Immediate Antecedents of Cigarette Smoking in Smokers With and Without Posttraumatic Stress Disorder: A Preliminary Study

Jean C. Beckham  
Duke University Medical Center and Veterans Affairs Medical Center, Durham, North Carolina

Michelle E. Feldman  
Institute for Medical Research

Scott R. Vrana  
Virginia Commonwealth University

Susannah L. Mozley  
Veterans Affairs Medical Center, Durham, North Carolina

Alaattin Erkanli, Carolina P. Clancy, and Jed E. Rose  
Duke University Medical Center

Using ambulatory methods for 1 day of monitoring, the authors of this study investigated the association between smoking and situational cues in 63 smokers with posttraumatic stress disorder (PTSD) and 32 smokers without PTSD. Generalized estimating equations contrasted 682 smoking and 444 nonsmoking situations by group status. Smoking was strongly related to craving, positive and negative affect, PTSD symptoms, restlessness, and several situational variables among PTSD smokers. For non-PTSD smokers, the only significant antecedent variables for smoking were craving, drinking coffee, being alone, not being with family, not working, and being around others who were smoking. These results are consistent with previous ambulatory findings regarding mood in smokers but also underscore that, in certain populations, mood and symptom variables may be significantly associated with ad lib smoking.

Keywords: posttraumatic stress disorder, ambulatory monitoring, smoking, mood

Posttraumatic stress disorder (PTSD) is a prevalent and often chronic psychiatric disorder in the U.S. population. Seven of 10 individuals will be exposed to at least one traumatic event during their lifetime (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Ten percent of trauma-exposed individuals will develop PTSD and 30% of those affected will develop chronic PTSD (Kessler et al., 1995). Additionally, 60% of individuals with PTSD smoke cigarettes (compared with 23% of the general U.S. population), and persons with PTSD are more likely to be heavy smokers (Beckham, 1999; Beckham et al., 1997). Epidemiologic evidence suggests that PTSD status is associated with a fourfold increase in the odds ratio (OR) of smoking (Breslau, Davis, & Schultz, 2003).

A high prevalence of smoking in the PTSD population is consistent with smoking data from individuals with other psychiatric illnesses. Despite representing 22% of the adult U.S. population, individuals with psychiatric conditions consume 44% of all cigarettes sold in the United States (Lasser et al., 2000). Between 50% and 80% of those suffering from a mental illness smoke, whereas less than 40% of those who have never had mental illness smoke (Lasser et al., 2000). Thus, smoking represents a much greater health risk to psychiatric populations than the general population.

PTSD, like many psychiatric illnesses, is characterized by high levels of negative affect, and patients report that smoking cigarettes reduces their negative mood (Beckham et al., 1995). Negative affect has long been hypothesized to be associated with smoking behavior through multiple theorized mechanisms (cf. Shiffman et al., 2002). Nicotine dependence alone cannot account for situational variability in smoking; therefore, motivational and behavioral processes that control smoking have been hypothesized as having significance for the explanation of smoking behavior. Furthermore, there is evidence that greater negative affect exists among neurotic, anxious, and depression-prone individu-
uals shortly after quitting, and after at least 31 days of smoking abstinence there are no signs of negative affect being reduced (relative to smoking controls; Gilbert et al., 1998, 2002).

There is limited laboratory evidence that PTSD symptoms are associated with increased smoking craving. When individuals with PTSD were exposed to trauma-related stimuli using a modified Stroop procedure, they experienced increased smoking craving compared with those without PTSD (Beckham et al., 1996). These results suggest that trauma-related stimuli may serve as a compelling cue for smoking in individuals with trauma exposure or PTSD. These data, however, cannot address the question of whether the occurrence of PTSD symptoms across daily activity is related to ad lib smoking behavior. Real-world recording is beneficial because it allows an evaluation of whether specific cues actually influence smoking in the everyday environment. Unfortunately, as reported by Shiffman et al., global, retrospective reporting has been the modal method of evaluating the effect of environmental and affective cues on smoking, and this method of self-report fails to accurately reflect actual smoking patterns (Shiffman, 1993; Shiffman & Prange, 1988). Thus, a need exists for real-world ambulatory studies of cues associated with smoking behavior.

Only four previous studies have evaluated ad lib smoking in the smoker’s natural environment (Delfino, Jammer, & Whalen, 2001; Shapiro, Jammer, Davydov, & James, 2002; Shiffman et al., 2002; Shiffman, Paty, Gwaltney, & Dang, 2004). Shiffman et al. reported that smoking was strongly related to urges to smoke and modestly related to consumption of coffee and food, the presence of other smokers, and several activities (Shiffman et al., 2002). Positive and negative affect, however, were not significant antecedents to ad lib smoking (Shiffman et al., 2002, 2004). Conversely, Delfino et al. (2001) found that anxiety and decreased alertness predicted subsequent smoking for men only. Shapiro et al. also found that craving and mood (feeling happy, feeling stressed, and a decrease in feeling hungry) were significantly associated with ad lib smoking (Shapiro et al., 2002).

These findings represent limited evidence linking negative affect and smoking in the natural environment. The prior studies, however, only sampled smokers not evaluated for psychiatric illness. Subgroups of smokers may differ on the environmental and emotional variables that control smoking behavior. Because negative affect is more common in psychiatric populations and predicts relapse to smoking (Kassel, Stroud, & Paronis, 2003), the smoking behavior of psychiatric populations may be even more strongly associated with negative mood. Further, evidence exists suggesting that smoking withdrawal symptoms are related to idiosyncratic psychiatric symptomatology. For example, anxious smokers are more likely to have withdrawal symptoms related to anxiety (Pomerleau, Marks, & Pomerleau, 2000). This finding raises the possibility that not only are psychiatric symptoms related to craving and increased smoking but also that smoking withdrawal may lead to increased psychiatric symptoms. Thus, numerous benefits would arise from careful investigation of the relationship between negative affect (as well as psychiatric symptoms in general) and smoking behavior among individuals with mental illnesses.

The purpose of the current study was to evaluate smoking antecedents in smokers with and without PTSD. A range of affective, psychiatric, physiological, and environmental antecedents were investigated, including negative and positive affect, PTSD symptoms, cigarette craving, use of alcohol or coffee, medications, and current location and activity. On the basis of previous laboratory findings (Beckham et al., 1996), we hypothesized that negative affect and PTSD symptoms would be related to ad lib smoking in PTSD patients. However, based on inconsistent findings in previous ambulatory studies (Delfino et al., 2001; Shiffman et al., 2002), no such prediction was made for smokers without PTSD.

Method

Participants

There were 95 participants (63 PTSD and 32 non-PTSD) in the current study. Participants were recruited through advertisements for a smoking and trauma assessment study and were paid $150 for their participation ($50 for the screening interview and $100 for the 1 day of monitoring). Although this was a free-standing study, the majority of participants (95%) also enrolled in a separate laboratory study designed to evaluate the effect of PTSD symptoms on smoking craving (Beckham, et al., 2005). To qualify, participants had to be at least 18 years old, be able to read, and smoke at least 10 cigarettes per day. The following screening data were collected from each participant: demographic information (age, race, years of education; socioeconomic status; SES; Hollingshead & Redlich, 1958), the Structured Clinical Interview for DSM–IV criteria (SCID) for Axis I disorders (First, Spitzer, Gibbon, & Williams, 1994), the Clinician Administered PTSD Scale (CAPS; Blake et al., 1995), a smoking history questionnaire, and the Fagerström Test of Nicotine Dependence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Current diagnoses were determined by a 1-month time frame for PTSD, major depressive episode, and anxiety disorder and a 6-month time frame for current substance abuse or dependence. Six diagnostic raters were used over the 5 years during which this study was conducted: two clinical psychologists, three clinical psychology doctoral candidates, and the project director, who had 10 years of experience in clinical interviewing. Each rater was trained using SCID and CAPS standardized training (i.e., manual, videotapes, and corating training with a trained rater). Interrater reliability for diagnoses based on videotapes of patient interviews was $\kappa = .96$.

Participants who met criteria for current alcohol or other substance abuse or dependence, a current psychotic disorder (including schizophrenia), or bipolar disorder with active manic symptoms were excluded regardless of whether they met criteria for PTSD. Participants recruited for the comparison group were excluded if they met lifetime criteria for PTSD. Otherwise, participants meeting criteria for any other Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM–IV; American Psychiatric Association, 1994) disorder, including lifetime alcohol or other substance abuse or dependence assessed by the SCID, were included in the study.

One hundred eighty-three smokers completed the screening interview, 57 of whom were excluded for the following reasons: lifetime but not current PTSD ($n = 21$); current drug or alcohol abuse or dependence or a positive drug screen ($n = 18$); contraindicated
medical condition (i.e., chronic obstructive pulmonary disease or stroke; n = 2); psychiatric condition (n = 15 [3 for psychosis, 5 for bipolar with current manic symptoms, 6 for schizophrenia, and 1 for other]); and current suicidal ideation (n = 1). One hundred twenty-six individuals met enrollment criteria; of these, 13 never returned to start the study. One hundred thirty smokers completed the 1-day ambulatory monitoring. The diary data of 18 participants were excluded for the following reasons: monitor malfunction (n = 4); noncompliance (see Diary Compliance Information section for a description; n = 7); less than 5 hr of monitoring (n = 2); and obvious misunderstanding of the instructions (n = 5). The final data set included 95 smokers (63 with PTSD and 32 without PTSD). The exclusion, dropout, and data completion rates are similar to previous laboratory and ambulatory studies conducted with this population (Beckham et al., 2000, 2002).

A wide range of trauma exposure histories were represented. In this sample, the following were endorsed (by group): combat (11% in non-PTSD, 36% in PTSD); childhood physical or sexual assault (19% in non-PTSD, 14% in PTSD); adult sexual assault (0% in non-PTSD, 5% in PTSD); accident (15% in non-PTSD, 6% in PTSD); domestic violence (11% in non-PTSD, 16% in PTSD); death (22% in non-PTSD, 11% in PTSD); adult violence (18% in non-PTSD, 8% in PTSD); and natural disaster (4% in non-PTSD, 2% in PTSD).

Medications were recorded and classified into the following groups: alpha-adrenergic blockade; beta-blockade; anticholinergic and other antihypertensive medications (diuretics, angiotensin-converting enzyme inhibitors, and calcium channel blockers); specific serotonin reuptake inhibitor (SSRI); heterocyclic antidepressant; lithium; monoamine oxidase inhibitor antidepressant; other antidepressant; benzodiazepine; neuroleptic; or sedative–hypnotic. This classification system was developed in our previous work (Beckham et al., 2000). To simplify description in the current study, the categories were further classified as either psychiatric or cardiovascular.

Statistical comparisons for demographics, diagnostic characteristics, medications, and smoking variables between PTSD and non-PTSD groups are reported in Table 1. Smokers with PTSD were significantly more likely to be prescribed psychiatric medications, including SSRIs and other antidepressant medications, and, consistent with Kessler et al. (1995), more likely to meet criteria for current major depressive disorder, lifetime major depressive disorder, lifetime alcohol dependence, and lifetime and current specific phobia. Participants with PTSD were more nicotine dependent, of significantly lower educational and socioeconomic status, and significantly less likely to be employed.

**Ambulatory Monitoring Procedure**

Participants wore an ambulatory heart rate and blood pressure monitor (the Accutracker II; Suntech Medical Instruments, Raleigh, NC), which was used as a cuing device. They were fitted typically between 9:00 a.m. and 11:00 a.m. and completed 1 day of monitoring. Reliability and validity of this monitor have been demonstrated previously (Appel, Whelton, Seidler, Patel, & Klag, 1995), more likely to meet criteria for current major depressive disorder, lifetime major depressive disorder, lifetime alcohol dependence, and lifetime and current specific phobia. Participants with PTSD were more nicotine dependent, of significantly lower educational and socioeconomic status, and significantly less likely to be employed.

**Diary Description and Measurement**

A stratified random sampling plan was used to obtain a representative sample across the time period; the monitor was programmed to prompt a diary entry every 60 min (± 5 min) during waking hours. Smokers were instructed to complete a diary entry each time they monitored the reading. In addition, they were instructed to initiate a monitor reading and complete a diary entry each time they prepared to smoke. These procedures resulted in three types of readings: random nonsmoking occasions, random smoking occasions, and self-initiated smoking occasions. Because the monitor was primarily used as a signaling and compliance device, we limit our presentation of the results to the relationship of mood, PTSD symptoms, and situational variables to smoking.

Participants completed the following diary items each time the monitor operated: time; smoking status; place (home, friend or family member’s home, work, car or bus, bar or restaurant, outside, or other location); social situation (alone, with family, with strangers, with co-workers or friends); activity (working, leisure, interacting with others, telephone, inactive, or driving); and physical activity (inactive, light, medium, heavy). In addition, participants were asked to record whether smoking was allowed and whether others were smoking. This diary format has been used successfully in previous research (Beckham et al., 2000). Affect ratings were used to assess participants’ moods during the 10 min before the diary entry. To evaluate mood, participants rated items from the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Carey, 1988; Watson, Clark, & Tellegen, 1988), along with three additional items of hungry, worried, and restless. The PANAS is a 10-item positive affect (PA) and 10-item negative affect (NA) scale (range 1–5 for each item for each scale) designed to measure both types of affect. The two scales are largely uncorrelated with one another and are fairly reliable over a 2-month period (Watson, Clark, & Carey, 1988). NA is correlated with symptoms of depression and anxiety. PA is inversely related to symptoms of depression (Watson, Clark, & Tellegen, 1988).

Other antecedents were also sampled: craving (0–10 scale in 1-point increments) as well as eating or consumption of caffeine, alcohol, or medication during the past 30 min. The frequency (0 = not at all to 4 = more than six times) and severity (0 = not at all distressing to 4 = extremely distressing) of 12 PTSD symptoms from the Davidson Trauma Scale (Davidson et al., 1997) were also assessed: PTSD B reexperiencing symptoms (intrusive thoughts, event recurring, upsetting reminders, and physically upset by reminders); PTSD C avoidance and numbing symptoms (avoiding thoughts and feelings, difficulty enjoying things, distant, and numbing of feelings); and PTSD D hyperarousal symptoms (irritation, difficulty concentrating, on edge, and easily startled). Certain PTSD symptoms that would not be expected to change across the course of 1 day were omitted from the diary: recurrent distressing dreams (B2), inability to recall an important aspect of the trauma (C3), sense of a foreshortened future (C7), and difficulty falling or staying asleep (D1). Frequency and severity for the 12 items that were included in PTSD were assessed within each participant, resulting in four scores: total PTSD symptoms and total PTSD B, C, and D symptoms. The paper diary size was 21.5 × 13.5 cm, and the time required to complete the diary was approximately 2 min per entry. All but 2 participants completed their monitoring on a weekday.

**Diary Compliance Information**

Each time the monitor randomly took a reading, there was a signal (i.e., the blood pressure cuff inflating) that was impossible to ignore. The Accutracker also provided a unique time code at the time of signal, and the time was also recorded on the diary by the participant. This time stamp in the monitor record-
Table 1
Participant Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>PTSD (n = 63)</th>
<th>Non-PTSD (n = 32)</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>%</td>
</tr>
<tr>
<td>Age</td>
<td>44.51</td>
<td>11.67</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>13.35</td>
<td>2.09</td>
<td></td>
</tr>
<tr>
<td>Socioeconomic statusa</td>
<td>50.73</td>
<td>14.04</td>
<td></td>
</tr>
<tr>
<td>Veteran</td>
<td>56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minority</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (including Asian and Native American descent)</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fagerström score</td>
<td>6.76</td>
<td>1.74</td>
<td></td>
</tr>
<tr>
<td>Cigarettes per day</td>
<td>23.10</td>
<td>9.21</td>
<td></td>
</tr>
<tr>
<td>Total years smoked</td>
<td>26.86</td>
<td>12.38</td>
<td></td>
</tr>
<tr>
<td>Pack years</td>
<td>33.58</td>
<td>23.33</td>
<td></td>
</tr>
<tr>
<td>Heavy smokersb</td>
<td>38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychiatric medication</td>
<td>51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac medication</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring duration (min)</td>
<td>10.76</td>
<td>1.63</td>
<td></td>
</tr>
<tr>
<td>Mean start and end time</td>
<td>10:06 a.m./8:46 p.m.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current MDD</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime MDD</td>
<td>81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime alcohol dependence</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime alcohol abuse</td>
<td>49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime drug dependence</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime drug abuse</td>
<td>38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current panic disorder</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime panic disorder</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current OCD</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime OCD</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current specific or social phobia</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime specific or social phobia</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current GAD</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime GAD</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current bipolar</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime bipolar</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current dysthymia</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifetime dysthymia</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. PTSD = posttraumatic stress disorder; MDD = manic-depressive disorder; OCD = obsessive–compulsive disorder; GAD = generalized anxiety disorder.

b Hollingshead scores range from 11–77. Upper class is a range from 11–17, upper-middle class is from 18–27, middle class is 28–43, middle-lower class is 44–60, and lower class is 61–77. b Heavy smoker was defined as a smoker who smoked 25 or more cigarettes per day.

*p < .05.

ing was unavailable to the participants because it is directly stored in the monitor software. This time stamp was compared with participants’ written time of diary entry. Although these two methods (signaling and time stamp comparison) are not as convincing as time-stamped electronic diary data entry (Stone & Shiffman, 2002), these two features allowed for partial assessment of compliance.

Several diaries were excluded for obvious misunderstanding of or not following the instructions (e.g., no self-initiated readings [n = 2], left smoking question blank [n = 2], and did not complete diary for self-initiated smoking occasions [n = 1]). In addition, participants were excluded if there were less than 5 hr of monitoring (n = 2) or if less than 60% of the Accutracker monitor readings and diary pages matched up within 10 min (n = 7). This resulted in the exclusion of 14 smokers. For the remaining 95 records, the mean percentage of compliance (± 10 min SD), as measured by a comparison of the Accutracker recorded time with the time written by the participant in the diary, was 90% (SD = 9.58%, range = 60–100%). These means by group were as follows: PTSD, 90% (SD = 7.26, range = 60–100); non-PTSD, 91% (SD = 14.22, range = 64–100); group difference was nonsignificant. The mean number of hours of monitoring was 10.70 (SD = 1.64; range = 5–15). These means by group were as follows: PTSD, 10.75 (SD = 1.63, range = 6–15); non-PTSD, 10.59 (SD = 1.70, range = 5–14); group difference was nonsignificant. The lower number of monitoring hours for particular smokers was due to their either coming late to the session or taking the monitor off before bedtime. The mean number of Accutracker readings associated with a diary page (meaning that when the cuing occurred, the smoker completed a corresponding
diary entry) was 17.19 (SD = 4.22, range = 7–30). These means by group were as follows: PTSD, 18.40 (SD = 4.54, range = 9–31); non-PTSD, 17.00 (SD = 4.69, range = 8–26); group difference was nonsignificant.

Data Reduction and Analysis

The total number of Accutrack monitor readings was 1,762 observations from the 95 participants. As described previously, the time stamp from the monitor was compared with the participants’ written entry time. Sixty observations from 27 participants were deleted for not matching with a blood pressure reading, resulting in 1,702 observations for 95 participants. Next, 189 random smoking readings were deleted because it was impossible to determine whether the diary was completed before or during smoking. Because smoking regulations that forbid smoking may mask certain associations among the variables of interest, the 387 nonsmoking readings during which smoking was not allowed were deleted (Shiffman et al., 2002). Of the final 1,126 observations, 682 were smoking occasions and 444 were nonsmoking occasions.

Age, ethnicity, SES, employment status, nicotine dependence, comorbid psychiatric disorders, and medications were evaluated as potential covariates of the ad lib smoking variable using a generalized estimating equation (GEE; Zeger, Liang, & Albert, 1988) analysis. When one of these potential covariates had a significant effect on the independent variable, it was entered first in the GEE model. This strategy is in accord with recommendations of experts in the PTSD field (Keane & Kaloupek, 1997). The identified covariates entered into each model are included in the individual analysis descriptions.

Smoking antecedent analyses were patterned closely after those reported by Shiffman et al. (2002). The data were participant-specific, time series–repeated measurement data, and the unit of analysis was the individual observation. Analyses were performed using GEE in SAS Proc GENMOD (SAS Institute, 2001) to account for multiple observations within participants and differing numbers of observations for each participant. This analytic approach allows the inclusion of variables at different levels of analysis (i.e., individual characteristics and time-dependent variables) and is not dependent on each individual having the same number of data points. The analysis treated the dependent variable of smoking occurrence (cigarette smoking vs. nonsmoking) as a categorical variable and modeled it as a function of independent mood, symptom, and situational variables.

The mood and symptom variables (PTSD symptoms, negative PANAS, positive PANAS, worried, restless, and hungry) approximated a Poisson distribution. The sums for total PTSD, PTSD B, PTSD C, and PTSD D were coded for each occasion as either present (> 0) or absent (= 0). For the negative PANAS and the positive PANAS, each was coded for an occasion as either present (> 10) or absent (= 10). The possible range for the positive PANAS was 10 to 50, with an actual range of 10 to 50. The possible range for the negative PANAS was 10 to 50, with an actual range of 10 to 42. Situation variables (e.g., being at home) were tested by contrasting each variable against the aggregate of all others. The dependent variable (smoking or not) was binary. In GEE, the specified model is the ratio of the odds that smoking occurs in a particular situation to the odds that smoking occurs in the absence of that situation. We evaluated each antecedent separately because individual variables were highly multicollinear. In addition, because interactions are difficult to detect relative to main effects and because this sample size is small compared with similar smoking studies (Shiffman et al., 2002), the effects were tested separately by group.

Results

Group Differences

Group differences were evaluated first using analyses of covariance. As expected, compared with non-PTSD smokers, PTSD smokers reported higher craving ratings controlling for Fagerström score, \( \chi^2(1, N = 94) = 6.31, p < .05 \) (M ± SD: PTSD, 6.05 ± 2.42; non-PTSD, 4.92 ± 1.88); higher negative affect, \( \chi^2(1, N = 95) = 7.83, p < .01 \) (M ± SD: PTSD, 13.07 ± 5.55; non-PTSD, 10.95 ± 3.15); and more total PTSD symptoms, \( \chi^2(1, N = 95) = 13.34, p < .01 \) (M ± SD: PTSD, 12.39 ± 20.10; non-PTSD, 1.49 ± 7.27). Further, PTSD smokers also reported more PTSD B symptoms, \( \chi^2(1, N = 95) = 10.12, p < .01 \) (M ± SD: PTSD, 3.08 ± 6.25; non-PTSD, 0.37 ± 2.19); PTSD C symptoms, \( \chi^2(1, N = 95) = 13.00, p < .01 \) (M ± SD: PTSD, 4.91 ± 8.21 and non-PTSD, 0.53 ± 2.77); and PTSD D symptoms, \( \chi^2(1, N = 95) = 12.86, p < .01 \) (M ± SD: PTSD, 4.42 ± 7.45; non-PTSD, 0.58 ± 2.67). PTSD smokers also reported greater restlessness, \( \chi^2(1, N = 95) = 9.64, p < .01 \) (M ± SD: PTSD, 1.51 ± 0.85; non-PTSD, 1.18 ± 0.53), and worry, \( \chi^2(1, N = 95) = 10.32, p < .01 \) (M ± SD: PTSD, 1.52 ± 0.96; non-PTSD, 1.10 ± 0.40). There were no group differences detected in the report of positive affect or hunger ratings.

Smoking Antecedent Analysis

Overall, participants completed an average of 18 record entries (SD = 4.61; range = 8–31). The group means were 18.4 for PTSD smokers and 17.0 for non-PTSD smokers. All antecedents are presented in Table 2 by group (PTSD or non-PTSD) and observation types. For each variable other than craving (for which the mean and standard deviation are presented), percentage of occurrence during smoking readings and percentage of occurrence during non-smoking occasions are reported. Age, minority status, nicotine dependence, medications, and current and lifetime Axis I diagnoses were tested as possible covariates. For PTSD smokers, psychiatric and cardiac medications were significantly related to ad lib smoking (OR = 1.78 [range = 1.33–2.39], p < .01, for psychiatric medications; OR = 1.47 [range = 1.09–1.99], p < .05, for cardiac medications). For non-PTSD smokers, lifetime major depression was significantly related to ad lib smoking (OR = 1.57 [1.00–2.48], p < .05). Each of these significant covariates was then entered into subsequent models reported later.

In PTSD patients, smoking was strongly related to negative and positive affect, total PTSD symptoms, PTSD B symptoms, PTSD D symptoms, smoking craving, and restlessness. The odds for smoking in PTSD patients was also higher when interacting with others, lower when with family, higher when with strangers, lower when at home, higher when outside, and higher when around others who were smoking. Only psychiatric medications (and not cardiac medications) were significant in all models (except craving) with odds ratios ranging from 1.63 (1.13–2.34) to 1.94...
Taking psychiatric medications was more likely to be associated with ad lib smoking. For non-PTSD smokers, there were no significant mood antecedents to smoking. In all significant models, lifetime major depressive disorder was also significant (except craving) such that those with lifetime major depressive disorder were more likely to smoke (OR range: 1.56 [1.03–2.59] to 1.85 [1.15–2.98], with \( p \) values ranging from .04 to .01).

The significant antecedent variables were smoking craving, drinking coffee, being alone, being with family, working, and being around other smokers who were smoking. No other environmental contexts, locations, activities, or food, alcohol, and medication consumption were significant antecedents. However, as can be seen in Table 2, in some cases the base rate of the variable (e.g., had alcohol) was so low (fewer than five observations for either smoking or non-smoking occasions) that it was impossible to adequately test an association. Means and standard deviations for smoking craving are presented in Table 2. The craving variable demonstrated a substantial linear association with smoking in both the PTSD and the non-PTSD groups.

### Discussion

The results generally supported the hypotheses regarding smoking antecedents. Craving, positive and negative affect, PTSD symptoms, and restlessness were significant antecedents. However, as can be seen in Table 2, in some cases the base rate of the variable (e.g., had alcohol) was so low (fewer than five observations for either smoking or non-smoking occasions) that it was impossible to adequately test an association. Means and standard deviations for smoking craving are presented in Table 2. The craving variable demonstrated a substantial linear association with smoking in both the PTSD and the non-PTSD groups.

### Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>PTSD</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not smoking</td>
<td>Smoking</td>
</tr>
<tr>
<td>Craving</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Negative affect</td>
<td>5.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Positive affect</td>
<td>84</td>
<td>9</td>
</tr>
<tr>
<td>Total PTSD</td>
<td>46</td>
<td>7</td>
</tr>
<tr>
<td>PTSD B</td>
<td>25</td>
<td>37</td>
</tr>
<tr>
<td>PTSD C</td>
<td>39</td>
<td>35</td>
</tr>
<tr>
<td>PTSD D</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>Restlessness</td>
<td>27</td>
<td>35</td>
</tr>
<tr>
<td>Worry</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>Hunger</td>
<td>29</td>
<td>31</td>
</tr>
</tbody>
</table>

**Note.** Odds ratios are equal to the odds that report of the variable preceded smoking with percentage of reports prior to not smoking as the referent; the basic findings do not change without covariates in the models. PTSD = posttraumatic stress disorder. * \( p < .05. ** \( p < .01. ** \( p < .005. ** \( p < .001.
ents to ad lib smoking among PTSD smokers. Situational variables associated with a decreased likelihood of smoking for PTSD smokers were being at home and being with family. Situational variables associated with a greater likelihood of smoking for PTSD smokers were being with strangers, interacting with others, and being around others who were smoking. Consistent with previous research (Shiffman et al., 2002) involving smokers not diagnosed for psychiatric disorders, craving, drinking coffee, not working, and being in the presence of others smoking were significant antecedents to smoking. Whereas craving and others smoking were important antecedents for all our participants, positive and negative affect and psychiatric symptoms were smoking antecedents only for the PTSD group.

The association between PTSD symptoms and smoking in the PTSD group is consistent with previous laboratory findings in which exposure to trauma cues increased urges to smoke (Beckham et al., 1996) as well as with a study showing that people suffer from smoking withdrawal symptoms consistent with their psychiatric symptomatology (Pomerleau et al., 2000). These findings suggest that, at least in some psychiatric populations, smoking may represent a form of self-medicating of their psychiatric symptoms. The detection of an association between mood and smoking may be more likely in psychiatric smokers because (a) there may be disorder-specific symptom–smoking associations, (b) certain psychiatric subgroups may use smoking as a coping response, or (c) simply deliberately increasing the yield of highly symptomatic smokers of any kind may allow a mood effect to be detected. However, these are simply possibilities; mechanisms of detection of this association in psychiatric populations need further replication and investigation.

Compared with smokers without PTSD, PTSD smokers demonstrated higher daily negative affect, smoking craving, and more PTSD symptoms across daily activity. In examining magnitude of effect for mood and PTSD variables, although total PTSD and PTSD D (hyperarousal) symptoms were significantly related to smoking in PTSD smokers, PTSD B symptoms (reexperiencing symptoms) were most strongly associated with smoking. Thus, compared with the non-PTSD group, the PTSD smokers had greater symptoms of negative emotion and possibly their smoking behavior was more affected by these symptoms. This outcome is parallel to a finding showing that, compared with individuals without PTSD, those with PTSD reported more hostility and their blood pressure taken when they were angry was more strongly related to their hostility level (Beckham et al., 2002). It has been suggested that individuals with PTSD have difficulty regulating their level of psychophysiological arousal (Chemtob, Novaco, Hamada, Gross, & Smith, 1997). It may be that the increased smoking observed in association with these affective symptoms was an attempt to control emotion in the absence of more effective regulation strategies.

However, an alternative explanation to the finding detected in this study (PTSD and negative affect were associated with smoking in PTSD smokers) is that PTSD smokers reported a higher base rate of negative affect; the analyses were able to detect an association between mood and smoking because PTSD smokers spent more time experiencing negative moods. It is possible that, as a general rule, negative affect drives smoking for all smokers but that it is only one of the many possible instigators and only detectable in samples with sufficiently prevalent negative mood. For example, although Whalen, Jannier, Henker, and Delfino (2001) did not examine smoking antecedents in their study with adolescents, they found that adolescent smokers spend a relatively high proportion of their daily experience in negative mood states, and it also shows that psychiatric problems were highly associated with smoking among adolescents. Taken together, results of the current study and these data suggest that base rates of mood across different smoking subpopulations could lead to different conclusions about mood–smoking relations.

Further, there is long-standing empirical support for a self-medication model of smoking (Kassel et al., 2003) as well as an interaction of situation and trait variables as determinants of smoking (Eysenck, 1973; Gilbert, 1995; Schachter, Silverstein, & Perlick, 1977; Tomkins, 1968). In the example of PTSD smokers, there are likely multiple determinants of smoking, including possible shared familial vulnerability (Koenen et al., 2003; Yoshimasu & Kiyohara, 2003), self-medication, and possible personality traits such as negative emotionality (Miller, 2003) that may significantly impact the onset, maintenance, and cessation efforts in smokers with PTSD.

Positive affect served as an antecedent for smoking in smokers with PTSD. This is consistent with the finding of Shapiro et al. (2002) that feelings of happiness were associated with ad lib smoking. This finding is also consistent with laboratory studies that have shown that positive affect in continuing smokers produces stronger urges or cravings compared with a neutral condition (Tiffany & Drobes, 1990) as well as smoking urges that are directly associated with positive affect (Zinser, Baker, Sherman, & Cannon, 1992). Further, positive affect has been shown to be a significant positive predictor of nicotine boost (i.e., individualized measure of how much nicotine has been extracted from smoking a cigarette; Patterson et al., 2002). Taken together, these findings suggest that positive and negative affect play different, albeit significant, roles in smoking behavior.

In contrast to previous studies (Delfino et al., 2001; Shapiro et al., 2002; Shiffman et al., 2002) of smokers not diagnosed for PTSD, we failed to detect an association between smoking and restlessness (Delfino et al., 2001) or a number of other situational variables such as consumption of food (Shiffman et al., 2002) and feelings of stress (Shapiro et al., 2002). There may be other variables (e.g., moderator variables) that affected disparate results across studies. For example, one difference between the Shiffman study (Shiffman et al., 2002) and the other three cited studies (the current study; Delfino et al., 2001; Shapiro et al., 2002) is that participants in the Shiffman et al. study were enrolled in a smoking cessation research study.

All but 5 of the non-PTSD smokers reported prior trauma exposure. Previous data have suggested that trauma exposure alone is a risk factor for smoking onset (Acierno,
Kilpatrick, Resnick, Saunders, & Best, 1996; Breslau et al., 2003). The data from this study suggest that results from the non-PTSD smokers are more similar to those reported in Shiffman et al. (2002) than to the results obtained from smokers with PTSD. Nonetheless, further research is needed to determine whether trauma exposure alone may affect smoking.

Covariate analyses revealed that prescription of psychiatric medications was an independent predictor of smoking in the PTSD group. This finding likely represents the most symptomatic PTSD patients, who are also more likely to be prescribed psychiatric medications (Keane & Kaloupek, 1997). Lifetime major depressive disorder was an independent predictor of smoking in smokers without PTSD, and this finding is consistent with the wealth of data supporting an association between depression and smoking (Covey, Glassman, & Stetner, 1998). Taken together, these results underscore the importance of evaluating potentially significant covariates in smoking populations.

There are limitations associated with this study. The use of a written diary to collect information is limited by the potential risk of retrospective completion of entries and completing entries in advance (Shiffman et al., 2000; Stone, Shiffman, Schwartz, Broderick, & Hufford, 2002). A mitigating concern regarding the diary to some degree is that diary completing was cued by blood pressure measurement or was self-cued, both of which may increase compliance (Stone & Shiffman, 2002); however, Broderick, Schwartz, Shiffman, Hufford, and Stone (2003) suggested that signaling does not adequately improve diary compliance. It should be noted that the findings of the current study were significant, although, given the small sample size and only 1 day of monitoring, the results must be replicated. Thus, any random or systematic error variance added to the study by participants not completing their diaries when instructed would most likely have resulted in weakening the effects reported here.

Future studies would be improved by the use of palmtop computers to capture and time-tag records to ensure real-time recording (Shiffman, Paty, Gny, Kassel, & Hickcox, 1996; Stone et al., 2002; Whalen, Jamner, Henker, Delfino, & Lozano, 2002). Only part of 1 ambulatory day for each smoker was sampled, and to increase generalizability a larger sample of recording days would be beneficial (e.g., Shiffman et al., 2002). Because there was no practice day, the first day of monitoring could have been associated with reactivity to the novelty of the procedure such that the behavior, environment, and mood of the individuals may have been altered. Further, only antecedents to smoking were sampled. An additional valuable sampling occasion would be mood and symptoms after smoking in the naturalistic environment (Delfino et al., 2001). For example, smoking and nicotine administration have been associated with increased distress (Parrott, 2000) and the development of panic attacks (Breslau & Klein, 1999; File, Cheeta, & Kenny, 2000). By evaluating consequences of smoking in the naturalistic environment, a more complete picture of how affect, PTSD symptoms, and smoking behavior are related in PTSD smokers could be developed. Nonetheless, this study represents one of only a few smoking ambulatory studies to date, is the only one to specifically examine smoking antecedents in smokers with any identified psychopathology, and provides initial evidence that mood and PTSD symptoms are significantly related to smoking in this group.

References


Received April 12, 2004
Revision received December 20, 2004
Accepted January 18, 2005