Original investigation

Affective and Situational Precipitants of Smoking Lapses Among Adolescents

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Abstract

Introduction: Most adolescent smokers report a desire to quit, and many have made several unsuccessful quit attempts; however, when adolescents attempt to quit, they often resume smoking quickly. This ecological study aimed to (1) characterize affective and situational precipitants of smoking lapses among adolescents and (2) explore the moderating influence of nicotine dependence severity on lapse precipitants.

Methods: Adolescent daily smokers ($n = 166$; ages 14–18 years) completed electronic diaries of cigarettes smoked, craving and affective states, and situational variables on handheld computers in their natural environment for 2 weeks following an unassisted quit attempt. On average, adolescents were moderately nicotine dependent (Modified Fagerström Tolerance Questionnaire [mFTQ] score = 4.9; SD = 1.6).

Results: Craving was a significant episodic cue for lapse and stable influence on lapse, relating to 44% and 15% increased odds of lapse, respectively. High-arousal affective states—regardless of valence—were associated with 12%–13% increased odds of lapse. Low-arousal positive affective states were associated with 17% decreased odds of lapse. A 1-unit difference in a teen's mFTQ score related to 27% increased odds of lapse, but dependence severity did not moderate proximal lapse influences.

Conclusions: This report provides some of the first ecological data characterizing adolescent smoking lapses following a quit attempt. As in prior work with teens, lapses were nearly universal and quickly followed the quit attempt. Specific situational and affective contexts of smoking lapses for adolescents were implicated, indicating the need for cessation interventions to address craving and high-arousal affective states as precipitators of lapse in this high-risk group.

Implications: This report provides some of the first ecological data characterizing smoking lapses among teens attempting to quit smoking on their own. Like adults, adolescents face many barriers when making quit attempts. The present work provides ecological data to suggest that the experience of heightened arousal in teens' daily lives interferes with their efforts to quit smoking. Thus, this work highlights the importance of affective dysregulation, or amplitude of emotional feelings, for teen smoking lapses. Moment-to-moment fluctuation in craving was also implicated as a dynamic precipitator of smoking lapse in this high-risk group.

Introduction

Although smoking among US adolescents has declined, lowering prevalence appears to be because of a reduction in initiation of smoking rather than successful smoking cessation.¹ Unfortunately, most adolescent smokers are unlikely to seek formal cessation treatment, have limited access to treatment, and receive relatively less benefit than adults do from effective treatments.^{2,3} Yet, adolescents who smoke generally report a desire to quit, and many make repeated, unassisted, and unsuccessful quit attempts.^{4,5} Thus, understanding the factors predicting a return to smoking among adolescents who are trying to quit without treatment is a key step toward improving smoking cessation rates among adolescents.

A return to smoking following a quit attempt—commonly referred to as a “lapse”—may not result in full relapse to the same previous pattern of smoking, but is an important milestone in the quitting and relapse process in adult smokers.⁶ Influences on smoking lapses may be categorized by their temporal proximity to the reoccurrence of smoking, from distal, person differences (eg, gender, nicotine dependence, and age), to within-person episodic factors (eg, craving, acute affective changes). Social-learning models highlight the unique relevance of more proximal predictors—the emergent, high-risk situations that underlie smoking lapses following a quit attempt—as mechanisms determining unsuccessful quit efforts.⁷

This report focuses on distal and proximal lapse determinants with strong empirical and theoretical support in adults, that is, nicotine dependence, affect, and craving.^{8–10} Relevance for adolescents has received considerably less empirical attention, but these lapse precipitants are implicated in both retrospective descriptions¹¹ and ecological research with teenagers.^{12,13} The current research paired distal, person differences with real-time, ecological momentary assessment (EMA) of proximal lapse determinants in adolescents’ daily lives. Goals of this report are twofold: (1) characterize the affective and craving context of smoking lapses among adolescent smokers making an unassisted quit attempt and (2) explore the moderating influence of nicotine dependence severity on lapse precipitants. Specifically, we expected that smoking lapses would be most common at times when teens were experiencing elevated craving, heightened negative affect, or heightened arousing positive affect. Further, we anticipated that more dependent teens would be more likely to lapse in these contexts than less dependent teens.

Methods

Participants and Procedure

Adolescent smokers, recruited from the community, completed EMA reports for 3 weeks, 1 week before and 2 weeks following a quit attempt. Eligibility required: age 14–18, smoking at least 1 cigarette per day (past month) and at least 100 (lifetime), desire to quit within 6 months, strong confidence in ability and motivation to quit, ability and permission to carry a mobile device at school, no use of other tobacco or nicotine products for at least 6 of past 30 days, not enrolled in college, and no planned or active participation in formal treatments.^{14,15} This report examines the timeframe from a quit attempt to first lapse. Of 209 with smoking status biochemically verified (via carbon monoxide readings and salivary cotinine) and enrolled, 4 were not compliant with EMA, 26 did not report a quit attempt, and 13 did not report a lapse (7.3%). Thus, this report is of 166 male and female adolescent smokers who reported at least one lapse during the post-quit study phase. For those under age 18,

parental consent and participant assent were obtained. Participants could earn up to \$355 for participating in the study, including \$20 bonuses for at least 80% EMA compliance. Data were collected from 2007 to 2011, and all study methods were approved by the Brown University Institutional Review Board.

At both the first session and follow-ups, carbon monoxide and salivary samples (cotinine) were collected to verify smoking status. Participants who were abstinent at the first session (as indicated by ≤ 14 ng/ml cotinine and breath carbon monoxide levels ≤ 8) were excluded from analyses. In addition, weekly compliance cuts were made for each post-quit week based on biochemically verified abstinence. Participants who reported continuous abstinence for a post-quit week (ie, did not report a lapse) but had cotinine levels more than 14 and carbon monoxide more than 8 had their data removed for that post-quit week. This corresponded to removal of data for five participants in post-quit week 1, and no removal of data for post-quit week 2.

Before EMA, participants completed baseline questionnaires assessing demographic information and smoking-related beliefs and behaviors. On study Day 0, participants were trained to make entries on a mobile device, Teen Experience Diary (TED). Reports were both self-initiated and made in response to device-delivered audible prompts. At the Day 7 visit, participants were instructed on assessment changes that would occur when they began their quit attempt by selecting the “I’ve Quit” option on their TED. Participants were asked to begin their quit attempt when they woke up on Day 8, but they could initiate the attempt at any time after Day 8 by making an “I’ve Quit” entry on the TED. In the post-quit phase, participants had the options to indicate a “slip” (any cigarette smoked, even if only a puff) and “temptation” (an episode of increased urge to smoke with no actual smoking) with special report buttons.

Measures

Adolescents reported age at their first cigarette and number of prior quit attempts. The Smoking Timeline Follow-Back¹⁶ assessed cigarettes smoked per day and number of smoking days (in the past 30 days). The 7-item Modified Fagerström Tolerance Questionnaire (mFTQ) assessed smoking dependence.¹⁷ Scores range from 0 to 9 (0–2 = no dependence; 3–5 = moderate dependence; 6–9 = substantial dependence).

EMA reports were prompted by the device at random times; prompted by the device 1 hour after each “I’ve Quit” entry; self-initiated “temptation”; self-initiated “slip.” Motivation to quit smoking was indicated on a 0–10 scale from 0 = “Not at all” to 10 = “Extremely”. Affect items were derived from the circumplex model of affect^{18,19} along two orthogonal dimensions: valence (positive–negative) and activation (activated–deactivated). Participants responded to affective items separately (eg, “How feeling? Excited?”), using a 0–10 scale with endpoints labeled “No!!” and “Yes!!”. Responses were averaged to create four quadrants: high-arousal positive (excited, cheerful), low-arousal positive (calm, relaxed), high-arousal negative (stressed, irritable, frustrated/angry), and low-arousal negative (bored, sad). Using the same 0–10 scale, participants reported cigarette craving and motivation to quit smoking “right now.” Adolescents indicated their location and whether they were with someone (see Table 1 for descriptors). Participants also indicated what they were currently doing, with “using drugs or alcohol” as one of multiple options. If alcohol and/or drug use was indicated, follow-up items assessed whether they were using alcohol, marijuana, or other drugs. Time and date stamps were automatically

Table 1. Logistic Multilevel Models Predicting First Lapse Following an Unassisted Quit Attempt From Affective and Situational Context, as well as Person-Difference Influences

	<i>b</i>	SE	95% CI	OR	<i>p</i>
Momentary influences (Level 1)					
Presence of others					
Parent	−0.19	0.39	[−0.96 to 0.59]	0.83	.630
Sibling	0.45	0.38	[−0.33 to 1.22]	1.57	.250
Peer	0.37	0.23	[−0.09 to 0.83]	1.45	.113
Teacher	−1.77	0.55	[−2.87 to −0.67]	0.17	.002
Other	−0.34	0.34	[−1.02 to 0.33]	0.71	.312
Location					
Other	0.38	0.55	[−0.70 to 1.45]	1.46	.489
Car	0.38	0.31	[−0.23 to 0.99]	1.47	.216
Public place	0.34	0.32	[−0.29 to 0.96]	1.40	.288
Other's house	0.09	0.62	[−1.14 to 1.32]	1.10	.881
Friend's house	0.13	0.37	[−0.59 to 0.85]	1.14	.729
School	0.53	0.36	[−0.17 to 1.23]	1.69	.139
Work	−3.70	9.69	[−22.77 to 15.38]	0.02	.703
Reference is home					
Time of day					
4 to 7:59 AM	−0.66	0.61	[−1.86 to 0.55]	0.52	.283
8 to 11:59 AM	−0.69	0.59	[−1.86 to 0.48]	0.50	.246
Noon to 3:59 PM	−0.61	0.59	[−1.77 to 0.54]	0.54	.296
4 to 7:59 PM	−1.27	0.61	[−2.48 to −0.06]	0.28	.040
8 to 11:50 PM	−1.59	0.70	[−2.97 to −0.21]	0.20	.024
Reference midnight to 3:59 AM					
Weekend	−0.41	0.24	[−0.91 to 0.09]	0.66	.099
Alcohol, marijuana, or other drug	0.90	0.36	[0.20 to 1.60]	2.47	.011
Cigarette craving	0.36	0.06	[0.24 to 0.48]	1.44	<.001
Affect					
High-arousal positive (cheerful, excited)	0.12	0.06	[0.01 to 0.24]	1.13	.033
Low-arousal positive (relaxed, calm)	−0.18	0.05	[−0.29 to −0.08]	0.83	.001
High-arousal negative (stressed, irritable, angry)	0.12	0.06	[0.01 to 0.23]	1.12	.042
Low-arousal negative (bored, sad)	−0.08	0.06	[−0.20 to 0.04]	0.93	.209
Person-difference influences (Level 2)					
Smoking dependence	0.24	0.07	[0.10 to 0.38]	1.27	.001
Age	0.13	0.10	[−0.06 to 0.32]	1.13	.192
Female gender	−0.02	0.22	[−0.47 to 0.42]	0.98	.912
Average craving	0.14	0.06	[0.01 to 0.27]	1.15	.033
Average high-arousal positive	−0.09	0.06	[−0.21 to 0.04]	0.92	.180
Average low-arousal positive	0.05	0.07	[−0.09 to 0.19]	1.05	.471
Average high-arousal negative	−0.05	0.07	[−0.19 to 0.08]	0.95	.444
Average low-arousal negative	0.18	0.07	[0.04 to 0.32]	1.20	.010

b = unstandardized estimate; CI = confidence interval; OR = multivariate, adjusted odds ratio; SE = standard error of the estimate. Presence of other categories was not mutually exclusive, and thus each is included without a reference group. Continuous, time-invariant predictors (ie, smoking dependence, age, average craving, and average affect) were centered at the grand mean; all other continuous predictors were time-varying and were centered at the person mean. Bold typeface indicates significant results, *p* < .05.

recorded by the TED and used to create time of day categories and identify weekend reports (Friday through Sunday).

Analytic Plan

Logistic, multilevel models accounted for nested data because of participants (Level 2) making multiple TED reports (Level 1). Analyses were implemented using SAS software, version 9.3 (SAS Institute Inc., 2012), with residual pseudolikelihood estimation and Laplace approximation. First lapse reports (coded as 1, *n* = 166) were compared with all preceding quit-attempt, temptation, and nonsmoking

assessments (coded as 0; referred to collectively herein as non-lapse reports, *n* = 1,108). Level 2 effects for craving and affect were disaggregated momentary changes in craving and affect (Level 1) from person averages (Level 2). Smoking dependence was evaluated as a putative moderator of the relation from craving and affect to lapse likelihood through the inclusion of cross-level interactive effects. (Table 1 lists covariates). Before analysis, all continuous, momentary (Level 1) effects were person-mean centered to model deviations from one's own average score, and all continuous, person (Level 2) effects were grand-mean centered.

Results

Participants were 166 adolescents ($n = 60$ female) aged 14–18 ($M = 16.6$, $SD = 1.2$). Ten adolescents indicated Hispanic or Latino ethnicity. Adolescents primarily identified as white ($n = 138$), with 3 black, 1 Asian, 6 other, and 18 indicating more than one racial identity. Age at first smoking ranged from 9 to 17 years ($M = 13.1$, $SD = 1.7$), with two prior quit attempts, on average ($SD = 2.2$; range = 0–20). Average cigarettes per day ranged from 2 to 30 ($M = 11.3$, $SD = 5.6$), and average smoking dependence levels were moderate (M mFTQ score = 4.9, $SD = 1.6$; range = 1–8).

TED reports used for analyses included 166 quit reports; 602 reports prompted by the device at random times; 127 reports prompted by the device 1 hour after each “I’ve Quit” entry; 213 self-initiated “temptation” reports; and 166 self-initiated “slip” reports. In addition, the TED recorded when a device-delivered random prompt was missed ($n = 120$). Thus, 729 (85.9%) of 849 potential random prompts were completed.

The average latency from a quit report to the first lapse report was 21.1 hours ($SD = 34.2$; range = 0.01–206.1; median = 8.2 hours). Despite the rapid progression to a first lapse, several indicators suggested that participants were making a valid quit attempt. First, motivation to quit smoking was high during the pre-quit period ($M = 7.7$, $SD = 2.3$) and during the post-quit period preceding a first lapse ($M = 8.1$, $SD = 2.1$). Second, 90 adolescents (54.2%) initiated at least one temptation report before their first lapse ($M = 5.5$, $SD = 5.7$ temptation reports post-quit and $M = 2.4$, $SD = 2.3$ before first lapse). Finally, the average latency from waking to first cigarette of the day during the pre-quit period was 3.3 hours ($SD = 3.6$), whereas the average latency to first cigarette of the day during the quit attempt was 5.8 hours ($SD = 4.5$). For participants who ended their quit attempt, the average latency reverted back to 3.3 hours ($SD = 4.1$).

Alcohol and/or drug use was indicated for 4.4% of non-lapse reports ($n = 49$) and 11.4% of first lapse reports ($n = 19$). The majority of times where alcohol and/or drug use was indicated involved marijuana use ($n = 56$), with 14 reports indicating alcohol use and 5 indicating other drug use. Concurrent use was indicated in five reports, with two of these indicating uses of all three categories: alcohol, marijuana, and other drugs.

Table 1 summarizes results of logistic multilevel models comparing first lapse reports to non-lapse reports. Figure 1 illustrates model-based (empirical Bayes) predicted probabilities of lapse at varying levels of in-the-moment craving and affective states. Momentary (Level 1) craving and high-arousal affective states (both positive and negative) were significantly and positively associated with increased odds of lapse, $ORs = 1.13$ and 1.12 , respectively, indicating a 12%–13% increase in the odds of lapse, for each 1-unit increase in the focal predictor. In contrast, low-arousal positive affect was associated with reduced odds of lapse, $OR = 0.83$, $p = .001$, indicating a 17% reduction in the odds of lapse for each 1-unit increase in low-arousal positive affect (ie, relaxed and calm), whereas low-arousal negative affect was unassociated with lapse, $p = .209$. These momentary effects remained significant after accounting for person-average (Level 2) affective experiences, and a range of Level 1 contextual influences, including the presence of others, location, and time of day. Severity of smoking dependence was a significant person-level influence, representing a 27% increase in the odds of lapse for each 1-unit increase in mFTQ score, $OR = 1.27$, $p = .001$, but did not significantly moderate the influences of craving or affective states on lapse, $ps > .313$.

Discussion

This report characterized precipitants of adolescent smoking lapses following an unassisted quit attempt. As in prior work with teens, lapses quickly followed the quit attempt (within the first 24 hours) and were nearly ubiquitous (92.7% of teens who were enrolled and compliant with study procedures). Although research on adolescent lapse is limited, nicotine dependence, affect, and craving have been implicated as potential lapse precipitants in extant retrospective¹¹ and ecological studies.^{12,13} Craving and high-arousal affective states (both positively and negatively valenced) were associated with increased odds of lapse and were influential on lapse after accounting for exteroceptive stimuli (eg, location and present company) and person-difference predictors (eg, age and gender). In contrast, low-arousal positive affective states were protective against lapse, and low-arousal negative affective states were not influential. Although smoking dependence increased the overall likelihood of lapsing, it did not moderate affect-lapse associations.

Figure 1. Model-based (empirical Bayes) predicted probabilities of lapse at varying levels of momentary craving and affective states.

This study had several strengths. By pairing measures of distal, person-difference level factors with EMAs of proximal lapse determinants, we could explore cross-level influences on smoking lapses in adolescents. Further, where emotional valence (ie, positive, negative) and arousal (ie, high, low) are nearly universally conflated in assessments of affective smoking precipitants to date, we disaggregated affect into four categories reflecting the crossing of valence and arousal dimensions. Thus, this work advances understanding of the relative importance of arousal over valence, including positive arousal, which has received considerably less empirical attention than negative arousal. Where our prior findings highlighted positive affect enhancement as a potentially underutilized target for increasing youths' confidence in their ability to abstain from smoking,¹⁴ the present work elucidates the role of positive arousal (ie, excited and cheerful) for heightening lapse risk, even after accounting for known social influences.¹⁵

This study builds on only a handful of studies using EMA to understand adolescent smoking lapse. That momentary craving predicted lapse aligns with research examining craving at the daily level.¹² Our findings also linked dependence severity to increased odds of lapse among adolescent daily smokers, consistent with a study of adolescent, lighter smokers,¹³ but inconsistent with findings from a sample of daily smokers.¹² However, Van Zundert et al.¹² analysis of Dutch adolescents required 24 hours of abstinence, whereas our analysis of lapse included all lapse events since initiation of the quit attempt. The most dependent smokers may not have achieved a full day of abstinence, thus truncating the upper end of variability in smoking dependence.

In addition to strengths, the results of this study should be viewed in light of its limitations. Our finding that dependence did not moderate affect-lapse associations is inconsistent with prior, retrospective work with youth¹¹ and theory that smoking-motivation processes shift as dependence progresses.⁸ Analyses were cross-sectional with regard to dependence severity, however, and future studies implementing longitudinal designs and evaluating other aspects of affect (eg, variability) may produce different results.²⁰ Although EMA is intensively longitudinal (often over a period of weeks), imbedding EMA protocols within longitudinal designs in the traditional sense (over a period of months or years) is an exciting new direction for future work. Another limitation is the assessment of only combustible tobacco product use, which excludes electronic nicotine delivery systems. In addition, EMA reports did not ask participants to confirm the amount of time that had passed since the lapse and completion of the lapse report, and data were not collected at follow-up on how timely participants were in reporting these self-initiated events. Despite these limitations, this study is key to building a body of work examining distal and proximal influences in dynamic models of adolescent smoking relapse.

Adolescents face many major barriers when attempting to quit smoking, including restricted access to evidence-based, effective treatments and limited treatment results. In addition, this work suggests that the cessation efforts of teens who attempt to quit on their own are impeded by craving for cigarettes and in-the-moment heightened arousal. Craving findings point toward a particular need for enhanced craving-reduction treatment approaches for adolescents, with craving implicated both as a dynamic, episodic cue preceding lapse and as a static lapse determinant over a longer period of time. Our finding that high arousal, regardless of positive or negative valence, related to smoking lapse is a novel contribution that highlights the importance of affective dysregulation, or amplitude of emotional feelings, as a risk factor for adolescent lapse. Indeed, both positive and negative pathways to emotion-based rash action

are strongly implicated in substance-based impulsivity more generally.^{21,22} Further, emotional dysregulation is characteristic of adolescents with escalating smoking patterns or progressing dependence symptomatology.^{20,23} Thus, these findings suggest clinically meaningful value added for integrating content relevant to managing emotionally charged smoking precipitants to existing intervention strategies.

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Declaration of Interests

None.

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