for the participant, as he was able to handle the situation effectively (without resorting to violent behavior) in the context of drug-related cues.

While environmental context, mood, and various drugs have demonstrated the SDL effects, an interesting and consistent finding concerns the level of recall in the inconsistent state conditions. As predicted by the SDL theory, the state consistent conditions demonstrate increased rates of recall compared to the conditions where state was altered. In the inconsistent state conditions, it is typically the condition in which intoxication occurred during learning that produces the most detriment. This is referred to as an asymmetrical effect. Lowe (1986) suggests

the difference can be accounted for by the discrepancy in learning levels attained in the drug conditions as opposed to the no-drug conditions, and when equivalence in learning is achieved, symmetrical effects are displayed. Petersen (1977) also noted this pattern, and added that the material learned in consistent drug states may be different from that learned in inconsistent drug states, with inconsistent conditions showing greater detriment in recall of abstract words than consistent conditions.

State-specific Effects and Smoking

Kunzendorf and Wigner (1985) used four conditions (smoking at learning/smoking at recall, not smoking at learning/not smoking at recall, smoking at learning/not smoking at recall, and not smoking at learning/smoking at recall) to demonstrate state-specific effects on memory in smokers. The two groups, which were consistent in state, produced a significantly greater number of correct answers than the two state inconsistent groups, providing evidence of SDL effects in nicotine users. SDL effects have also been identified when nicotine and alcohol are paired (Lowe, 1986; 1988).

Limitations of SDL occur when alternative cues for recall are provided, such as in the case of cued recall (Petersen, 1977; Weingartner, 1978). Overlearning presents another case where SDL effects are often unobserved. Petersen (1977) investigated changes in recall when cues were provided. Four conditions were used: context-cued recall, free recall, category recall without cues, and category recall with cues. Context-cued recall involved creating mental images for word triplets occurring in the list. Category cues to word pairs in the list were provided in the Category recall with cues condition. The context-cued recall and category recall with cues conditions did not exhibit the SDL effects, while free recall and category recall without cues both

demonstrated significant SDL effects. This suggests that lack of obvious or provided cues at recall encourages the individual to turn to more subtle retrieval cues, such as SDL.

Statement of Problem and Hypotheses

The current study considered implications of the state-specific learning theory applied to withdrawal conditions of cigarette smokers. A central question under consideration was whether withdrawal states produce SDL effects in a recall activity for smokers. This is an important question as most treatment programs introduce cessation and relapse prevention coping skills while participants are in a state of physiological withdrawal. While SDL effects have been demonstrated in various drugs (Bustamente et al., 1970; Kudzendorf & Wigner, 1985; Lowe, 1982; 1983; 1986; 1987; 1988; Rickles, Cohen, Whitaker, & McIntyre, 1973), few studies have investigated these effects in relation to treatment, particularly in regards to withdrawal states. State-specific effects have been found in smokers (Kunzendorf & Wigner, 1985) looking at smoking versus not smoking conditions during testing and recall, however withdrawal was not investigated. Inconsistent results of physiological measures have been found among withdrawal and cue-reactivity studies, providing evidence for the distinction between the two states. A measure of urge/ craving was included to investigate the interaction of physiological responses of withdrawal and urges.

The present study investigated the implications of SDL theory for treatment by manipulation of withdrawal state in college smokers. The design (see Table 2) was a 2 x 2 factorial, crossing the two factors state at learning (withdrawal vs. smoking) and state at recall (withdrawal vs. smoking). It is hypothesized that memory would be facilitated by having smokers learn and recall in withdrawal, a condition that reflects the experience of post-cessation smokers when recalling coping skills. SDL effects have been demonstrated in smokers, but the withdrawal state has not been as well studied in the SDL literature. Additional consideration was given to the reported urge of participants, as the combination of urge and withdrawal most

accurately resembles the condition of smokers when recalling of coping skills is most needed. Significant effects would have introduced another perspective of the relapse process and possibly contributed to improving efficacy of treatment programs.

Table 2

Study Design

		State at Learning	
		Withdrawal	Smoking
State at Recall	Withdrawal	WW	WS
	Smoking	SW	SS

The following hypotheses were proposed:

(1) State-consistent learning and recall conditions would produce greater participant recall than state inconsistent conditions. Specifically,

(a) Participants in smoking-smoking and withdrawal-withdrawal conditions would demonstrate greater recall than smoking-withdrawal or withdrawal-smoking conditions.

(b) Smoking-smoking condition would display least detriment in recall scores.

(2) Heart rate would be negatively correlated with self-reported withdrawal.

Additionally, high scorers on the urge measure would demonstrate less decrease in heart rate compared to low scorers.

(3) Physical dependence would be positively correlated with the self-report measure of withdrawal, and negatively correlated with heart rate.

(4) Negative affect would be positively correlated with self-reported withdrawal, and positive affect would be negatively correlated with self-reported withdrawal.

Method

Power Analysis

As studies in this area have used a myriad of experimental procedures and few with consideration of the withdrawal state, an estimated effect size was used. In previous SDL studies, large effect sizes have been found for the primary outcome measure of number of recalled words. However, reported effect sizes for additional measures included in the present study, specifically physiological measures of heart rate and blood pressure, are much smaller. In order to detect these smaller changes we will use a smaller effect size than those reported in the SDL literature. Alpha were set at 0.05 and power = 0.80. Cohen's (1977) estimate of a medium effect size was used for a 2 x 2 factorial design, generating a sample size of 132 participants (33 per cell). As explained below, however, far fewer participants completed the study.

Participants

Eighty-nine participants were screened for the current study, 37 of which did not qualify to continue. Three of these declined to participate because they were unaware of the 3-day design of the study, and 34 participants did not meet the smoking criteria (one participant had been smoking less than one year, and the remaining did not smoke 10 or more per day). Of the remaining 52 participants, 8 did not return for one or more visits. An additional three participants were excluded from analyses due to failure to comply with instructions to abstain from smoking during withdrawal periods. The remaining participants ($N = 41$; 63% female) were smokers from the psychology student subject pool at Louisiana State University. Ninety-five percent of the sample was Caucasian with an average age of 22 years ($SD = 5.7$). Inclusion criteria specify smoking at least 10 cigarettes per day for a minimum of 12 months. Mean dependence rating, measured by the Fagerstrom Test for Nicotine Dependence (FTND), was 2.6 ($SD = 1.4$). Mean

carbon monoxide measured at baseline was 16.2 ppm ($SD = 11.4$). Average number of years participants reported smoking daily was 5.2 years ($SD = 6.3$) with an average of 13.5 cigarettes smoked per day (range of 10 to 23 cigarettes per day). The study was explained to participants, and written informed consent was obtained. Extra course credit was given in return for their involvement.

Materials

Smoking Status Questionnaire (SSQ; see Copeland, Brandon, & Quinn, 1995). The SSQ (see Appendix A) includes several demographic questions and a measure of nicotine dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). The FTND is a modified version of the Fagerstrom Tolerance Questionnaire (FTQ; Fagerstrom, 1978), with improved internal consistency, greater face validity, and predictive ability (Radzius et al., 2001; Payne et al., 1994). Questions from the FTQ that were unable to distinguish between biochemical results from heavier and lighter smokers were deleted from the FTND. Specifically, the questions on inhalation patterns and nicotine yield were not included. Coefficient alpha was reported at 0.61 for the FTND (Heatherton et al., 1991).

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). The PANAS (see Appendix B) includes two scales, providing a brief measure of positive and negative affect. Each scale (positive and negative affect) consists of 10 items. Participants rate the extent to which they experience each of the states listed on a five-point scale ranging from slightly or not at all to very much. This measure was designed to be flexible in the choice of time period the participant is asked to consider. The probability of having experienced a given mood increased as the time periods lengthened (moment, today, past few days, past few weeks, etc.) (Watson et al., 1988). Reliability coefficients are provided for each of the time periods. For the

current study, instructions were given to answer in the present, “right now, that is, at the present moment”. Coefficient alphas (moment time period) for the positive and negative affect scales were .89 and .85, respectively. Test-retest reliability improved as time period lengthens, however, the authors point out that even the moment time period demonstrated stability (.54 for positive affect and .45 for negative affect). A principal components analysis produced two factors, accounting for 62.8% of the variance in the moment time period. Correlations with other commonly used measures were reported, but the moment time period was not used in those analyses.

Questionnaire of Smoking Urges (QSU; Tiffany & Drobes, 1991). The QSU (see Appendix C) is a 32-item measure of self-reported urge to smoke containing two factors: positive (items related to intention and positive outcomes) and negative reinforcement (desire to smoke and relief of negative affect/ withdrawal). This measure has been shown to be sensitive to changes in smokers’ urge to smoke during exposure to smoking cues and periods of abstinence (Morgan, Davies, & Willner, 1999). Factor 1 of this measure concerns intentions and desire to smoke, and anticipation of pleasure from smoking; while Factor 2 consists of questions related to the anticipation of relief of negative affect and withdrawal, and urges to smoke (Tiffany & Drobes). Kozlowski et al. (1996) offered criticism when attempting to replicate the original factor structure of the QSU, suggesting a one-factor solution, representing the questions related to urges, may better represent the construct. For another analysis, the authors created three categories: questions on urge to smoke, expectancies from smoking, and intentions to smoke, to assess the utility of a measure using only one question from each of the three categories. They concluded that a 2-3 item scale may be more convenient, as valid, and less likely to confuse expectancies (positive consequences of smoking were identified in the measure- positive

outcomes and relief from withdrawal) with urge to smoke (Kozlowski et al.). However, the original two-factor structure proposed by Tiffany and Drobes was replicated in studies with both regular and occasional smokers (Davies, Willner, & Morgan, 2000). Despite some criticism, research has provided support for the QSU's reliability, validity, and soundness as a measure of cravings for cigarettes (Davies et al., 2000; Morgan et al., 1999; Tiffany & Drobes).

Minnesota Nicotine Withdrawal Scale (MNWS; Hughes & Hatsukami, 1998; See Appendix D). The original scale assessed nicotine withdrawal symptomology as specified by the DSM-III (Hughes & Hatsukami, 1986). More recent modifications have adjusted the scale to fit DSM-IV criteria (craving was not included). The scale used for the current study will include the following items: anger/irritability/frustration, anxiety/nervousness, difficulty concentrating, impatience/restlessness, hunger, awakening at night, and depression. Participants will respond to a 100mm visual analogue scale using anchors of 'not at all' and 'extreme'. Participant responses were calculated to give a mean score across symptoms as suggested by the authors (Hughes & Hatsukami, 1998).

Physiological Measures: Carbon monoxide samples were taken using Vitalograph BreathCO machines, measuring the carbon monoxide content in parts per million (ppm). In addition, blood pressure and heart rate were recorded.

Learning Task: The learning activity consisted of twenty concrete words selected from a list with average frequency rating of 50.26 and concreteness of 6.51 (Paivio, Yuille, & Madigan, 1968). Word length ranged from 5 to 8 letters. The 20-word lists (see Table 3) were presented using Microsoft Power Point at 3-second intervals per word with a 15-second gap between lists. Three rotations of the same twenty words were presented to participants. The first presentation was in random order, subsequent presentations rotated the order; however, lists were checked for

serial position effects and adjusted if necessary (a word was only be placed in first or last three positions one time throughout all three presentations). A 15-second time interval occurred between presentations of rotated lists. Instructions were given as follows: “This is a memory test. You will now see a list of words presented one word at a time. You will see the same list in three different orders.” After the third presentation, participants were asked to engage in a multiplication task for a two-minute duration, serving as a distraction to prevent rehearsal. Participants were then given the instructions, “Please write as many words as you can remember on this paper. You may write them in any order. You will have three minutes, if you have not remembered all of the words and still have time remaining, please use the extra time to think. At the end of three minutes, the experimenter will notify you to stop.”

Table 3

Learning Task Word Lists in Three Rotations

Hospital	Pudding	Lemonade
Arrow	Umbrella	Forest
Rattle	Elbow	Hammer
Storm	Trumpet	Rattle
Lemonade	Forest	Pudding
Railroad	Window	Magazine
Trumpet	Cellar	Cellar
Hammer	Hammer	Thorn
Elbow	Thorn	Prairie
Window	Arrow	Umbrella
Pudding	Slipper	Storm
Forest	Library	Railroad
Slipper	Rattle	Arrow
Umbrella	Village	Library
Village	Hospital	Elbow
Prairie	Storm	Trumpet
Magazine	Lemonade	Hospital
Cellar	Magazine	Window
Library	Railroad	Slipper
Thorn	Prairie	Village

Free Recall Task: Participants were asked to recall the list of words presented 24 hours previously. The following instructions were given: “On this paper, please try to remember the words you learned yesterday. You may write them in any order. You will have five minutes to use, if you find you have trouble remembering words, please use the remaining time to think. The experimenter will notify you after five minutes.” No cues were provided, as cues have been shown to diminish SDL effects (Petersen, 1977).

Procedure

Participants were asked to attend sessions at three time points (See Table 4). The first assessment consisted of a baseline measurement of affect, nicotine dependence, smoking urges, withdrawal, and physiological measures. At the baseline session, participants were randomly assigned to one of four conditions and given instructions regarding smoking status as appropriate

Table 4

Summary of Measures at Given Timepoints

	Baseline	Session One	Session Two
Smoking Status Questionnaire (SSQ)	X		
Minnesota Nicotine Withdrawal Scale (MNWS)	X	X	X
Questionnaire of Smoking Urges (QSU)	X	X	X
PANAS	X	X	X
CO	X	X	X
Heart Rate	X	X	X
Blood Pressure	X	X	X
Learning Task		X	
Recall Task			X

to condition. The 2 X 2 design (refer to Table 2) includes two conditions at learning (withdrawal or smoking) and at recall (withdrawal or smoking). The withdrawal-withdrawal (WW) group abstained from smoking throughout testing and recall. These participants were given instructions to begin abstaining at midnight before session one. The smoking-smoking (SS) group was instructed to smoke at their normal rate throughout the study. The SS and WW groups comprised the state-consistent conditions. The state-inconsistent conditions were the withdrawal-smoking (WS) and smoking-withdrawal (SW) groups. The WS group was given instructions to abstain from midnight until completion of session one. The SW group was instructed to smoke at their normal rate until completion of session one, and at that time, was given instructions to abstain until completion of the study.

Session one (learning task) took place roughly 24 hours following baseline assessment. The choice of time was based on length of times reported in cue-exposure studies (Sayette et al., 2001- used 7 hours to establish deprived state; Sayette & Hufford, 1994- 12 hours). Participants in WW or WS conditions were instructed to abstain from smoking beginning midnight on the day of baseline assessment until session one (approximately 12 hours). Session one included a repeat of the measures given at the baseline assessment with the exception of nicotine dependence and demographics (SSQ). In addition to the physiological and self-report measures, the cognitive learning task was completed.

Session two took place approximately 24 hours following session one. The decision of 24 hours was based on timelines used in state-dependent learning studies involving alcohol (Lowe, 1983; Lowe, 1987) and ensures participants complete learning and recall in the approximate three day window where withdrawal is reportedly most intense (Shiffman & Jarvik, 1976) and

reported urges the greatest (Doherty, Kinnunen, Militello, & Garvey, 1995). Participants repeated the same measures, and engaged in a free recall task.

Results

A measure of carbon monoxide was taken at each assessment to provide verification of smoking status. As can be seen in Table 5, the pattern of expired CO reflects that which would be expected from condition assignment. Specifically, on smoking days, CO remains consistent with baseline report compared to withdrawal days where CO is less than that reported at baseline. Two independent-sample T-tests were used to investigate compliance to smoking instructions for learning and recall days. On the day of learning, participants in the smoking condition had significantly higher CO measurements ($M = 14.65$, $SD = 8.82$) than participant in the withdrawal condition ($M = 6.00$, $SD = 3.93$), $t(39) = -3.86$, $p < .001$. Similarly, on the day of recall, participants in the smoking condition had significantly higher CO measurements ($M = 14.81$, $SD = 9.37$) than participants in the withdrawal condition ($M = 6.06$, $SD = 4.19$), $t(39) = -3.66$, $p < .001$.

A 2 (condition at learning) X 2 (condition at recall) ANOVA was conducted using 24-hour recall as the dependent variable. The number of words recalled was calculated giving credit for only those words on the list, ignoring non-list intrusions and repeated words. The number of non-list intrusions varied across conditions. The WW condition had the highest number of intrusions ($M = 1.6$, $SD = 3.8$). The remaining three conditions averaged less than one intrusion (SS, $M = 0.64$, $SD = 1.0$; SW, $M = 0.5$, $SD = 1.3$; WS, $M = 0.4$, $SD = 0.7$). No significant main effects were found for condition at learning, $F(1, 35) = .948$, $n.s.$, or condition at recall, $F(1,35) = .658$, $n.s.$. There was no significant interaction, $F(1, 35) = .133$, $n.s.$ (see Table 6 for means and standard deviations for words recalled at each condition).

Table 5

Means of Physiological Measurements by Condition at Each Assessment Point

		WW (n=8)	SS (n =11)	SW (n =12)	WS (n = 10)
Baseline	CO	16.0 (6.7)	20.9 (16.7)	14.7 (10.6)	12.9 (7.0)
	Heart Rate	89.6 (21.1)	83.5 (17.9)	82.8 (16.2)	83.6 (20.7)
	Systolic/ Diastolic BP	125.6 / 79.8 (20.8 / 9.6)	118.5 / 67.2 (12.0 / 9.7)	125.5 / 80.3 (19.1 / 17.5)	122.4 / 75.9 (16.9 / 8.3)
Session 1	CO	5.8 (3.5)	16.4 (10.6)	13.1 (6.9)	6.2 (4.4)
	Heart Rate	69.5 (11.1)	80.9 (15.6)	75.8 (14.3)	73.8 (19.3)
	Systolic/ Diastolic BP	116.0 / 70.6 (13.6 / 8.4)	118.2 / 72.5 (13.1 / 7.4)	122.9 / 75.3 (15.8 / 13.9)	126.9 / 75.0 (20.6 / 9.7)
Session 2	CO	5.0 (2.1)	17.1 (11.1)	6.9 (5.3)	12.3 (6.7)
	Heart Rate	73.6 (6.7)	78.8 (13.7)	70.5 (19.8)	81.2 (22.2)
	Systolic/ Diastolic BP	14.3 / 73.9 (17.7 / 10.4)	121.8 / 77.3 (12.4 / 7.5)	128.4 / 76.1 (21.5 / 14.1)	128.3 / 76.2 (15.9 / 8.3)

Note: Standard deviations provided in parentheses. None of these comparisons were significant between groups.

Pearson product-moment correlations were calculated for self-report measures of urge, withdrawal, affect, and dependence, and physiological measure of blood pressure and heart rate. The FTND (a measure of dependence) correlated positively with baseline negative affect, $r(41) = .38, p < .05$, and session one withdrawal, $r(41) = .32, p < .05$. Heart rate (see Table 7) and withdrawal (see Table 8) at each of the three assessments was investigated for correlation among the remaining variables.

Table 6

Mean Corrected Number of Words Recalled

	Session One- immediate recall	Session Two- 24 hour recall
Condition		
WW	11.0 (3.2)	8.0 (3.4)
SS	11.4 (3.2)	8.2 (3.4)
SW	10.8 (3.9)	9.5 (4.4)
WS	10.8 (2.5)	7.5 (2.5)

Note: Standard deviations provided in parentheses. Corrected recall was calculated by excluding intrusions or repeated words.

Table 7

Correlations Among Heart Rate and Select Variables.

	Comparison Variables	Correlation (r)	P-value
Baseline Heart Rate	S1 Heart Rate	0.49	P < .01
	S2 Heart Rate	0.48	P < .01
	S1 Diastolic Blood Pressure	0.32	P < .05
Session One Heart Rate	S2 Heart Rate	0.55	P < .01
	S2 Positive Affect	-0.36	P < .05
Session Two Heart Rate	B QSU Factor 2	0.37	P < .05
	S1 QSU Factor 1	-0.37	P < .05
	S2 Systolic Blood Pressure	0.32	P < .05

Note: B = Baseline; S1 = Session One; S2 = Session Two

Table 8

Correlations Among Withdrawal and Select Variables.

	Comparison Variables	Correlation (r)	P-value
Baseline Withdrawal	S1 Withdrawal	0.71	P < .01
	S2 Withdrawal	0.72	P < .01
	B Negative Affect	0.49	P < .01
	B Positive Affect	-0.42	P < .01
	S2 Positive Affect	-0.36	P < .05
	B QSU Factor 2	0.42	P < .01
Session One Withdrawal	B Negative Affect	0.43	P < .01
	S1 Negative Affect	0.39	P < .05
	S2 Negative Affect	0.35	P < .01
	FTND	0.32	P < .05
	B QSU Factor 2	0.48	P < .05
	S2 QSU Factor 2	0.46	P < .01
	S2 Withdrawal	0.67	P < .01
Session Two Withdrawal	B Negative Affect	0.53	P < .01
	S1 Negative Affect	0.34	P < .05
	S2 Negative Affect	0.61	P < .01
	S2 Positive Affect	-0.36	P < .05

Note: B = Baseline; S1 = Session One; S2 = Session Two

A hierarchical regression analysis was conducted examining the interaction between reported urge and withdrawal in predicting heart rate. FTND scores were entered as a covariate on the first step of the regression. Self-reported withdrawal score was entered on the next step, followed by self-reported urge. The interaction term, the product of urge x withdrawal, was entered on the last step. In order to maximize the proportion of variance accounted for by the model, care was used in the selection of predictors. Session two measurements were used for heart rate, factors 1 and 2 of the QSU, and withdrawal as they correlated highly with both baseline and session one measurements of the same type. Session two systolic blood pressure was used as it correlated with both baseline and session one systolic and diastolic blood pressure measurements. The final model, which included all six predictors, accounted for only 18% of the variance, $F(6,36)=1.33$, *n.s.*, indicating the amount of variance accounted for is not significantly different from 0.

Discussion

The current study investigated the implications of the state-dependent learning theory for withdrawal states in smokers. Few studies have investigated these effects in smokers, and even fewer with regards to treatment applications of such an effect. Additionally, the interaction of physiological responses of withdrawal and urges was investigated due to the discrepancies of findings between the withdrawal and cue-reactivity literature. Drawing solid conclusions regarding analyses is risky given the small sample size for each condition; however, tentative inferences can be made.

Few participants were lost through attrition during the study; however, 42% of those screened did not qualify to continue, making recruitment a time-consuming and lengthy task (see Appendix E for consent form and description of study). Additional problems occurred with the use of a college sample such as the low levels of nicotine, diurnal variation in smoking rate (e.g., many students reported smoking only in the evening), and sporadic smoking habits. Even though the majority of sessions were conducted in the late morning to afternoon, most participants reported smoking only one cigarette before attending session. This may present a confound in analyses comparing smoking and abstaining groups; as the differences between a participant in withdrawal and one who has had only one cigarette may be minute. Future studies should consider these difficulties in using college student smokers as participants. Community smokers may be more accessible and demonstrate greater dependency to nicotine, avoiding many of the above problems.

The pattern of expired CO was as expected given the condition assignments; for both sessions one and two, the conditions where participants were instructed to smoke demonstrated significantly higher mean CO's than conditions where participants were asked to abstain. This

indicator provides verification beyond self-report of participants' compliance with condition instructions.

An analysis of recall was conducted using a two-way ANOVA. No significant between-subjects effects or an interaction was found, indicating that the condition assigned did not affect learning and recall rates. The research hypotheses, specifically that state-consistent conditions would demonstrate the greatest 24-hour recall and that the SS condition would show the least detriment in recall compared to the other conditions, were unsupported. The present data do not support typical patterns of recall in the state-dependent learning literature (Lowe, 1982; Peterson, 1977), where detriment in recall is greatest in state-inconsistent conditions.

The correlations reveal that, in general, withdrawal symptoms correlated with one another. Specifically, the withdrawal scores and negative affect demonstrated a positive relationship, while a negative relationship was found between withdrawal scores and positive affect. This provides support for the hypotheses concerning affect. As negative affect is often greater during withdrawal, and withdrawal is often associated with a lack of positive affect, this is not surprising (Hatsukami et al., 1984; Hughes et al., 1984). Two of the withdrawal measurements correlated with factors of the QSU. Specifically, positive correlation among the baseline withdrawal and factor 2, and session one withdrawal and both baseline and session two factor 2 indicate a relationship between withdrawal and urge (particularly factor two concerning anticipation of relief of negative affect and withdrawal, and urges to smoke).

The FTND was correlated positively with withdrawal and negative affect scores at one time point, providing partial support for the hypothesis that withdrawal indices would be related to dependency. The hypothesis that the measure of dependence would be negatively correlated with heart rate was unsupported. This may be in part due to an insufficient sample size, or an

alteration of heart rate based on urges. As known from the cue-reactivity literature, heart rate increases in response to smoking-related cues (meant to induce urges or cravings to smoke). It may be possible that naturally occurring urges would also demonstrate the same effect, interfering with the physiological reactivity expected by a smoker in withdrawal.

Session two heart rate, which would demonstrate the greatest effects of withdrawal, showed a negative relationship with factor 1 of the QSU. As heart rate decreased, factor 1 (indicating anticipation of pleasure, and intent/ desire to smoke) scores increased. Interpreting this in the framework of the knowledge provided from the withdrawal literature, it appears that as heart rate decreases (implied increased withdrawal) scores on the QSU concerning anticipation of pleasure from smoking and desire/ intent to smoke increase. Those individuals in withdrawal would see more pleasure forthcoming from smoking a cigarette. However, the positive relationship between heart rate and factor 2 of the QSU indicates the opposite effect, where decrease in heart rate (implied increased withdrawal) is connected to decreasing scores reflecting anticipation of relief from withdrawal and negative affect, and urges to smoke. Factors 1 and 2 of the QSU were correlated positively, indicating that as desires/ intent to smoke, and anticipation of pleasure increased, the anticipation of relief from withdrawal and negative affect, and urges increased.

The regression analysis did not prove to be a significant predictive model of heart rate. One explanation for this finding is the oppositional heart rate reactions to withdrawal and cue-elicited urges. While withdrawal studies typically show a decrease in heart rate, induction of urges (at least those in the cue-reactivity research) is usually related to an increase in heart rate. Additional confusion occurs when participants experience both intense withdrawal and strong urges to smoke simultaneously. Determining which of these states exerts the most influence on

heart rate, and at what level of intensity for each state, may be an area of future study. Future studies should include a larger sample size in order to determine whether the lack of findings in the current study are due to an insufficient sample size to detect differences.

References

- Abrams, D. B., Monti, P. M., Carey, K. B., Pinto, R. P., & Jacobus, S. I. (1988). Reactivity to smoking cues and relapse: Two studies of discriminant validity. *Behavioral Research and Therapy, 26*, 225-233.
- Brandon, T. H., Tiffany, S. T., Obremski, K. M., & Baker, T. B. (1990). Postcessation cigarettes use: The process of relapse. *Addictive Behaviors, 15*, 105-114.
- Bustamante, J. A., Jordan, A., Vila, M., Gonzalez, A., & Insua, A. (1970). State-dependent learning in humans. *Physiology and Behavior, 5*, 793-796.
- Carter, S. J., & Cassaday, H. J. (1998). State-dependent retrieval and chlorpheniramine. *Human Psychopharmacology, 13*, 513-523.
- Carter, B. L., & Tiffany, S. T. (1999). Meta-analysis of cue-reactivity in addiction research. *Addiction, 94*, 327-340.
- Centers for Disease Control and Prevention (1994). Cigarette smoking among adults- United States, 1993. *Morbidity and Mortality Weekly Report, 43*, 925-929.
- Centers for Disease Control and Prevention (2002). Cigarette smoking among adults- United States, 2000. *Morbidity and Mortality Weekly Report, 51*.
- Cohen, J. (1977). *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Conklin, C. A., & Tiffany, S. T. (2001). The impact of imagining personalized versus standardized urge scenarios on cigarette craving and autonomic reactivity. *Experimental and Clinical Psychopharmacology, 9*, 399-408.
- Copeland, A. L., Brandon, T. H., & Quinn, E. P. (1995). The Smoking Consequences Questionnaire- Adult: Measurement of smoking outcome expectancies of experienced smokers. *Psychological Assessment, 7*, 484-494.
- Davies, G. M., Willner, P., & Morgan, M. J. (2000). Smoking-related cues elicit craving in tobacco "chippers": A replication and validation of the two-factor structure of the Questionnaire of Smoking Urges. *Psychopharmacology, 152*, 334-342.
- Doherty, K., Kinnunen, T., Militello, F. S., & Garvey, A. J. (1995). Urges to smoke during the first month of abstinence; Relationship to relapse and predictors. *Psychopharmacology, 119*, 171-178.
- Drobes, D. J., & Tiffany, S. T. (1997). Induction of smoking urge through imaginal and in vivo procedures: Physiological and self-report manifestations. *Journal of Abnormal Psychology, 106*, 15-25.

- Elash, C. A., Tiffany, S.T., & Vrana, S. R. (1995). Manipulation of smoking urges and affect through a brief-imagery procedure: Self-report, psychophysiological, and startle probe responses. *Experimental and Clinical Psychopharmacology*, *3*, 156-162.
- Fagerstrom, K. O. (1978). Measuring degree of physical dependence to tobacco smoking with reference to individualization of treatment. *Addictive Behaviors*, *3*, 405-411.
- Hall, S. M., Wasserman, D. A., & Havassy, B. E. (1991). Relapse prevention. In (Eds.) Pickens, R. W., Leukefeld, C.G., & Schuster, C. R., *Improving Drug Abuse Treatment*. Washington: U.S. Government Printing Office.
- Hatsukami, D. K., Hughes, J. R., Pickens, R. W., & Svikis, D. (1984). Tobacco withdrawal symptoms: An experimental analysis. *Psychopharmacology*, *84*, 231-236.
- Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerstrom, K. O. (1991). The Fagerstrom Test for Nicotine Dependence: A revision of the Fagerstrom Tolerance Questionnaire. *British Journal of Addiction*, *86*, 1119-1127.
- Hodgeson, R. (2001). State-dependent learning for alcohol-dependent people. *Addiction*, *96*, 1097-1098.
- Hughes, J. R., & Hatsukami, D. (1986). Signs and symptoms of tobacco withdrawal. *Archives of General Psychiatry*, *43*, 289-294.
- Hughes, J., & Hatsukami, D. K. (1998). Errors in using tobacco withdrawal scale. *Tobacco Control*, *7*, 92-93.
- Hughes, J. R., Hatsukami, D. K., Pickens, R. W., & Svikis, D. S. (1984). Consistency of the tobacco withdrawal syndrome. *Addictive Behaviors*, *9*, 409-412.
- Kozlowski, L. T., Pillitteri, J. L., Sweeney, C. T., Whitfield, K. E., & Graham, J. W. (1996). Asking questions about urges or cravings for cigarettes. *Psychology of Addictive Behaviors*, *10*, 248-260.
- Kunzendorf, R., & Wigner, L. (1985). Smoking and memory: State-specific effects. *Perceptual and Motor Skills*, *61*, 558.
- Lowe, G. (1982). Alcohol-induced state-dependent learning: Differentiating stimulus and storage hypotheses. *Current Psychological Research*, *2*, 215-222.
- Lowe, G. (1983). Alcohol and state-dependent learning. *Substance and Alcohol Actions/ Misuse*, *4*, 273-282.
- Lowe, G. (1986). State-dependent learning effects with a combination of alcohol and nicotine. *Psychopharmacology*, *89*, 105-107.

- Lowe, G. (1987). Combined effects of alcohol and caffeine on human state-dependent learning. *Medical Science Research*, *15*, 25-26.
- Lowe, G. (1988). State-dependent retrieval effects with social drugs. *British Journal of Addiction*, *83*, 99-103.
- Marlatt, G.A. (1985). Relapse prevention: Theoretical rationale and overview of the model. In Marlatt, G.A., & Gordon, J. R. (Eds.), *Relapse Prevention*. (pp 3-70). New York: Guilford Press.
- Morgan, M. J., Davies, G. M., & Willner, P. (1999). The Questionnaire of Smoking Urges is sensitive to abstinence and exposure to smoking-related cues. *Behavioral Pharmacology*, *10*, 619-626.
- Niaura R., Abrams, D. B., Pedraza, M., Monti, P. M., & Rohsenow, D. J. (1992). Smokers' reactions to interpersonal interaction and presentation of smoking cues. *Addictive Behaviors*, *17*, 557-566.
- Niaura, R., Abrams, D. B., Shadel, W. G., Rohsenow, D. J., Monti, P. M., & Sirota, A. D. (1999). Cue exposure treatment for smoking relapse prevention: A controlled clinical trial. *Addiction*, *94*, 685-695.
- Neath, I. (1998). *Human Memory: An Introduction to Research, Data, and Theory*. Pacific Grove, CA: Brooks/Cole.
- Paivio, A., Yuille, J. C., & Madigan, S. A. (1968). Concreteness, imagery, and meaningfulness values for 925 nouns. *Journal of Experimental Psychology*, *76*, 1-25.
- Payne, T.J., Smith, P. O., McCracken, L. M., McSherry, W. C., & Antony, M. M. (1994). Assessing nicotine dependence: A comparison of the Fagerstrom Tolerance Questionnaire (FTQ) with the Fagerstrom Test for Nicotine Dependence (FTND) in a clinical sample. *Addictive Behaviors*, *19*(3), 307-317.
- Petersen, R. C. (1977). Retrieval failures in alcohol state-dependent learning. *Psychopharmacology*, *55*, 141-146.
- Radzius, A., Moolchan, E. T., Henningfield, J. E., Heishman, S. J., & Gallo, J. J. (2001). A factor analysis of the Fagerstrom Tolerance Questionnaire. *Addictive Behaviors*, *26*, 303-310.
- Reus, V. I., Weingartner, H., & Post, R. M. (1979). Clinical Implications of state-dependent learning. *American Journal of Psychiatry*, *136*, 927-931.
- Rickles, W. H., Cohen, M. J., Whitaker, C. A., & McIntyre, K. E. (1973). Marijuana induced state-dependent verbal learning. *Psychopharmacologia*, *30*, 349-354.

- Ross, S. M., & Schwartz, C. W. (1974). State-dependent learning and its implications for treatment of drug abusers. *Psychiatric Quarterly*, *48*, 368-373.
- Sayette, M. A., & Hufford, M. R. (1994). Effects of cue exposure and deprivation on cognitive resources in smokers. *Journal of Abnormal Psychology*, *103*, 812-818.
- Sayette, M. A., Martin, C. S., Wertz, J. M., Shiffman, S., & Perrott, M. A. (2001). A multi-dimensional analysis of cue-elicited craving in heavy smokers and tobacco chippers. *Addiction*, *96*, 1419-1432.
- Shadel, W. G., Niaura, R., & Abrams, D. B. (2001). Effect of different cue stimulus delivery channels on craving reactivity: Comparing in vivo and video cues in regular cigarette smokers. *Journal of Behavior Therapy and Experimental Psychiatry*, *32*, 203-209.
- Shadel, W. G., Niaura, R., Abrams, D. B., Goldstein, M. G., Rohsenow, D. J., Sirota, A. D., & Monti, P. M. (1998). Scripted imagery manipulations and smoking cue reactivity in a clinical sample of self-quitters. *Experimental and Clinical Psychopharmacology*, *6*, 179-186.
- Shealy, A. E., & Shen, J. (1973). The use of state-dependent learning principles in treatment: A case report. *Journal of Community Psychology*, *1*, 232-234.
- Shiffman, S.M., & Jarvik, M. E. (1976). Smoking withdrawal symptoms in two weeks of abstinence. *Psychopharmacology*, *50*, 35-39.
- Siegel, S. (1978). Tolerance to the hyperthermic effect of morphine in the rat is a learned response. *Journal of Comparative and Physiological Psychology*, *92*, 1137-1149.
- Siegel, S. (1979). The role of conditioning in drug tolerance and addiction. In: Keehn, J. D., ed. *Psychopathology in Animals: Research and Treatment Implications*. New York: Academic Press.
- Siegel, S. & Ramos, B. M. C. (2002). Applying laboratory research: Drug anticipation and the treatment of drug addiction. *Experimental and Clinical Psychopharmacology*, *10*(3), 162-183.
- Stitzer, M. L. (1998). Combined treatments. Presentation at Addicted to Nicotine: A National Research Forum. Bethesda, Maryland.
- Taylor, R. C., Harris, N. A., Singleton, E. G., Moolchan, E. T., & Heishman, S. J. (2000). Tobacco craving: Intensity-related effects of imagery scripts in drug abusers. *Experimental and Clinical Psychopharmacology*, *8*, 75-87.
- Tiffany, S. T., Cox, L. S., & Elash, C. A. (2000). Effects of transdermal nicotine patches in abstinence-induced and cue-elicited craving in cigarette smokers. *Journal of Counseling and Clinical Psychology*, *68*, 233-240.

- Tiffany, S.T., & Drobes, D. J. (1990). Imagery and smoking urges: The manipulation of affective content. *Addictive Behaviors, 15*, 531-539.
- Tiffany, S.T., & Drobes, D. J. (1991). The development and initial validation of a questionnaire of smoking urges. *British Journal of Addictions, 86*, 1467-1476.
- U.S. Department of Health and Human Services. *Reducing Tobacco Use: A Report of the Surgeon General- Executive Summary*. Atlanta, Georgia: U.S. Department of the Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2000.
- Watson, D., Clark, L.A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.
- Weingartner, H. (1978). Human state-dependent learning. In (Ed.) Ho, B. T. *Drug Discrimination and State-dependent Learning*. New York: Academic Press.

Appendix A

Smoking Status Questionnaire

1. Age: _____
2. Sex: (circle one) MALE FEMALE
3. With which ethnic/racial group do you most identify yourself? (circle one)
 - a. Caucasian
 - b. African American
 - c. Other _____
4. Do you smoke cigarettes everyday? (circle one) YES NO
5. How many years have you been smoking daily? _____
6. How many cigarettes per day do you smoke? _____
7. How soon after you wake up do you smoke your first cigarette? (circle one)
 - a. Within 5 minutes
 - b. 6-30 minutes
 - c. 31-60 minutes
 - d. After 60 minutes
8. Do you smoke more frequently during the first hours after waking than during the rest of the day?
(circle one) YES NO
9. Which of all the cigarettes you smoke in a day would you most hate to give up? (circle one)
 - a. The first cigarette of the day
 - b. All others
10. Do you find it difficult to refrain from smoking in places where it is forbidden, e.g., in church, at the library, in the theatre, etc.?

(circle one) YES NO
11. Do you smoke if you are so ill that you are in bed most of the day?

(circle one) YES NO

Appendix B

PANAS

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 feel this way right now, that is, at the present moment. Use the following scale to record your answers.

1 very slightly or not at all	2 a little	3 moderately	4 quite a bit	5 extremely
	_____	interested	_____	irritable
	_____	distressed	_____	alert
	_____	excited	_____	ashamed
	_____	upset	_____	inspired
	_____	strong	_____	nervous
	_____	guilty	_____	determined
	_____	scared	_____	attentive
	_____	hostile	_____	jittery
	_____	enthusiastic	_____	active
	_____	proud	_____	afraid

Appendix C
Smoking Urges (QSU)

1. Smoking would make me feel very good right now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

2. I would be less irritable now if I could smoke.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

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

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

4. I am not missing smoking right now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

5. I will smoke as soon as I get the chance.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

6. I don't want to smoke now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

7. Smoking would make me less depressed.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

8. Smoking would not help me calm down now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

9. If I were offered a cigarette, I would smoke it immediately.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

10. Starting now, I could go without smoking for a long time.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

11. Smoking a cigarette would not be pleasant.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

12. If I were smoking this minute, I would feel less bored.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

13. All I want right now is a cigarette.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

14. Smoking right now would make me feel less tired.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

15. Smoking would make me happier now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

16. Even if it were possible, I probably wouldn't smoke now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

17. I have no desire for a cigarette right now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

18. My desire to smoke seems overpowering.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

19. Smoking now would make things seem just perfect.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

20. I crave a cigarette right now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

21. I would not enjoy a cigarette right now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

22. A cigarette would not taste good right now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

23. I have an urge for a cigarette.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

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

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

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

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

26. I would not feel better physically if I were smoking.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

27. A cigarette would not be very satisfying now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

28. If I had a lit cigarette in my hand, I probably wouldn't smoke it.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

29. If I were smoking now I could think more clearly.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

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

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

31. I need to smoke now.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

32. Right now, I am not making plans to smoke.

1	2	3	4	5	6	7
Strongly disagree						Strongly agree

Appendix D

MNWS

How irritable, angry, or frustrated do you feel at this moment?

Not At All

Extremely Irritable

How anxious or nervous do you feel at this moment?

Not At All

Extremely Anxious

How much difficulty concentrating are you experiencing at this moment?

Not At All

Extreme Difficulty

How impatient or restless do you feel at this moment?

Not At All

Extremely Restless

How hungry are you at this moment?

Not At All

Extremely Hungry

How depressed do you feel at this moment?

Not At All

Extremely Depressed

How much disturbance in you sleeping have you experienced?

Not At All

Extreme Disturbance

Appendix E

Consent Form

Study Title:	Memory in Smokers
Performance Sites:	Psychology Department, Audubon Hall, at Louisiana State University
Contact:	This study is being conducted by Carla Rash (Graduate Student) and Amy Copeland, Ph.D. (Supervisor). Should you have any questions regarding your participation in this study, please contact the investigators at the numbers listed below between the hours of 9am and 5pm. Carla Rash 578-9033 Amy Copeland 578-4117
Purpose of this Study:	The purpose of this study is to investigate the effects of abstaining from smoking on memory.
Subjects:	
Inclusion Criteria:	To participate in this study, you must 1) be at least 18 years of age, and 2) currently smoke 10 or more cigarettes a day for at least a year.
Exclusion Criteria:	Non-smokers, and those under the age of 18 are excluded from participation.
Number of Subjects:	The maximum number of participants planned to enroll is 150.
Study Procedures:	You will be asked to complete several questionnaires concerning your 1) smoking history, 2) urges to smoke, 3) positive and negative feelings, and 4) withdrawal symptoms. You will be asked to give a breath sample by exhaling into a tube. This will measure the amount of carbon monoxide in your system (a by-product of smoking) verifying your current smoking status. Additionally, you will be asked to participate in a memory test. You will be asked to participate on three separate days, each session should last no longer than 45 minutes. You may or may not be asked to abstain from smoking for a specified period of time during the study.
Benefits:	You will receive 5 extra credit points upon completion for your participation in this study. The results gathered from this study may aid other smokers in the future.
Risks/Discomforts:	Loss of confidentiality is a possible risk, although extremely unlikely. All research assistants are trained to follow protocol regarding confidentiality. An I.D. number will be used in place of your name, and all forms will be kept in a locked filing cabinet in the research laboratory.
Right to Refuse:	Your participation in this study is voluntary. You may choose to discontinue at any point without prejudice. You will receive the extra credit earned up to that point.

Privacy:

Results from this study may be published, but no identifying information will be included in the publication. Your name will not appear on any forms; instead a number will be used to identify your data. All data will be stored in a locked filing cabinet. Data will be kept confidential unless release is legally compelled.

Signatures:

“The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects’ rights or other concerns, I can contact Robert C. Mathews, LSU Institutional Review Board, (225) 578- 8692. I agree to participate in the study described above and acknowledge the researchers’ obligation to provide me with a copy of this consent form if signed by me.”

If you have read the above information and understand your rights regarding participation in this study, please sign below.

_____ **Date:** _____

Vita

The author, Carla J. Rash, received her Bachelor of Arts degree from the University of Central Florida (2001). She completed an undergraduate Honor's Thesis concerning the role of self-efficacy and motivation in the attrition rates of exercise programs. Currently, she attends Louisiana State University's doctoral program for clinical psychology. Research interests include expectancies related to drug use, cue-reactivity, and cue-exposure.