THE FACE OF AMBIVALENCE: SIMULTANEOUS EXPRESSIONS OF POSITIVE AND NEGATIVE EMOTIONS DURING CUE-ELICITED CRAVING IN HEAVY SMOKERS

by

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This study used the Facial Action Coding System (FACS; P. Ekman & W. V. Friesen, 1978) to examine abstinent smokers' immediate facial responses while exposed to smoking cues. The aim was to investigate potential associations between facial expressions thought to be linked to ambivalence and more traditional measures of ambivalence about their smoking habits. Ambivalence during cue exposure was operationalized as the simultaneous occurrence of positive and negative affect-related facial expressions. Thirty-four nicotine-deprived dependent smokers were presented with *in vivo* smoking cues, and their facial expressions were coded with the FACS; participants also completed self-report measures related to ambivalence about smoking. Smokers who displayed ambivalent facial expressions during smoking cue exposure reported significantly higher scores on three out of four measures of smoking ambivalence than did those who did not display ambivalent facial expressions. This effect was unique to those smokers displaying *simultaneous* positive and negative affect-related facial expressions, and the effect was not demonstrated in smokers' displaying just positive, just negative, or sequential instances of positive and negative affect-related expressions.

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1.0 INTRODUCTION

The importance of craving is underscored in nearly all models of drug addiction (Anton, 1999; Drummond, Litten, Lowman, & Hunt, 2000; Heather, 1998; Marlatt & Gordon, 1985). Despite its emphasis, significant questions remain about the construct of craving (Kozlowski & Wilkinson, 1987; Sayette et al., 2000). One such question involves the association between craving and emotion. If one considers craving to be an emotional experience (Baker, Morse, & Sherman, 1987; Sayette & Hufford, 1995), then it may be useful to examine the broader emotions literature to inform conceptualizations of craving. An overarching theme of this study was to apply theory and measurement techniques taken from the general emotions literature to help advance knowledge about the nature and assessment of craving. In particular, Cacioppo and Berntson's (1994) Evaluative Space Model, which holds that one can simultaneously experience positive and negative affect, provided a framework for studying craving. I investigated the simultaneous expression of positive and negative facial expressions during a cue-elicited craving episode and examined whether this momentary ambivalent state, referred to herein as cue-induced ambivalence, related to broader indices of ambivalence resulting from real world difficulties controlling substance use, referred to herein as general smoking ambivalence.

After reviewing various conceptualizations of craving and linking these into the broader emotions literature, I will describe a study with two general aims. The first was to document the existence of cue-induced ambivalence in nicotine-deprived dependent smokers. Borrowing from

emotion and social attitude literatures, cue-induced ambivalence was operationalized as the simultaneous occurrence of facial expressions indicative of positive and negative emotions. Nonverbal evidence of the simultaneous display of positive and negative emotions would have implications for theories of emotion that assert the improbability of this phenomenon (Russell, 1980; Russell & Carroll, 1999; Watson & Tellegen, 1985, 1999). The second aim was to show that smokers who evinced cue-induced ambivalence would report significantly higher scores on several measures of general smoking ambivalence, such as difficulty refraining from smoking and interest in quitting smoking.

1.1 CRAVING AND EMOTION

Although most theories of smoking view affective experiences as potent forces driving the addictive behavior (Baker et al., 1987; Baker, Piper, McCarthy, Majeskie, & Fiore, 2004; Marlatt & Gordon, 1985; Pomerleau & Pomerleau, 1987), it has proved challenging to relate craving and emotion. While some researchers have conceptualized craving as an emotion (Baker et al., 1987; Baker, Brandon et al., 2004; Sayette & Hufford, 1995), others have viewed cravings as causing emotions (Cummings, Gordon, & Marlatt, 1980) or conversely, have considered emotions to be triggers for cravings (Payne, Schare, Levis, & Colletti, 1991; Perkins & Grobe, 1992).

Furthermore, different addiction theories have emphasized the importance of either negative emotions (negative reinforcement models; Baker, Piper et al., 2004; Jellinek et al., 1955; Tiffany, 1992; Wikler, 1973) or positive emotions (incentive-based models; Robinson & Berridge, 1993; Stewart, de Wit, & Eikelboom, 1984; Wise and Bozarth, 1987; Zinser, Baker, Sherman, & Cannon, 1992) in explaining drug cravings, to the relative neglect of how the

simultaneous experience of both positive and negative emotions may influence one's motivation to smoke. Indeed, one addiction model (dual-affect model of drug urges; Baker et al., 1987) that allows for drug cravings to be either withdrawal-based (negative-affect urges) or appetitively-based (positive-affect urges) hypothesizes that the two urge networks are mutually inhibitory. In other words, the activation of one urge network purportedly suppresses the action of the other. This seems incompatible with the notion of the simultaneous experience of positive and negative emotions (or ambivalence) involved in some craving episodes (Breiner, Werner, Stritzke, & Lang, 1999). One aim of the current study was to show that the concurrent activation of positive and negative emotions during craving does occur for at least some smokers, and that this reaction offers unique and meaningful information related to difficulty refraining from smoking.

If smokers consistently report that both positive and negative emotions influence their smoking behavior, and self-report survey data confirm this association (e.g., Brandon, Tiffany, Obremski, & Baker, 1990; Brownell, Marlatt, Lichtenstein, & Wilson, 1986; Gilbert, Sharpe, Ramanaiah, Detwiler, & Anderson, 2000), then why has it been so difficult to understand the relationship between craving and emotion? One reason may be the methodological difficulty involved in accurately measuring these two constructs. For instance, wildly different time parameters have been used to assess both cravings and affective experiences, and the assumptions underlying these different time frames can affect the findings (Gwaltney, Shiffman, & Sayette, 2005; Sayette et al., 2000; Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996).

In addition, most of the studies examining craving, emotion, and smoking have utilized retrospective designs, asking participants to recall their past cravings. Although this approach has yielded important clinical data, concerns arise about the ability of smokers to accurately recall and report on these associations in their every day life. In fact, one study explicitly tested

this question and found that the accuracy of smokers' recall was quite poor (Shiffman et al., 1997). There was a near absence of an association between retrospective reports and actual field records recorded within minutes of smoking across both mood and activity domains. These smokers tended to retrospectively overestimate the influence of negative affect on their smoking behavior, and recall was influenced by their current smoking status. Most noteworthy, though, was the respondents' use of preconceived theories, to create reasonable, but perhaps inaccurate, accounts of their smoking lapse episodes. Shiffman and colleagues (1997) found that a sample of never-smokers actually produced a pattern of "relapse data" nearly identical to that created by the smokers' retrospective reports.

Although the retrospective recall of internal events preceding smoking episodes is subject to bias, this is not the only concern involved with this type of research. In fact, the few studies that have used real-time data collection strategies also have yielded conflicting results, with some researchers reporting modest positive associations between smoking urges and mood states (Delfino, Jamner, & Whalen, 2001; Shapiro, Jamner, Davydov, & James, 2002) and others finding a lack of an association between the two (Shiffman et al., 2002; Shiffman, Paty, Gwaltney, & Dang, 2004).

Discrepancies in the literature may result from several sources. First, smoking researchers typically treat moods and emotions similarly. However, there is reason to believe that these two constructs should not be used interchangeably, as notable differences exist for the duration, intensity, and origin of moods and emotions. While emotions are typically defined as dynamic processes that have a beginning and end and are of relatively brief duration, moods are generally considered to be more diffuse, to last much longer, have a lower overall intensity, and are often not tied to a specific eliciting event (Scherer, 2000). Furthermore, both mood and

emotions are frequently related to smoking behavior as opposed to craving per se (Shapiro et al., 2002). This is problematic because smoking restrictions may require smokers to go without a cigarette when they are experiencing a craving and to smoke when not craving in anticipation of future smoking restrictions (Shiffman et al., 2004).

Another methodological limitation of past research on emotional processes in smoking is that studies often utilize mood scales that are based on the circumplex model of affect (Shiffman et al., 2002, 2004). Indeed, the common use of bipolar scales makes it highly unlikely to find evidence for the simultaneous experience of positive and negative affect (Sayette et al., 2000). Consideration of the emotions literature may prove helpful in this regard and will be discussed in more detail below. Finally, self-report assessments may not be sensitive enough to detect subtle affective changes that may influence motivational processes such as craving (Cinciripini et al., 2006; Drobes & Tiffany, 1997; Baker, Piper, et al., 2004; Sayette & Hufford, 1995; Zinser, Fiore, Davidson, & Baker, 1999), and requiring participants to fill them out may actually disrupt the emotion being experienced (Nisbett & Wilson, 1977; Schooler & Schreiber, 2004). Therefore, questions still remain regarding the affective tone of craving (Zinser, Fiore, Davidson, & Baker, 1999). Because the challenges involved in the assessment and conceptualization of craving mirror those in the general emotions literature, it may be possible to draw on insights from emotion theories to advance our understanding of craving.

1.2 THEORIES OF EMOTION

There is an ongoing debate in the emotions literature over the relationship between positive and negative emotions and, in particular, over whether these two types of emotions can be

experienced simultaneously (Diener, 1999). Some theorists favor the circumplex model of affect (e.g., Larsen & Diener, 1992; Russell, 1980; Russell & Carroll, 1999), which posits that emotions fall in a circular order around a bipolar valence dimension (labeled unpleasant to pleasant) and an orthogonal activation dimension. A similar model was proposed by Watson and Tellegen (1985) that features an approximately circular ordering of emotions with a bipolar valence dimension and two orthogonal dimensions, labeled Positive Activation and Negative Activation.

These circumplex models make two important assumptions about the subjective experience of emotion. First, at any point in time, individuals are thought to fall at one discrete point within the circumplex (Russell & Barrett, 1999; Russell & Carroll, 1999). Second, the likelihood of experiencing two emotions concurrently depends on the distance between the two emotions in the circumplex (Russell & Carroll, 1999). In fact, circumplex models make specific and mathematically testable predictions about which emotions are likely and unlikely to be experienced together (Russell & Fehr, 1987). In other words, although pleasant and unpleasant feeling states may be positively correlated at low to moderate levels of activation (Thayer, 1989), at high levels of activation, they are assumed to be negatively correlated (Remington, Fabrigar, & Visser, 2000; Watson & Tellegen, 1999) or mutually exclusive (Russell & Carroll, 1999). Nearly all of the supporting evidence for these claims, however, is based on self-report data. Indeed, Russell and Carroll (1999) conclude, "Perhaps different results would occur if affect were made operational through nonverbal means, such as smiles and tears" (p. 26).

Conceptualizing the structure of the affect system as a circumplex leaves little room for the subjective experience of ambivalence, which is typically defined as experiencing both positive and negative feelings about some referent (Cacioppo & Berntson, 1994; Priester &

Petty, 1996; Thompson, Zanna, & Griffin, 1995). Importantly, the positive and negative emotions experienced during some ambivalent states may not be exclusively of low intensity, as these conflicting emotions show positive correlations with measures of activated emotions such as tension and anxiety (Priester & Petty, 1996; Thompson et al., 1995). Thus, the circumplex model of affect, which asserts that highly activated positive and negative emotions are negatively correlated or mutually exclusive, does not readily accommodate the construct of ambivalence (see Larsen, McGraw, & Cacioppo, 2001).

Alternatively, some theorists conceptualize the affect system within a bivariate space rather than a bipolar continuum. Cacioppo and Berntson's (1994) Evaluative Space Model (ESM), which was originally developed in the area of attitudes, has recently been expanded into a general model of the affect system (Cacioppo, Gardner, & Berntson, 1999). The ESM posits that the experience of valence represents the integration of two separable and partially distinct components of the affect system, one attuned to "appetition" (i.e., positivity), and the other attuned to aversion (i.e., negativity) (Larsen, McGraw, & Cacioppo, 2001). Importantly, this conceptualization of the affect system allows not only for positive and negative emotions to be reciprocally activated, but also for uncoupled activation (i.e., singular increases/decreases of either negative or positive emotion), coactivation, and coinhibition. The notion of coactivation, or the simultaneous increase in both positive and negative affectivity, seems to capture the subjective experience of ambivalence.

Both the circumplex model and the ESM have their own body of supportive research (see Reich, Zautra, & Davis, 2003 for a review). Clearly, one's underlying theory influences findings in important ways. In fact, the assumptions of bipolarity and reciprocal antagonism often are built into measuring instruments, and this makes disconfirmation of a circumplex model of affect

impossible (Green & Goldfried, 1965 as cited by Cacioppo & Berntson, 1994). For instance, because smoking researchers typically use emotion scales derived from the circumplex model of affect (Shiffman et al., 2002, 2004), our ability to assess simultaneous expressions of emotion during craving may be limited (e.g., Sayette, Martin, Wertz, Shiffman, & Perrott, 2001). Although unipolar measures have been utilized in the emotions literature, some argue that evidence for the co-occurrence of positive and negative emotions is actually an artifact of ambiguous response formats (Russell & Carroll, 1999). These theorists provided evidence that individuals may treat unipolar measures as bipolar measures, resulting in participants inaccurately endorsing feeling both happy and sad.

The above mentioned limitations suggest that self-report instruments may not provide an optimal test of whether certain emotions can be experienced simultaneously. Surprisingly, the bulk of the evidence for both the circumplex structure of affect and the ESM is based on self-report data (but see Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Gray, 1991). This has led some theorists to note the importance of cross validating self-report data with findings using non-self-report measures of emotions (Cacioppo, Gardner, & Berntson, 1999; Larsen & Diener, 1992; Russell & Carroll, 1999). If it is rare that a stimulus event calls forth just one type of emotion (Ekman, 1984) and self-report formats have trouble accurately capturing these subtle changes in emotional experiences (Rosenberg & Ekman, 1994), then it may be useful to focus attention on expressive-behavioral assessments that arguably offer a more basic and direct measure of emotion (Barlow, 2002). Thus, a secondary aim of the current study was to provide a better test of whether emotions may be experienced simultaneously by utilizing a robust affect-inducing manipulation and relying on an assessment technique less influenced by the biases inherent in self-report.

1.3 ADVANCES IN THE ASSESSMENT OF EMOTION

For nearly 3 decades, emotion researchers have used observational coding systems to identify facial expressions thought to be associated with emotion (Ekman & Rosenberg, 2005; Sayette, Cohn, Wertz, Perrott, & Parrott, 2001). The most comprehensive of these approaches is the Facial Action Coding System (FACS; Ekman & Friesen, 1978), which is an anatomically based system for measuring facial movement. By using the FACS and viewing videotaped facial behavior in slow motion, coders can code all possible facial displays, referred to as action units (AUs) (Ekman & Friesen, 1978; Ekman, Friesen, & Hager, 2002). This technique provides an objective and reliable method of measuring facial behavior over extremely rapid time frames (Sayette et al., 2001). Importantly, the use of the FACS to examine emotional responses can provide key information that otherwise could go unnoticed if relying exclusively on self-report measures. Recent research on depression suggests that facial expressions measured by the FACS are related to important clinical behavior, above and beyond what is indicated by standard self-report instruments (Ekman, Matsumoto, & Friesen, 2005). Similarly, the present study will use the FACS to determine if some smokers will express cue-induced ambivalence in the laboratory, and if so, whether these smokers report higher scores on measures of real world difficulty controlling smoking (i.e., general smoking ambivalence, described in more detail below).

The utility of the FACS in advancing understanding of cigarette cravings already has been established, but research interests in this area have tended to focus on the independent influences of positive and negative affect. For instance, Sayette and Hufford (1995) demonstrated that, during initial smoking cue exposure, smokers are significantly more likely to express facial expressions indicative of positive affect, for a longer duration and with greater intensity, than after they are informed that they cannot smoke. In another laboratory experiment,

Sayette and colleagues (2003) replicated and extended this finding. Specifically, a brief latency cue exposure period (signaling cigarette availability) elicited approach motivation indexed by positive facial expressions, while longer latencies were more likely to elicit negative expressions. Previous research has not, however, used the FACS to examine whether a potent craving induction results in the simultaneous expression of positive and negative AUs. The current study attempted to provide evidence for cue-induced ambivalence, in dependent smokers presented with *in vivo* smoking cues.

1.4 AMBIVALENCE AND ADDICTION

Most recent conceptualizations of addiction include conflict and ambivalence as central features of the addict's behavior and experience (Breiner, Stritzke, & Lang, 1999; Cox & Klinger, 1988; Heather, 1998; Prochaska, DiClemente, & Norcross, 1997; Miller & Rollnick, 1991). These models assert that necessary components of addiction are the awareness of harm in continued drug use and the unsuccessful effort to reduce that harm. In essence, people addicted to drugs are thought to experience ambivalence, having inclinations to both approach and avoid substance use.

Interventions consistent with this conceptualization of addiction attempt to motivate health behavior change by influencing the relative weight a client attributes to negative and positive aspects of the behavior (e.g., Transtheoretical Model of behavior change; Prochaska et al., 1997). The notion that ambivalence can affect intentions and change behavior is a core feature of motivational interviewing (Miller & Rollnick, 1991). Motivational interviewing is defined as "a person-centered, directive method for enhancing intrinsic motivation to change by

exploring and resolving ambivalence" (Moyer & Rollnick, 2002, p. 185). In other words, the counselor first encourages the client to experience the uncomfortable state of ambivalence; the key to successful treatment, though, is for the client to take appropriate action to resolve this conflict and eliminate ambivalence. A meta-analysis indicates the efficacy of this approach for treating a wide range of behavioral problems, including exercise, diet, and drug addiction (Burke, Arkowitz, & Menchola, 2003). Thus, the success of intervention strategies based on ambivalence further supports the importance of this construct in understanding the process of drug addiction.

Despite the emphasis placed on ambivalence in current theoretical models of drug addiction, the literature includes inconsistent definitions of this construct. As is the case with current conceptualizations of craving, varying time parameters have been used to assess ambivalence. For instance, some researchers have assessed ambivalence as if it were relatively stable, asking individuals to consider their attitudes over the previous week when rating their level of ambivalence toward drug use (McEvoy, Stritzke, French, Lang, & Ketterman, 2004). However, instruments designed to measure ambivalence over extended time intervals may lack the precision to show changes in one's level of ambivalence about drug use (Avants, Margolin, Kosten, & Cooney, 1995; Stritzke et al., 2004).

The utility of conceptualizing ambivalence as a momentary and changing state is illustrated by the incorporation of ambivalence into cue-induced craving research. Unlike traditional views of craving, which typically operationalize the construct as a unidimensional drug-acquisitive state, researchers have begun to test the utility of a more complex, multidimensional model of craving. For instance, Breiner, Stritzke and Lang's (1999) conceptualization of craving emphasizes the role of ambivalence in maintaining addictive

behaviors and allows for competing inclinations to both approach and avoid drug consumption. These researchers build on motivational (Cox & Klinger, 1988; Heather, 1998) and behavioral choice theories of drug use (Vuchnich & Tucker, 1998) to view craving as the relative activation of two dimensions of approach and avoidance. Similar to Cacioppo and Berntson's (1994) model, these dimensions are thought to be independent. This view of craving accommodates the simultaneous (i.e., ambivalent) activation of both types of inclinations.

This multidimensional view of craving becomes more compelling as research continues to accumulate supporting the concurrent operation of conflicting inclinations during drug craving (Drummond, Litten, Lowman, & Hunt, 2000; Stritzke, Breiner, Curtin, & Lang, 2004). Although elements of the Transtheoretical Model of behavior change have been questioned (West, 2006), studies reveal an association between ambivalence and healthful behavior change (Armitage, Povey, & Arden, 2003; Lipkus et al., 2005). The advantage of independently assessing both approach and avoidance reactions to substance cues also has been demonstrated (Avants et al., 1995; Stritzke et al., 2004).

Despite recent advances in testing the role of cue-induced ambivalence in drug addiction, most studies conducted thus far have relied solely on self-reports of these conflicting inclinations. Yet, many theorists agree that there is a need to better understand the concurrent nonverbal responses associated with these craving responses (Abrams, 2000; Anton, 1999; McEvoy et al., 2004). Research on the topic of cue-induced ambivalence in drug addiction might benefit from operationalazing ambivalence as the simultaneous experience of positive and negative affect (Cacioppo et al., 1999).

1.5 AMBIVALENCE AND EMOTION

Like most of the evidence supporting a circumplex model of affect, previous studies on attitudinal ambivalence have relied almost exclusively on self-report data (e.g., Preister & Petty, 1996). However, the coactivation of positive and negative emotions (i.e., ambivalence) is thought to be "unpleasant, unstable, and often short-lived" (Larsen et al, 2001, p. 687). Accordingly, self-report measures of ambivalence have been criticized, as people are likely limited in their ability to consciously acknowledge and report on their own ambivalence (Bassili, 1996; Cacioppo et al., 1999). Additionally, most studies on ambivalence and emotions ask participants to rate how they are feeling while sitting in a sterile laboratory. Research suggests, however, that participants' responses in these artificial environments differ greatly from reports given in more emotionally arousing situations (e.g., Ariely & Loewenstein, 2006; Loewenstein, 1996; Loewenstein, O'Donoghue, & Rabin, 2003).

Given these limitations, it is not surprising that evidence for the simultaneous experience of positive and negative affect is scarce. The current methodological shortcomings have led some to wonder if different results (i.e., non-bipolarity of negative and positive emotions) would occur if assessing "moments of great emotion or times of conflict or decision" (Russell and Carroll, 1999, p. 26). For instance, when more emotionally complex situations have been assessed, 25-50% of participants reported experiencing simultaneous positive and negative emotions (Larsen et al., 2001; Stritzke et al., 2004).

In addition to moving beyond self-report data and sterile laboratory assessments, researchers also have noted the importance of using experimental paradigms that permit concurrent expression of positive and negative affective processes (Cacioppo et al., 1999; Lipkus et al., 2005). The current study offers an effective way to deal with the aforementioned

shortcomings. By exposing dependent smokers to a potent smoking cue while instructing them that they are not permitted to smoke, this study used a robust and well-established manipulation to elicit emotion and create conflict. Moreover, use of the FACS to assess immediate reactions to *in vivo* smoking cues provided a way to capture the fleeting experience of simultaneous emotions (Cacioppo et al., 1999). To our knowledge, the current study is the first application of Cacioppo and colleagues' (1999) ESM to evaluate conflicting approach and avoidance reactions to smoking cues using analysis of facial behavior (Barlow, 2002; Rosenberg & Ekman, 1994).

Another limitation of prior research on cue-induced ambivalence is that data analyses have tended to focus on the separate and independent correlates of approach and avoidance reactivity, rather than the combined effect of high approach and high avoidance inclinations (i.e., ambivalence). For instance, Stritzke and colleagues (2004) linked increasing approach ratings for drug cues with heavier use, increased craving, increased desire for restraint of use, and increased dependence. Increasing avoidance ratings were associated with greater report of restraint, lower craving and lighter use. Importantly, the joint consideration of approach and avoidance reactivity was only examined in relation to a single item assessing readiness to quit smoking. In addition, Drobes and Tiffany (1997) examined facial muscle movement during imaginal and *in vivo* cigarette cue exposure using electromyography (EMG). Although they measured both zygomatic and corrugator muscle movement (regions typically associated with positive and negative emotions respectively), the authors analyzed and reported on these regions separately.

Therefore, it remains unclear how smokers manifesting both increased approach and avoidance reactions to smoking cues would score on measures of smoking motivation. The current study related simultaneous positive and negative facial reactions to constructs

presumably related to general smoking ambivalence, such as abstinent-induced withdrawal symptoms and desire to quit smoking (Avants et al., 1995; Heather, 1998; Stritzke et al., 2004).

The general aim of this study was to examine a possible link between the concept of general smoking ambivalence common to many models of drug addiction and dependent smokers' cue-induced ambivalence, as reflected by affect-related facial responses. If this association is observed, this study would provide converging evidence that laboratory-based cue-induced ambivalence may provide useful information pertaining to real world difficulty controlling smoking (Stritzke et al., 2004).

Because previous studies indicate that craving reports obtained at different times provide different information (Shiffman et al., 1996), with the strongest correlations with other measures of smoking motivation found during high craving episodes (Gwaltney, Shiffman, & Sayette, 2005; Sayette, Martin, Hull, Wertz, & Perrott, 2003; Waters et al., 2003), the current study used a manipulation (nicotine deprivation plus *in vivo* cue exposure) that has produced the most robust self-reported cravings in the published literature (see Wertz & Sayette, 2001). Consequently, this study offers an effective way to test whether a momentary, cue-induced ambivalent response will reveal important information about smokers' real world difficulties controlling their substance use.

1.6 THE CURRENT STUDY

In order to create a powerful experimental manipulation to examine cue-induced ambivalence, 34 nicotine-deprived dependent smokers were presented with *in vivo* smoking cues while instructed that they would not be permitted to smoke (Sayette et al., 2003). The FACS was used

to assess the momentary occurrence of simultaneous positive and negative AUs, and those smokers' displaying these affect-related expressions (i.e., cue-induced ambivalence) were predicted to report significantly higher scores on variables thought to relate to general smoking ambivalence. Although light-smoking, non-dependent tobacco chippers were also recruited, this study focused only on dependent heavy smokers. Current conceptualizations of ambivalence in drug addiction assert that necessary components of addiction are the awareness of harm in continued drug use and the unsuccessful effort to reduce that harm (Cox & Klinger, 1988; Heather, 1998). Because tobacco chippers do not show signs of tobacco dependence (Shiffman et al., 1994), it is unlikely that the construct of ambivalence has relevance for this sample of smokers.

In summary, my aims were to (a) test a new approach for assessing cue-induced ambivalence by providing evidence of the simultaneous display of positive and negative emotion-related expressions during an *in vivo* smoking cue exposure protocol, and (b) relate my assessment of cue-induced ambivalence to several addiction relevant constructs (i.e., general smoking ambivalence), with the thought that the joint consideration of positive and negative emotions would provide unique information that is not found when examining these two types of emotions separately.

1.7 HYPOTHESES

Hypothesis 1: Approximately one-third (N=11) of the dependent smokers in this study will manifest simultaneous positive and negative affect-related facial expressions.

Hypothesis 2: Smokers displaying cue-induced ambivalence will report significantly higher scores on our 4 measures of general smoking ambivalence than will those who do not manifest cue-induced ambivalence.

Hypothesis 3: Higher scores on measures of general smoking ambivalence will be found only in those smokers expressing cue-induced ambivalence, and not found in smokers expressing either positive or negative affect-related expressions alone. Specifically, smokers expressing positive (negative) AUs alone will not endorse feeling more general smoking ambivalence compared to smokers who do not express positive (negative) AUs.

2.0 METHOD

2.1 PARTICIPANTS

Smokers (N=34; male=19, female=15) age 21-35 were recruited through advertisements in newspapers and radio programs. Their ethnic background was as follows: 82% Caucasian, 9% African American, and 9% Hispanic or Asian American. Exclusion criteria included medical conditions that contraindicated nicotine ethically and illiteracy. Participants had to report smoking an average of 21 or more cigarettes per day for at least 24 continuous months (Shiffman, Paty, Kassel, Gnys, Zettler-Segal, 1994). Abstinent smokers had to have carbon monoxide (CO) levels that did not exceed 16 ppm (M=9.38, *SD*=3.58). Participants' mean age was 25.21 years (*SD*=4.42). They averaged 14.35 years of formal education (*SD*=1.98), 9.49 years of smoking (*SD*=4.97), 24.41 cigarettes per day (*SD*=5.33), and 6.53 prior quit attempts (*SD*=3.14).

2.1.1 Baseline Assessment

Demographic information, smoking history and patterns, and current interest in quitting were assessed with standard forms (see Sayette, Martin, et al., 2001).

2.1.2 Facial Coding

Facial expressions were coded by a FACS-certified coder during smoking cue exposure when participants initially saw (5s), touched (5s), and held (10s) the lit cigarette. Specific AUs and AU combinations were classified as positive affect-related AUs (referred to herein as POS AUs) or negative affect-related AUs (referred to herein as NEG AUs) on the basis of a review of FACS literature. The following AUs and AU configurations were coded as POS: 12 and 6 + 12, both of which could be accompanied by 1 + 2, 25, or 26 (Ekman, Friesen, & Ancoli, 1980; Sayette & Hufford, 1995; Sayette & Parrott, 1999). For expressions to be considered POS, AU 12 (the contraction of zygomatic major, in which the corners of the lips are raised) had to receive a minimum intensity rating of "b" using Friesen and Ekman's (1992) updated "a" to "e" intensity scale. NEG AUs were defined by the presence of at least one of the following AUs: 9 (nose wrinkle), 10 (upper lip raise), unilateral 14 (dimpler), 15 (lip corner depress), 20 (lip stretch), and 1 + 4 (pulling the medial portion of the eyebrows upward and together. These AUs are thought to appear during the expression of negative emotion (Ekman & Friesen, 1982, 1986; Ekman et al., 1980; Sayette & Parrott, 1999). For NEG AUs, a minimum intensity rating of "b" was required to meet criteria (Friesen & Ekman, 1992).

Because I was interested in the simultaneous occurrence of positive and negative AUs, I recoded the facial data to account for the concurrent activation of muscle groups associated with both positive and negative emotions. Cue-induced ambivalence (AMB) was defined as the simultaneous presence of both POS AUs and NEG AUs. These expressions had to include a POS AU (12) in addition to a NEG AU (as described above). Reliability was tested using comparison coding by a second FACS-certified coder of a random sample of 15% of the total

coding periods. Kappa coefficients showed that POS AUs (.90) and NEG AUs (.69) were coded reliably.

2.1.3 General Smoking Ambivalence

Several measures putatively associated with ambivalence about continuing to smoke (i.e., general smoking ambivalence) were examined. Heather (1998) defines ambivalence behaviorally, as repeated failures to refrain from substance use despite intentions to do so. Therefore, several questions related to both the difficulty experienced when attempting to refrain from smoking (DIFFICULTY QUITTING, WITHDRAWAL, and SELF-EFFICACY) and interest in quitting smoking (INTEREST IN QUITTING) were examined. Specifically, participants who endorsed at least one previous quit attempt were asked to rate the following question on a four-point scale (easy, slightly difficult, difficult, and very difficult): "How hard was it for you to quit smoking on your most recent attempt?" (DIFFICULTY QUITTING)

Past WITHDRAWAL symptoms experienced when attempting to refrain from smoking were assessed by asking participants to recall their experience when they had "quit smoking, cut down on smoking or gone without smoking for a while." This wording was chosen so that withdrawal history could be obtained from those who have not previously succeeded in quitting smoking (Shiffman, Waters, & Hickox, 2004). WITHDRAWAL was assessed on scales ranging from 1-5 applied to six individual symptoms (craving, irritability, nervousness, difficulty concentrating, physical symptoms, and sleep disturbance), which were averaged to form a reliable composite ($\alpha = .77$).

Research suggests that ambivalence toward smoking also may be related to perceived self-efficacy in coping with high-risk situations (Avants et al., 1995). Accordingly, I was

interested in the assessment of expected difficulty abstaining from smoking (SELF-EFFICACY). Participants were asked to rate their expected difficulty refraining for various periods (a half day, a day, up to a month) on five-point scales (very easy, somewhat easy, neither easy nor difficult, somewhat difficult, very difficult) (Shiffman et al., 2004). These individual ratings were summarized as a composite score (Cronbach's α=.71). Note that higher scores on this scale indicate *lower* perceived SELF-EFFICACY.

Finally, previous research shows that ambivalence is often related to health behavior change (Armitage et al., 2003; Burke et al., 2003; Lipkus et al., 2005). Accordingly, participants were asked to rate their current interest in quitting (INTEREST IN QUITTING) on a ten-point scale (1=not at all interested and 10=extremely interested).

2.1.4 Procedure

2.1.4.1 Telephone screening and instructions

Participants who responded to advertisements underwent a phone interview designed to exclude those not meeting selection criteria. Eligible smokers were asked to attend a 2-hr laboratory session. They were instructed to refrain from smoking for at least 7 hours and were told that breath samples would test whether they had abstained. All participants were told to bring a pack of their preferred brand of cigarettes to the laboratory session.

2.1.4.2 Laboratory set-up

Participants underwent the cue exposure manipulation while seated in a comfortable chair behind a desk. Facing the desk was a mounted video camera. Participants were told that the

camera and intercom facilitated communication and helped the investigator determine whether instructions were understood throughout the study.

2.1.4.3 Baseline assessment

Experimental sessions began between 3:00 p.m. and 5:00 p.m. On participants' arrival, their written informed consent was obtained. To confirm abstinence, participants reported the last time they smoked and a CO reading was recorded. Participants presented their pack of cigarettes and lighter to the experimenter, and they completed baseline assessment.

2.1.4.4 Cue exposure

Prior to cue exposure, participants were instructed how to perform a simple response time task, which involved clicking a mouse button whenever a tone sounded (Sayette, Martin, et al., 2001). Next, a tray holding an inverted plastic bowl was placed on the desk. Participants then lifted the bowl, which revealed a role of tape. After picking up the tape in their dominant hand, participants rated their urge to smoke. Two minutes later, the experimenter replaced the tray and bowl with a second tray and bowl. Participants then lifted the bowl, which revealed their pack of cigarettes, an ashtray, and a lighter. They were told to remove one cigarette form the pack and light it without putting it in their mouths. They then held the lit cigarette and looked at it. After 31 s, they rated their urge to smoke on a scale ranging from 0 (labeled "absolutely no urge to smoke at all") to 100 (labeled "strongest urge to smoke I've ever experienced). They then extinguished the cigarette and completed several additional measures reported elsewhere (see Sayette, Martin, et al., 2001, for further details about cue exposure procedure). Finally participants completed a form asking them about the study's purpose, were debriefed, and were paid $45.

2.1.4.5 Data Analysis

This study aimed to examine three hypotheses. To test the first hypothesis, which stated that approximately 1/3 of the dependent smokers in this study would manifest AMB during an *in vivo* smoking cue exposure protocol, I recoded the facial data to examine the concurrent activation of both POS and NEG AUs (i.e., AMB). The distributional properties of the facial data were examined to determine the appropriate coding. Based on prior research using the FACS during smoking cue exposure (Sayette & Hufford, 1995; Sayette et al., 2003), I anticipated using a categorical variable for AMB.

Because the first hypothesis was supported and there were instances of AMB, I then performed four t-tests to determine if smokers showing AMB reported more general smoking ambivalence (i.e., significantly higher scores on WITHDRAWAL, DIFFICULTY QUITTING, INTEREST IN QUITTING, and SELF-EFFICACY), as stated in the second hypothesis. Although the t-test is typically fairly robust against inequality of variances, this is not the case with small and unequal sample sizes. Thus, alternative more conservative t-tests (i.e., the Welch-Aspen t-test) were used when appropriate (i.e., when Levene's test for equality of variances was significant) (Glass & Hopkins, 1995). The Welch-Aspen t-test is an alternative to the pooled-variance t-test and is used when the assumption of homoscedasticity is violated. It provides a t-statistic that asymptotically approaches a t-distribution, thus allowing for an approximate t-test to be calculated when variances are unequal.

Because the second hypothesis was supported and those expressing AMB reported more general smoking ambivalence, the third hypothesis was tested. The third hypothesis stated that the ability of AMB to discriminate general smoking ambivalence would not be a reflection of expressing either POS AUs or NEG AUs alone. That is, I wanted to determine whether or not

there was something unique about smokers expressing AMB (and not smokers expressing either POS AUs or NEG AUs) in relationship to general smoking ambivalence. To test this hypothesis, I examined the 25 participants who did not express AMB to see if smokers expressing just POS AUs or just NEG AUs reported different levels on the four scales of general smoking ambivalence. This allowed me to determine if either POS AUs or NEG AUs (without AMB) would show a similar (i.e., increased) response pattern for general smoking ambivalence.

3.0 RESULTS

Facial data are presented for 33 smokers (one smoker's cue exposure was not recorded due to experimenter error). Most smokers (73%) displayed POS AUs when presented with the *in vivo* smoking cue. A smaller percentage of smokers (33%) displayed NEG AUs during this cue exposure period. Most pertinent to the first hypothesis, a subset of smokers (24%) displayed AMB during smoking cue exposure. As anticipated, the AMB data was not normally distributed (skewness=3.23). Therefore, I created a categorical coding of this variable. Importantly, AMB reactions were specific to the cigarette cue, as none of the participants displayed this facial configuration during control cue exposure.

The second hypothesis stated that smokers displaying AMB would report significantly higher scores on the four factors comprising general smoking ambivalence (WITHDRAWAL, DIFFICULTY QUITTING, INTEREST IN QUITTING, and SELF-EFFICACY) than would those who did not manifest AMB (referred to herein as NO-AMB). As noted above, DIFFICULTY QUITTING was assessed in only those participants who endorsed at least one previous quit attempt (AMB; N=5, NO-AMB: N=20). Four separate t-tests were conducted to test the second hypothesis. However, Levene's test for the equality of variances indicated that the sample variances were unequal for two of the dependent variables (DIFFICULTY QUITTING; F=14.95, p=.001 and INTEREST IN QUITTING; F=11.16, p=.002). To address this homoscedasticity, I used the Welch-Aspen t-test for these two variables.

Figure 1 presents general ambivalence scores for AMB and NO-AMB smokers. AMB smokers reported significantly more WITHDRAWAL symptoms when refraining from smoking than did NO-AMB smokers ($t=2.18$, $df=31$, $p<0.04$). AMB smokers also reported significantly higher INTEREST IN QUITTING than did NO-AMB smokers (Welch-Aspen $t=2.44$, $df=28$, $p<0.02$). In addition, AMB smokers reported significantly more DIFFICULTY QUITTING than did NO-AMB smokers (Welch-Aspen $t=2.93$, $df=19$, $p<.01$). Although in the expected direction, smokers did not differ in their reported SELF-EFFICACY to remain abstinent from smoking ($t=1.32$, $df=31$, $p=.20$).

In sum and consistent with my second hypothesis, AMB smokers reported significantly higher scores on three of the four scales of general smoking ambivalence than did NO-AMB smokers. To test the third hypothesis, that more general smoking ambivalence is unique to smokers displaying AMB and not to smokers displaying POS AUs or NEG AUs alone, I conducted two separate sets of t-tests. The first examined scores on the four measures of general smoking ambivalence for the 18 smokers who expressed POS AUs (excluding those who also showed AMB) compared to the 7 participants who did not display POS AUs. None of these comparisons were significant (all p-values > .09).

The second set of analyses examined general ambivalence scores for the 9 participants who manifested NEG AUs (excluding those who also showed AMB) compared to the 16 smokers who did not show NEG AUs. Again, there were no significant differences between these two groups' scores of general smoking ambivalence (all p-values > .14). Taken together, these results support the third hypothesis and indicate that smokers displaying AMB (and not POS AUs or NEG AUs alone) report more general smoking ambivalence.

3.1 EXPLORATORY ANALYSES

Smokers who displayed *simultaneous* POS AUs and NEG AUs reported significantly higher scores on measures of general smoking ambivalence than did those who did not display simultaneous POS and NEG AUs. I wondered whether smokers displaying *sequential* POS and NEG AUs would report higher general smoking ambivalence scores compared to those who did not display sequential POS and NEG AUs. I originally aimed to focus on those smokers who showed at least one POS AU and one NEG AU (excluding those who showed AMB) in the same coding time period (i.e., during look, touch, or hold). Note that these coding periods were not contiguous, as they assessed the initial 5 seconds that smokers looked at the cigarette, the initial 5 seconds that they touched the cigarette, and the initial 10 seconds that they held the cigarette. Unfortunately, only 3 smokers displayed separate instances of both POS and NEG AUs within a single coding period, resulting in limited power to detect differences. I was, however, able to compare smokers showing sequential instances of POS AUs and NEG AUs (referred to herein as SEQ) across coding intervals (excluding AMB smokers) to those who did not show SEQ (referred to herein as NO-SEQ). SEQ (N=6) and NO-SEQ (N=19) smokers reported similar values for INTEREST IN QUITTING and SELF-EFFICACY (p's > .40). However, SEQ smokers reported significantly more WITHDRAWAL symptoms (M=3.36) than NO-SEQ smokers (M=2.64; t=2.82, *df*=23, p=.01). The SEQ smokers who endorsed at least one prior quit attempt (N=4) also reported more DIFFICULTY QUITTING (M=4.00) than did the NO-SEQ smokers who endorsed at least one prior quit attempt (N=16; M=3.44; Welch-Aspen t=3.09, *df*=15, p=.007).

In sum, smokers who displayed simultaneous or sequential POS and NEG AUs reported increased DIFFICULTY QUTTING and more WITHDRAWAL symptoms when refraining from

smoking compared to smokers who did not express simultaneous or sequential POS and NEG AUs. The simultaneous expression of POS and NEG AUs discriminated those smokers experiencing more INTEREST IN QUITTING, while sequential POS and NEG AUs did not.

4.0 DISCUSSION

This study provides preliminary evidence for the presence of momentary *simultaneous* displays of POS and NEG AUs in some heavy, nicotine-deprived smokers during *in vivo* cigarette cue exposure. Assessment of cue-induced ambivalence was related to three of the four indices of general smoking ambivalence. Specifically, those smokers displaying cue-induced ambivalence reported experiencing increased severity of withdrawal symptoms when abstaining from smoking, more difficulty quitting smoking in their most recent quit attempt, and a higher current interest in quitting than did those who did not express cue-induced ambivalence. Although cue-induced ambivalence was not related to self-perceived efficacy in abstaining from smoking, this may have resulted from inadequate measurement of self-efficacy. There were marked ceiling effects across entire the sample, which made it difficult to find significant differences between those smokers who did and did not display cue-induced ambivalence. In addition, a notable difference existed between the scale used in the current study and that used in prior research (Avants et al., 1995); the latter scale examined high-risk situations, whereas the scale used here assessed self-efficacy beliefs across varying time parameters. It would be interesting to examine whether a relationship would emerge with previously validated questionnaires assessing self-efficacy beliefs about smoking across various situations (e.g., Relapse Efficacy Situation Questionnaire (RSEQ); Gwaltney, Shiffman, Norman, Paty, Kassel, Gnys, et al., 2001).

Despite the preliminary nature of these results, it is intriguing that smokers who reacted to *in vivo* cigarette cues with concurrent positive and negative affect-related facial expressions reported significantly higher scores on several measures thought to be related to ambivalence about smoking (Heather, 1998; Miller & Rollnick, 2002; Stritzke et al., 2004). This pattern of increased self-reported ambivalence about smoking did not emerge when examining either positive or negative affect-related expressions alone, suggesting there may be something unique about experiencing both feelings at the same time.

It is also interesting that while measures of difficulty refraining from smoking (i.e., WITHDRAWAL and DIFFICULTY QUITTING) were significantly increased in smokers displaying *sequential* expressions of POS and NEG AUs, only smokers showing *simultaneous* POS and NEG AUs reported significantly more difficulty refraining from smoking (i.e., WITHDRAWAL and DIFFICULTY QUITTING) and a higher INTEREST IN QUITTING smoking. As noted above, ambivalence has been defined by a combination of both of these conditions (Heather, 1998). Although this finding needs to be replicated in a larger sample, these initial results suggest the importance of simultaneous positive and negative emotional reactions to smoking cues in the experience of ambivalence.

These findings have implications for addiction models, as well as emotion theories more broadly. With respect to addiction, the present data add to a growing body of literature suggesting the ecological validity of laboratory cue-induced craving paradigms (Abrams et al., 1988; Niaura, Abrams, Demuth, et al., 1989; Niaura, Abrams, Monti, et al., 1989; Waters et al., 2003), as the argument for continuing this line of research rests heavily on the assumption that craving responses elicited in the lab relate to addictive processes occurring in the natural environment. Of note, this is the first study to link a momentary facial expression evinced in the

lab to an index of real world difficultly controlling cigarette use. Just as facial behavior measured by the FACS has been shown to predict clinical outcome in a sample of patients diagnosed with depression (Ekman et al., 2005), the present findings suggest the potential utility of the FACS to detect smokers experiencing ambivalence. If replicated, these results could have important clinical implications. For instance, the FACS could be used to assess ambivalence in treatments where increased ambivalence is purportedly the mechanism of action underlying healthful behavior change (e.g., Miller & Rollnick, 2002). Alternatively, the FACS could be used as a screening device to detect individuals who may have the greatest difficulty adhering to smoking cessation treatments (i.e., those smokers who report an increased motivation to change yet have the most difficulty refraining from smoking).

This study also highlights the utility of adopting a multidimensional view of cigarette craving, and it introduces a potent laboratory manipulation to induce ambivalence in some smokers. Although current theoretical models note the importance of ambivalence in addiction (e.g., Heather, 1998) and accumulating data suggest the appropriateness of assessing conflicting (i.e., approach and avoidance) reactions during craving episodes (e.g., Breiner et al., 1999; Stritzke et al., 2004; McEvoy et al., 2004), past studies on the topic of ambivalence about smoking have relied exclusively on self-report instruments. This is problematic given that self-report assessments may not be sensitive enough to detect subtle affective changes that may influence motivational processes such as craving (Cinciripini et al., 2006; Drobes & Tiffany, 1997; Baker, Piper, et al., 2004; Sayette & Hufford, 1995; Zinser, Fiore, Davidson, & Baker, 1999). Our findings suggest that *in vivo* smoking cue exposure can induce a momentary state of ambivalence, and our FACS analyses provide a technique sensitive enough to assess these subtle conflicting reactions in the lab as they unfold over time (Rosenberg & Ekman, 1994).

In addition to advancing our understanding of ambivalence in drug addiction, the current study also contributes to current conceptualizations of the structure of the affect system. The present study adds to a small but growing body of literature that shows that the circumplex model may not always be able to explain the data from studies using non-verbal emotional assessments (see Larsen & Diener, 1992 for a review) or potent affect-inductions (Larsen et al., 2001; Stritzke et al., 2004). Emotion researchers have noted the importance of cross validating self-report data with nonverbal measures of emotions (Cacioppo, Gardner, & Berntson, 1999; Larsen & Diener, 1992), and use of the FACS to measure the coactivation of positive and negative affect-related emotions in the current study provided an immediate and sensitive assessment of this complex response.

To our knowledge, this study marks the first application of the ESM (Cacioppo et al., 1999) using an *in vivo* smoking cue paradigm, which provided a meaningful and powerful trigger for ambivalence. Accordingly, this study fuses two disparate literatures on ambivalence as conceptualized by addiction and emotion researchers. While previous studies in both areas have relied on self-report assessments and affect-inducing manipulations with questionable effectiveness and ecological validity, the current study used a robust manipulation to create conflict (exposing dependent smokers to a potent smoking cue while instructing them that they are not permitted to smoke) and a sensitive method (FACS) for capturing the fleeting occurrence of simultaneous positive and negative emotion-related facial expressions.

4.1 LIMITATIONS AND FUTURE DIRECTIONS

The current study was subject to several limitations. First, participants in the sample were relatively young (ranging in age from 21 to 35 years) and, at the time of recruitment, were not actively trying to quit smoking. The construct of ambivalence, which is purportedly related to one's difficulty controlling substance use, may have even more relevance in a sample of older smokers with higher motivation to quit smoking. Nevertheless, the construct of ambivalence is likely more relevant in this community sample of dependent smokers than in college student samples common to this literature (e.g., Sayette & Parrott, 1999). It will be important, though, to replicate these findings in a larger treatment-seeking sample. Second, this study used a retrospective design to examine prior difficulties refraining from smoking. Despite this methodological shortcoming, a relationship was found between cue-induced ambivalence and general smoking ambivalence. Future studies that utilize a prospective design to examine the link between cue-induced ambivalence in the laboratory and subsequent smoking relapse are indicated. For example, Waters and colleagues (2005) have found other measures of cue-reactivity to predict relapse. Third, the sample size was small, which limited our ability to contrast AMB with POS and NEG AUs alone. Given the time demands associated with the FACS coding and the preliminary nature of the present study, we chose to initially investigate this measure of cue-induced ambivalence in a sample of smokers that was especially likely to experience this phenomenon (i.e., nicotine-deprived heavy smokers who were exposed to a potent smoking cue). Future studies should attempt to replicate these findings with a larger sample size.

APPENDIX A

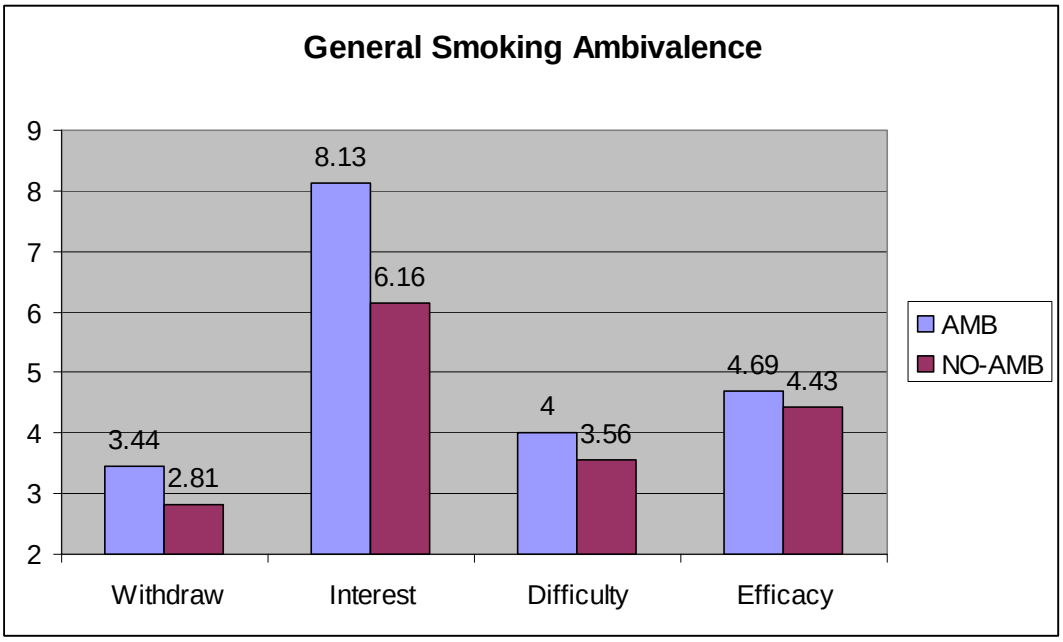

Figure 1 Mean general smoking ambivalence scores for AMB and NO-AMB smokers.

Note: Scores for Withdraw ranged from 1-5, scores for Interest ranged from 1-10, scores for Difficulty ranged from 1-4, and scores for Efficacy ranged from 1-5.

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