Original Investigation

Contextual and subjective antecedents of smoking in a college student sample

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Abstract

Introduction: College is a time when individuals are at risk for initiating or increasing their smoking behavior. Little is known, however, about the contexts in which college students smoke. Identifying antecedents to smoking would provide insights into motivation and stimulus control of smoking in this population.

Method: In a sample of 50 college student smokers, situational, behavioral, and subjective state variables were compared between prompted interviews ($N = 2,095$) and participant-initiated smoking interviews ($N = 865$) using electronic handheld diaries.

Results: The strongest predictors of smoking were recently inhabiting an outside location (odds ratio [OR] = 4.19, $p < .001$), the presence of others smoking ($OR = 3.93$, $p < .001$), and being where smoking was permitted ($OR = 3.26$, $p < .001$), indicating situational control over smoking. Less cue control over smoking was found for daily than nondaily smokers. Craving was the most robust subjective antecedent of smoking behavior ($OR = 1.32$, $p < .001$).

Discussion: These results suggest that smoking among college students is largely opportunistic, craving is important and may develop early in the progression of smoking, and stimulus control may erode with greater smoking experience.

Introduction

Studies of smoking behavior have increasingly employed ecological momentary assessment (EMA) methods, which employ a combination of time-based and event-based sampling to capture smoking behavior and motivation in real time. These designs offer a valuable opportunity to study both contextual and subjective variables that immediately precede smoking behavior. Understanding the contexts in which smoking occurs, especially among college students, may provide valuable direction for the development of effective strategies for preventing, treating, and reducing smoking in this population. Recent EMA studies have yielded both expected and surprising findings regarding the stimulus control of and subjective mood states associated with smoking behavior among both light and heavier smokers.

Theory suggests that stimulus control of smoking behavior should be greater at low levels of dependence (e.g., nondaily smoking) and should decrease with increased dependence (Leventhal & Cleary, 1980). Perhaps not unexpectedly, EMA studies have demonstrated stronger stimulus control of smoking behavior among light smokers relative to heavier smokers. In a sample of adult smokers, Shiffman and Paty (2006) found that chippers (i.e., light smokers without nicotine dependence) reported smoking more frequently while socializing, drinking, and eating than did heavy smokers. Similarly, Otsuki, Tinsley, Chao, and Unger (2008) found in a sample of Asian American college students classified as light smokers that smoking was more likely to occur in social settings than alone and that more cigarettes were smoked during smoking episodes where others were present than when smoking episodes took place alone. Krukowski, Solomon, and Naud (2005) used daily assessments via phone calls to examine antecedents of smoking among college students. Relative to heavy smokers (i.e., mean of 10 or more cigarettes/day), alcohol consumption was more strongly associated with smoking behavior among light smokers (i.e., mean of 2–8 cigarettes/day). Although being in the presence of others smoking was not significantly differentially associated with smoking for light versus heavy smokers, heavy smokers reported being with other smokers more than 75% of the time, making the test of differences a conservative one.

In addition to situational factors, subjective antecedents of smoking, such as mood states, have been the subject of many EMA studies. Specifically, negative affect and the desire to cope with stress have emerged as common self-reported motives of smoking behavior (e.g., Brandon & Baker, 1991). However, subjective states such as the experiencing of negative emotion are episodic and often fleeting, making them particularly difficult to assess accurately with retrospective measures and well suited to be assessed with real-time assessment methods. Studies employing EMA have demonstrated a lack of consistent association between negative affect and smoking but a strong and consistent association of urge or craving and smoking (e.g., Carter et al., 2008; Piasecki, Richardson, & Smith, 2007; Shapiro, Jamner, Davydov, & James, 2002; Shiffman, Paty, Gwaltney, & Dang, 2004).

In this article, we used an EMA design to examine contextual and subjective antecedents of smoking, including self-monitored motives for smoking individual cigarettes, in a sample of college smokers. One goal of the study was to provide descriptive information regarding the association of environmental, behavioral, and motivational setting events with smoking behavior. We expected to find that situational variables, such as time of day and week, social contacts, the presence of others smoking, and alcohol use would be associated with smoking behavior. Because many college smokers are light smokers, we expected students' smoking would not be highly routinized, and so, factors like smoking restrictions would be influential. Based on previous work with chippers and theoretical tracts on stimulus control, we expected that daily smokers would tend to show weaker relations to particular antecedents than their nondaily peers. Specifically, we expected weaker relations of situational antecedents with smoking for daily smokers relative to nondaily smokers.

Method

Participants

Participants were part of a larger study of 130 students (73 nonsmokers and 57 smokers). To be eligible for the smoking group, volunteers had to report smoking at least one cigarette per week over the past month. This sample has been described previously by Piasecki et al. (2007). In that article, analyses focused on self-reported motives for smoking in smoking records only, whereas the current article focuses on comparisons of situational variables associated with smoking events versus prompted assessments.

Data from an older returning student were excluded from analyses to promote age homogeneity. Six smokers were excluded from analyses because they did not go into the field with a diary or failed to report smoking events. The remaining sample of 50 smokers provided a total of 3,234 reports (1,139 smoking records and 2,095 prompted interviews). The analyzed sample averaged 18.5 years of age (range: 18–21), was 62% female, and 85% White. The majority of the sample reported being daily smokers ($n = 33$) who reported smoking an average of 6.8 cigarettes/day (range: 3–20) for an average of 2.0 years (range: 0–6). The remaining 17 participants reported being nondaily smokers, smoking an average of 3.4 days per week (range: 2–6), using an average of 4.4 cigarettes on smoking days (range: 2–15) and having smoked an average of 1.7 years (range: 0–4).

Procedures

Electronic diary

Personal digital assistants (PDAs, Palm Zire; Palm, Inc., Sunnyvale, CA) equipped with commercially available database software (Pendragon Forms; Pendragon Software, Libertyville, IL) were used for implementation of electronic diaries. Audible prompts were delivered using PDA reminder software (Bug Me; Electric Pocket, Ltd., Chepstow, UK). Schedules were constructed so that one prompt per day would fall in each of four periods (8–11 a.m., 11 a.m.–2 p.m., 2–6 p.m., and 6–10 p.m.). Participants were instructed to complete the prompted interview form in response to the alarm and smoking-related interviews just before smoking. As reported by Piasecki et al. (2007), participants responded to 81.3% of the random prompt interviews.

A quick smoke interview was an abbreviated version of the presmoking interview intended to reduce assessment burden, and smokers were instructed to complete this form if they had completed a full presmoking interview within the past 30 min. Because we were interested in characterizing the antecedents of smoking, the current analyses focused on comparing signaled prompts with presmoking and quick smoke interviews (referred to collectively henceforth as "smoking records").

Measures

The abbreviated quick smoke interview was used infrequently ($n = 105$ records or 9.2% of smoking records). The following analyzed measures were omitted from quick smoke interviews: whether smoking was permitted in the current location, consumption of food, beverages, or other drugs in the past hour, the occurrence of new stressors, persistence of ongoing stressors, and subjective states (negative and positive affect, withdrawal, perceived stress, and craving). Analyses involving these variables therefore treated the quick smoke records as missing values.

Antecedent variables were assessed with one of three item types: yes/no forced choice, multipoint Likert scales, or multiitem checklists (see Table 1). Diary entries were automatically time stamped by the diary software. All audible prompts were scheduled between 8 a.m. and 10 p.m. Smoking recordings could be logged at any time. Reports were counted as having occurred on the weekend if they occurred between 6 p.m. Friday and 6 p.m. Sunday.

Statistical analyses

The primary analyses followed a "case-control" strategy (e.g., Paty, Kassel, & Shiffman, 1992; Shiffman, 2009). The dependent measure was whether or not a particular record was a smoking event (e.g., a "case," scored 1) or a prompted assessment (e.g., a "control," scored 0). Smoking was predicted from antecedent variables using generalized estimating equations (GEE) analyses specifying a binomial family, logit link function, and a first-order autoregressive working correlation structure. Because the analyses used a "case-control" strategy (viz. comparing random prompts to smoking records), constraints on prompted assessment times could bias results within regions of the day not covered by prompted assessments. Therefore, we limited analyses to records completed between 8 a.m. and 10 p.m. Of the 3,234 completed diary records, 2,960 (91.5%) were completed within this window (865 smoking records and 2,095 prompted records).

A series of GEE analyses were performed, with each antecedent variable tested alone as a predictor of smoking. Thus, for dichotomous measures, the odds ratios (ORs) indexed the effect of the presence of a given antecedent relative to all other records in which the antecedent was absent. Because the time categories comprised an ordered set of mutually exclusive categories, we entered them together as a set of dummy codes, treating 8 a.m.–11 a.m. as the reference. To illustrate the nature of the effects indexed by the ORs, we computed the rate at which each antecedent was present in smoking and nonsmoking records separately. A multivariate model was also tested in which all antecedent variables were entered simultaneously, so that each OR indexed the effect of a given antecedent conditional upon the remaining antecedents. To illustrate the nature of the obtained ORs for continuously scaled measures of subjective

Table 1. Items included in diary interviews

Item description	Item	Response options
Multiitem checklist		
Current location	Where were you when the alarm beeped/you decided to smoke this cigarette?	Dormitory
		Other locations
		Home
		Outside
		Class
		Other's home
		Bar/restaurant
Social contacts	Who have you been with in the past 15 minutes?	Friends
		No one, I was alone
		Family
		Other persons
Current activity	What were you doing when the alarm beeped/you decided to smoke this cigarette?	Socializing
		Studying/reading/working
		TV/hobby/phone
		Exercise/walking
		Sleeping
		Other
Consumption	Have you consumed any of the following in the past hour?	Alcohol
		Coffee
		Soda
		Marijuana
		Meal/snack
Motives	Why are you smoking this cigarette?	Reduce craving
		Soon going where cannot smoke
		Cope with negative emotion
		Enhance positive emotion
		Habit/automatic
		Opportunity to socialize
		Break from work/studying
		Boredom/to kill time
Yes/no forced choice		
Others smoking	Were other people smoking around you when the alarm beeped/you decided to smoke this cigarette?	Yes/no
Smoking permitted	Is smoking permitted in the location you were in when the alarm beeped/you decided to smoke this cigarette?	Yes/no
Ongoing stress	Has a significant ongoing stressor persisted up to the past 15 minutes?	Yes/no
New stress	Did a stressful event occur or begin in the past 15 minutes?	Yes/no
Multipoint likert scale[a]		
Negative affect[b] ($\alpha = .78$)	How have you felt in the past 15 minutes? Three items: "scared," "upset," and "distressed"	0 (*not at all*) to 4 (*extremely*)
Positive affect[b] ($\alpha = .79$)	How have you felt in the past 15 minutes? Three items: enthusiastic, interested, and proud	0 (*not at all*) to 4 (*extremely*)
Withdrawal[c] ($\alpha = .78$)	How have you felt in the past 15 minutes? Five items: "tense or anxious," "very hungry," "sad or depressed," "irritable or easily angered," and "hopeless or discouraged"	0 (*not at all*) to 4 (*extremely*)
Perceived stress ($\alpha = .68$)	Overall, how much have _____ stressors weighed on you in the past 15 minutes? Four items: "school-related," "work-related," "interpersonal," and "financial"	0 (*not at all*) to 4 (*extremely*)
Craving[c] ($\alpha = .90$)	Three items: "I had trouble getting cigarettes off my mind," "I was bothered by the desire to smoke," and "I had frequent urges to smoke."	0 (*not at all*) to 4 (*extremely*)

Note. [a]Items were transformed from a 1–5 to a 0–4 scale to be conceptually consistent with possible absence of each subjective state.
[b]Adapted from Positive Affect Negative Affect Scale (Watson, Clark, & Tellegen, 1988).
[c]Adapted from Wisconsin Smoking Withdrawal Scale (Welsch et al., 1999).

states, we split the sample according to the degree of each state reported and then computed the proportion of smoking records within each subset of records.

A second sequence of GEE analyses was performed to test whether the association between antecedents and smoking differed between daily and nondaily smokers. These analyses use

the same case-control strategy predicting smoking records from the antecedent, daily smoking status, and their interaction term entered simultaneously as predictors. When significant interactions were found, follow-up analyses were conducted testing the antecedent as a predictor in separate analyses restricted to either daily or nondaily smokers.

Results

Situational antecedents of smoking

Table 2 summarizes the number of participants endorsing each predictor at least once, the proportions of nonsmoking and smoking records in which each predictor was observed, and analyses testing associations with smoking. As shown in Table 2, most of the situational variables analyzed were significantly associated with smoking. It should be noted that in an attempt to assess whether inclusion of the quick smoke interviews influenced associations, analyses were run excluding those interviews. The results were very similar, and the pattern of significance was identical, indicating no significant impact of including these interviews. Therefore, results including both presmoke and quick smoke interviews are presented for completeness.

The multivariate model in which all significant antecedents from the univariate analyses were entered simultaneously produced results comparable with those obtained from univariate models (see Table 2). However, there is some evidence of suppressor effects due to multicollinearity. Specifically, in some cases, the effect of a predictor changed direction when contingent upon others; however, the strongest predictors from the univariate analyses remained significant, retained the same direction, and continued to be the strongest predictors in the multivariate analyses. We highlight these below.

Outside location at the time of the decision to smoke was among the strongest predictors of smoking in this sample. The association of inhabiting an outdoor location with smoking was directly assessed in this sample by comparing location of the decision to smoke with location of smoking in smoking records logged between 8 a.m. and 10 p.m. This association remained strong in the multivariate model ($OR = 1.85$, $p < .001$).

Being in the company of others who were smoking at the time of the decision to smoke ($OR = 3.93$, $p < .001$) and being in a location in which smoking was permissible at the time of the decision to smoke ($OR = 3.26$, $p < .001$) were among the strongest predictors of smoking. These associations also remained strong in the multivariate model (others smoking $OR = 2.66$, $p < .001$ and smoking permitted $OR = 2.19$, $p < .001$).

Subjective states and smoking

Table 3 summarizes findings from models predicting smoking from measures of subjective states. Negative affect was negatively related to smoking, whereas craving scores were positively related to smoking. As reported in Piasecki et al. (2007), when rates of relevant motive endorsements were examined as a function of subjective state scores, endorsement that smoking the current cigarette was motivated by a desire to "cope with negative emotion" was positively related to negative affect, withdrawal, and perceived stress. Additionally, smokers were more likely to endorse smoking to "enhance positive emotion" at

higher levels of positive affect and were more likely to endorse smoking to "reduce craving" as a function of current craving scores (Piasecki et al., 2007).

Interactions between antecedents and daily smoking

Table 4 summarizes the interactions found between daily smoking and the antecedent variables. In cases where the interaction term was significant, separate analyses were conducted for daily and nondaily smokers assessing the relationship of the predictor variable with smoking. Significant interactions were found for two location variables (class and others' home) as well as for being in the presence of others who were smoking, being in a location in which smoking was permitted, and the presence of an ongoing stressor. With the exception of being in class, each of these antecedent variables was more strongly positively associated with smoking for nondaily smokers relative to daily smokers. Recently, being in class was significantly negatively associated with smoking for nondaily but not daily smokers.

Discussion

This electronic diary study of college student smokers suggests that smoking was largely opportunistic, that craving may develop early in the progression of smoking, and that stimulus control may erode with greater smoking experience. Many of the antecedents measured in this study predicted smoking overall. Perhaps, the most noteworthy relations can be understood with respect to formal or informal prohibitions on smoking. There were strong effects for whether or not smoking was permitted in participants' current location, being outside, as well as the presence of others smoking at the time of the decision to smoke. The decision to smoke was less likely to take place when students reported recently being in locations where smoking was not permitted, such as dormitories and classrooms. These findings suggest that smoking in this population is opportunistic. It should be noted that we asked participants to report their location when they made the decision to smoke (vs. where they were smoking), decreasing the likelihood that this is an artificial association. Specifically, in 53% of smoking records with complete information on location, smokers indicated changing locations to smoke, suggesting that the location of the decision to smoke and the location of smoking were frequently different.

Students were less likely to smoke in the morning relative to later times of the day, which is indicative of a non–nicotine-dependent sample. Alternatively, although sleeping and waking times were not explicitly assessed in this study, this finding could be a reflection of the sleep–wake cycle of this sample, indicating that students were more likely to be awake at later times of the day. In contrast to previous self-report studies (e.g., Colder et al., 2006), students in this sample were less likely to report smoking on the weekends. It is unclear whether this is a genuine difference in smoking patterns, sampling error, or an indication of response bias (i.e., less conscientious diary recording on weekends).

Our findings also provide evidence for the co-occurrence of a variety of consummatory behaviors, such as use of alcohol, soft drinks, and food with smoking. This finding is consistent with previous research indicating that college student smoking

Table 2. Situational variables and their relations to smoking

Predictor	Participants Reporting n (%)	Nonsmoking occasions n (%)	Smoking occasions n (%)	Univariate, OR (95% CI) Predicting smoking	Multivariate, OR (95% CI) Predicting smoking[a]
Time of day					
8–11 a.m.	47 (94)	376 (18.87)	94 (9.72)	—	—
11 a.m.–2 p.m.	50 (100)	543 (27.25)	263 (27.20)	1.92*** (1.46–2.51)	1.24 (0.87–1.77)
2–6 p.m.	50 (100)	575 (28.85)	330 (34.13)	2.26*** (1.74–2.95)	1.29 (0.91–1.84)
6–10 p.m.	50 (100)	499 (25.04)	280 (28.96)	2.23*** (1.70–2.91)	1.31 (0.91–1.90)
Weekend	48 (96)	518 (25.99)	182 (18.82)	0.67^^^ (0.55–0.81)	0.63^^^ (0.49–0.81)
Location					
Dormitory	43 (86)	785 (39.39)	302 (31.23)	0.71^^^ (0.60–0.84)	1.37* (1.05–1.79)
Other locations	47 (94)	418 (20.97)	179 (18.51)	0.88 (0.72–1.07)	—
Home	38 (76)	422 (21.17)	192 (19.85)	0.92 (0.75–1.12)	—
Outside	50 (100)	145 (7.27)	235 (24.30)	4.19*** (3.34–5.25)	1.85*** (1.32–2.61)
Class	48 (96)	211 (10.59)	77 (7.96)	0.71^ (0.54–0.94)	0.88 (0.58–1.33)
Others home	41 (82)	138 (6.92)	84 (8.69)	1.27 (0.95–1.69)	—
Bar/restaurant	21 (42)	15 (0.75)	12 (1.24)	1.62 (0.75–3.50)	—
Social contacts					
Friends	50 (100)	931 (46.71)	517 (53.46)	1.38*** (1.18–1.61)	0.96 (0.72–1.28)
Alone	50 (100)	710 (35.62)	282 (29.16)	0.78^^ (0.65–0.92)	1.25 (0.92–1.72)
Family	31 (62)	70 (3.51)	20 (2.07)	0.61 (0.37–1.01)	—
Other persons	46 (92)	523 (26.24)	242 (25.03)	0.97 (0.81–1.16)	—
Activity					
Socializing	50 (100)	424 (21.27)	289 (29.89)	1.67*** (1.40–1.99)	0.91 (0.68–1.21)
Study/read/work	50 (100)	518 (25.99)	204 (21.10)	0.78^ (0.65–0.94)	0.86 (0.62–1.19)
TV/hobby/phone	50 (100)	519 (26.04)	281 (29.06)	1.23* (1.03–1.46)	1.01 (0.77–1.33)
Exercise/walking	38 (76)	64 (3.21)	69 (7.13)	2.39*** (1.68–3.38)	0.78 (0.46–1.33)
Sleeping	49 (98)	365 (18.31)	15 (1.55)	0.07^^^ (0.04–0.13)	0.11^^^ (0.05–0.21)
Other	49 (98)	295 (14.80)	173 (17.89)	1.30* (1.06–1.60)	0.85 (0.61–1.18)
Others smoking	50 (100)	119 (5.97)	184 (19.03)	3.93*** (3.07–5.04)	2.66*** (1.93–3.66)
Smoking permitted[b]	49 (98)	449 (22.53)	412 (47.03)	3.26*** (2.75–3.87)	2.19*** (1.68–2.86)
Consumption					
Alcohol[b]	35 (70)	40 (2.01)	33 (3.77)	1.94** (1.21–3.12)	0.94 (0.51–1.72)
Coffee[b]	28 (56)	58 (2.91)	29 (3.31)	1.15 (0.73–1.81)	—
Soda[b]	40 (80)	356 (17.86)	262 (29.91)	1.99*** (1.65–2.40)	1.10 (0.87–1.39)
Marijuana[b]	17 (34)	34 (1.71)	20 (2.28)	1.36 (0.77–2.38)	—
Meal/snack[b]	50 (100)	739 (37.08)	396 (45.20)	1.45*** (1.23–1.70)	1.10 (0.89–1.35)
Ongoing stressor[b]	43 (86)	262 (13.15)	152 (17.35)	1.38** (1.10–1.71)	1.56** (1.16–2.09)
New stressor[b]	48 (96)	224 (11.24)	107 (12.21)	1.09 (0.85–1.39)	—

Note. [a] Only antecedents that were significantly associated with smoking in univariate models were included in the multivariate model.

[b] Item not included in quick smoke interview. Smoking occasions percentage based on 876 presmoking interviews.

*p < .05 (positive); **p < .01 (positive); ***p < .001 (positive); ^p < .05 (negative); ^^p < .01 (negative); ^^^p < .001(negative).

often occurs in the context of parties or in settings where alcohol is being consumed (Acosta et al., 2008). The relationship between food and soft drink consumption and smoking could not be accounted for by the presence of caffeine (analyses not shown). However, smokers early in their smoking histories may be developing associations among consummatory processes. Specifically, these smokers may be learning to associate the consumption of food and drink with the consumption of nicotine, perhaps through a priming of appetitive behavioral processes. One alternative is that consumption of other substances enhances the enjoyment of cigarettes. For instance, alcohol consumption has been associated with reports of cigarettes tasting good (Piasecki, McCarthy, Fiore, & Baker, 2008). Alternatively, the effects of nicotine may reinforce associated behaviors, such

as consumption of food and drink, thereby making smoking more likely in these situations (Chaudhri et al., 2006). Though not directly assessed, our findings may represent either or both mechanisms or simply the fact that smoking and other consummatory behaviors are opportunistic, filling parts of the day with no competing obligations.

The strongest association observed was between recently inhabiting an outside location and smoking. Additionally, exercising or walking was also strongly associated with smoking, suggesting that behavioral transitions are positively associated with smoking. In contrast, recently being in class or in a dormitory and studying or reading were associated with decreased frequency of smoking. These findings suggest a complex mix of smoking prohibitions and

Table 3. Subjective states and their relations to smoking

Predictor	M (SD)	OR (95% CI)	Percentage of smoking records if average score[a]			
			0	0–1	1–2	>2
Negative affect	1.01 (1.98)	0.96^ (0.92–1.00)	32.1	28.4	28.7	27.2
Positive affect	2.32 (2.76)	0.98 (0.95–1.01)	31.2	32.2	31.7	27.2
Withdrawal	2.55 (3.59)	0.98 (0.96–1.00)	32.2	31.0	29.2	24.3
Perceived stress	2.58 (3.11)	0.97 (0.95–1.00)	31.1	34.2	26.3	29.7
Craving	2.36 (2.92)	1.32*** (1.29–1.36)	14.9	34.7	51.2	66.7

Note. [a]The number of total records in score categories 0, 0–1, 1–2, and >2, respectively, for each subjective state was as follows: negative affect: 1,948, 497, 279, and 147; positive affect: 1,260, 484, 678, and 449; withdrawal: 1,240, 1,042, 415, and 173; perceived stress: 1,133, 851, 651, and 232; and craving, 1,396, 620, 690, and 165.

***$p < .001$ (positive), ^$p < .05$ (negative).

opportunistic factors and are consistent with those of Shiffman and Paty (2006) who found that chippers were more likely to smoke in idle situations versus while working.

Consistent with recent EMA studies, we did not find that students were more likely to smoke when experiencing negative affect (Krukowski et al., 2005; Shiffman et al., 2004). In fact, negative affect was associated with slightly decreased likelihood of smoking, suggesting that subjective dsyphoria had a mildly inhibitory effect on smoking. However, smokers' motivation for smoking a cigarette as a desire to "cope with negative emotion" was significantly related to concurrent levels of negative affect. This suggests that although smoking is not a reliable concomitant of negative affect, the smoking that does occur during periods of elevated negative affect is frequently attributed to negative affect. We also found that the presence of an ongoing stressor was associated with smoking. This finding, taken together with the lack of association between smoking and negative affect, seems consistent with the negative reinforcement model posited by Baker, Piper, McCarthy, Majeskie, and Fiore (2004) in which self-administration is cued by interoceptive inklings of affect, potentially staving off mood deterioration before it becomes strong enough to influence conscious self-reports.

Consistent with other EMA studies, the only subjective state positively associated with smoking was craving (Carter et al., 2008; Piasecki et al., 2007; Shiffman et al., 2002, 2004). It should be noted, however, that participants were provided with a limited number of response options indicating subjective states and motives for smoking and were not presented with options assessing sensory enjoyment or social enhancement motives among others. The role of craving as a predictor of smoking episodes in this sample of relatively light smokers suggests that craving emerges early in the smoking careers of these students as an internal cue for smoking. Among nondaily smokers, craving significantly predicted smoking, indicating that urge to smoke is present and significant even among smokers whose smoking is under greater stimulus control. The lack of association of withdrawal with smoking may reflect the fact that these individuals have not progressed sufficiently along the path to dependence for negative subjective states, such as withdrawal to emerge or to serve as significant motivators for smoking behavior. Alternatively, consistent with the negative reinforcement model of addiction outlined by Baker et al. (2004), this finding may suggest that daily smokers have already learned to efficiently manage their withdrawal symptoms such that they are able to avoid the experience altogether rather than escape once it has begun.

There were few significant interactions between antecedents and daily smoking. However, the nature of the few significant interactions depicted in Table 4 consistently indicated less cue control over smoking among daily smokers relative to nondaily smokers. The transition to daily smoking may be characterized by the weakening of inhibitions and the dispersion of smoking across varied situations.

Limitations

There were several limitations of this study that warrant note. First, participants did not respond to all random prompts, and it can reasonably be assumed that not all participants completed interviews for all cigarettes smoked. Underreporting could have resulted in bias in the data. For instance, we found that smoking was less likely to take place on weekends, which is inconsistent with prior research with college smokers. This finding could be accounted for by noncompliance occurring disproportionately more often on weekends. There is no way to assess this directly given the constraints of the data. Second, participants may have found some of the wording of items confusing. For instance, questions regarding decisions to smoke could be difficult to interpret if they refer to times when participants were sleeping and therefore not able to make decisions about smoking. Third, random prompts were not scheduled between the hours of 10 p.m. and 8 a.m., and there are consequently no controls for smoking records during this timeframe. The decision to forego random prompts during this timeframe was based on the assumption that many college students live in shared living spaces, which frequently include shared sleeping spaces. It was decided that including random prompts after 10 p.m. would not only create assessment burden for participants but those with whom they lived as well. Investigation of antecedents of smoking behaviors during this timeframe are important targets of future protocols, and their exclusion from this study is a substantial limitation. Fourth, the strong association found between inhabiting an outside location and the decision to smoke may be a function of the restrictive smoking environment on this particular college campus. Whereas indoor smoking restrictions are becoming increasingly common, it cannot be assumed that these findings generalize to other community settings. Fifth, this study was cross-sectional not developmental in design. All smokers in this sample had

	Table 4. Interactions between antecedent variables and daily smoking status		
	Predictor × Daily Smoking	Nondaily smokers	Daily smokers
Predictor	*OR* (95% *CI*)	*OR* (95% *CI*)	*OR* (95% *CI*)
Time of day			
8–11 a.m.	—		
11 a.m.–2 p.m.	0.93 (0.46–1.88)		
2–6 p.m.	0.90 (0.45–1.79)		
6–10 p.m.	0.87 (0.43–1.74)		
Weekend	0.93 (0.57–1.53)		
Location			
Dormitory	0.94 (0.59–1.49)		
Other locations	1.21 (0.73–2.01)		
Home	1.48 (0.87–2.53)		
Outside	1.21 (0.70–2.09)		
Class	3.48* (1.20–10.10)	0.25^^ (0.09–0.69)	0.86 (0.64–1.16)
Others home	0.33^ (0.16–0.69)	2.87** (1.48–5.57)	0.16 (0.73–1.37)
Bar/restaurant	0.74 (0.11–4.84)		
Social contacts			
Friends	0.78 (0.51–1.18)		
Alone	0.96 (0.62–1.47)		
Family	0.66 (0.21–2.05)		
Other persons	1.58 (0.97–2.59)		
Activity			
Socializing	0.73 (0.46–1.16)		
Study/read/work	1.43 (0.83–2.45)		
TV/hobby/phone	0.75 (0.47–1.19)		
Exercise/walking	1.39 (0.60–3.22)		
Sleeping	0.94 (0.20–4.32)		
Other	1.05 (0.62–1.78)		
Others smoking	0.33^^^ (0.19–0.58)	9.77*** (6.11–15.62)	3.30*** (2.45–4.45)
Smoking permitted	0.43^^^ (0.28–0.68)	5.94*** (3.91–9.02)	2.55*** (2.12–3.07)
Consumption			
Alcohol	0.52 (0.15–1.73)		
Coffee	1.24 (0.41–3.75)		
Soda	1.07 (0.62–1.83)		
Marijuana	0.54 (0.10–3.03)		
Meal/snack	0.91 (0.59–1.41)		
Ongoing stressor	0.51^ (0.30–0.86)	2.34** (1.45–3.80)	1.15 (0.90–1.47)
New stressor	0.87 (0.49–1.55)		
Subjective states			
Negative affect	1.01 (0.92–1.11)		
Positive affect	1.04 (0.96–1.12)		
Withdrawal	1.02 (0.97–1.07)		
Perceived stress	0.95 (0.89–1.01)		
Craving	0.98 (0.90–1.06)		

Note. Models predict smoking from antecedent, daily smoking status, and antecedent × daily smoking status interaction.

*$p < .05$ (positive); **$p < .01$ (positive); ***$p < .001$ (positive); ^$p < .05$ (negative); ^^$p < .01$ (negative); ^^^$p < .001$ (negative).

relatively short tobacco use histories, and therefore, no developmental inferences can be drawn from these data. Finally, this study comprised a relatively small sample of smokers drawn from one residential college campus, few of whom were nondaily smokers, thereby limiting the generalizability of findings.

Overall, however, strengths of this study include the use of real-time assessments of behavioral, situational, and emotional antecedents of smoking through use of EMA. Specifically, fleeting subjective states and motives for smoking are perhaps most accurately assessed with real-time methods. Additionally, our

sample included smokers relatively early in their smoking careers, offering valuable information about the role of various antecedents of smoking among this population.

Our results suggest that in a sample of college students, smoking appears to be largely opportunistic and under substantial stimulus control. However, craving emerged as the strongest predictor of smoking behavior among the internal states assessed. Furthermore, as smokers progress to daily smoking, it appears that stimulus control erodes, and smoking may become more routinized. Our findings are consistent with data from

older heavier smoking samples in pointing to craving as the most robust subjective antecedent of ongoing smoking.

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Declaration of Interests

None declared.

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