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Original Investigation

Adolescents' Smoking Outcome Expectancies and Acute Emotional Responses Following Smoking

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Abstract

Introduction: Magnitude of mood change following smoking may be an important reinforcing effect in smoking escalation in adolescent smokers. This study used ecological momentary assessments (EMA) of adolescent smokers' reports of mood during smoking events to examine (a) whether global reports of negative affect (NA) expectancies were associated with in-the-moment magnitude of negative and positive mood change following smoking, (b) the possibility of a reciprocal feedback loop between global NA expectancies and acute mood change following smoking, and (c) whether this relationship generalizes to other expectancies and mood change.

Methods: Participants were 234 9th and 10th graders (54% female) who recorded at least one smoking event during 7 days of EMA data collection.

Results: Global reports of NA expectancies were significantly associated with the in-the-moment magnitude of changes in mood following smoking. Specifically, higher NA expectancies were associated with greater decreases in negative and greater increases in positive mood. Additionally, mood change following smoking predicted changes in NA expectancies but only for adolescents who continued to smoke 6 months later. The reciprocal feedback loop between expectancies and mood change was only present in adolescent smokers who continued to smoke over time. Findings indicated that this relationship is specific to NA expectancies and negative and positive mood change.

Conclusions: These results highlight the importance of considering NA expectancies and mood changes following smoking in adolescent smokers. Assessing expectancies about NA relief may provide an opportunity for identifying and intervening on adolescents who may be most at risk for continuing to smoke.

Introduction

Theoretical, empirical, and anecdotal reports suggest that cigarette smoking is reinforcing, and mood benefits following smoking may be an important factor for smoking escalation and dependence (Eissenberg and Balster, 2000; Mermelstein, Hedeker, and Weinstein, 2009). In a prospective study of adolescent smokers, Mermelstein, Hedeker, Flay, and Shiffman (2007) found that adolescents who progressed in smoking were the ones who got substantial in-the-moment mood benefits following smoking; adolescents who tried smoking but did not continue in their smoking failed to receive any acute mood benefits following smoking. In a separate sample of adolescents, Mermelstein et al. similarly found that greater magnitude of mood responses (both increased positive and decreased negative) following smoking predicted smoking escalation. However, there is relatively little research focusing on factors that influence adolescents' subjective mood experiences following smoking in real-world contexts. The purpose of this study was to examine whether global negative affect (NA) expectancies influence in-the-moment subjective mood experiences following smoking. We hypothesized that an adolescent's global expectancies about the negative mood-enhancing properties of smoking would predict the acute magnitude of subjective mood responses to smoking.

Adolescent smokers commonly report smoking when they are experiencing negative moods (Chassin et al., 1981; Kassel et al., 2007) and report that they expect that smoking will decrease the intensity of those negative moods (Brandon and Baker, 1991; Copeland, Brandon, and Quinn, 1995). More recently, positive mood states have been implicated as factors for adolescent smoking (Kassel et al.; Mermelstein et al., 2009). Evidence is accumulating that cigarette smoking may produce acute subjective changes in both positive and negative moods among adolescents (Hedeker, Mermelstein, Berbaum, and Campbell, 2009; Hedeker, Mermelstein, and Demirtas, 2008; Kassel et al.; Kassel, Stroud, and Paronis, 2003; Mermelstein et al.). An important question is not only whether smoking alleviates negative mood or increases positive mood but also for whom does it happen and why. The effects of smoking on mood change may vary by a variety of individual difference factors (Eysenck and Graydon, 1989; Gilbert and Gilbert, 1995), and identifying factors that predict the magnitude of the acute mood change following smoking may help predict smoking escalation.

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An adolescent's expectancies about the effects of smoking may be one individual difference factor that influences the magnitude of subjective response to cigarette smoking. Expectancies about the effects of smoking are consistently correlated with smoking behavior in adolescents (Chassin et al., 1981; Chassin, Presson, Sherman, Corty, and Olshavsky, 1984; Hine, McKenzie-Richer, Lewko, Tilleczek, and Perreault, 2002; Wahl, Turner, Mermelstein, and Flay, 2005). However, most of the research on expectancies and smoking have focused on initiation and cessation (e.g., Chassin et al.; Wahl et al.), with less research on how global expectancies may influence the acute reinforcing effects of mood change following smoking.

Outcome expectancies and behavior may also reinforce each other since expectancies reflect an individual's experience with a substance. For example, in the alcohol literature, Smith, Goldman, Greenbaum, and Christiansen (1995) found that expectancies and adolescent alcohol use influenced each other in a reciprocal positive fashion: initial positive alcohol expectancies were correlated with acute increased alcohol consumption and subsequent drinking was correlated with stronger expectancies about the benefits of alcohol use. However, in a longitudinal study of alcohol use and positive alcohol expectancies, Ouellette, Gerrard, Gibbons, and Reis-Bergan (1999) found that adolescents' own past alcohol consumption did not have a direct effect on later expectancies. To date, there are no studies examining the feedback loop between global expectancies and the reinforcing effects of in-the-moment mood change following smoking in adolescent smokers. As adolescents experiment with smoking, they are likely to learn directly about the effects of smoking, and expectancies about the mood-enhancing benefits of smoking may be either strengthened or diminished.

The purpose of the current study was to use ecological momentary assessment (EMA) to test whether global expectancies about the mood benefits of smoking were associated with the magnitude of in-the-moment positive and negative mood change following smoking while controlling for covariates. The current study also examined the possibility of a reciprocal feedback loop between NA expectancies and mood change following smoking in adolescents. In addition, we tested the specificity of this hypothesized relationship by examining similar models with boredom relief expectancies and changes in bored mood following smoking. Covariates considered included current level of smoking, since smoking level is a likely contributor to individual differences in expectancies (Piasecki, Richardson, and Smith, 2007), with greater use predicting higher expectancies (Martens and Gilbert, 2008). We considered level of nicotine dependence as another covariate to account for an alternative possible explanation of the relationship between expectancies and mood change, such as a general smoking "drive" (Shiffman, Waters, and Hickcox, 2004). Additionally, parental history of smoking may also influence both expectancies and level of subjective mood effects from smoking both through socialization and potential genetic influences on nicotine sensitivity.

Methods

Overview

Data for this study come from a longitudinal study of smoking among adolescents ("Social-Emotional Contexts of Adolescent Smoking Patterns," $N = 1263$). The longitudinal study utilized a multimethod approach to assess many components of adolescent smoking at 5 time points: baseline, 6, 15, 24, and 33 months. All adolescents completed extensive self-report questionnaires and in-depth interviews at each measurement wave, and subsets of adolescents completed EMA, videotaped family discussions, and laboratory-based psychophysiological assessments. Data for the current study include baseline, 6-month, and 15-month data from the subset of adolescents who participated in the EMA portion of the study.

Participants

Participants for this study were initially recruited from a pool of 9th and 10th grade students ($N = 12{,}970$) from 16 Chicago suburban–metropolitan area schools. Students were eligible to participate in the longitudinal study if they fell into one of four levels of smoking experience: (a) never-smokers, (b) former experimenters (smoked at least one cigarette in the past, have not smoked in the last 90 days, and have smoked fewer than 100 cigarettes in their lifetime), (c) current experimenters (smoked in the past 90 days, have smoked between 20 and 99 cigarettes in their lifetime, but were not yet daily smokers), and (d) regular smokers (smoked in the past 30 days and have smoked more than 100 cigarettes in their lifetime but smoked 5 or less cigarettes/day). Of the participants screened, 11,718 (90.3%) met inclusion criteria for the larger parent study based on smoking history and patterns and 3,695 of these (31.5%) were invited to participate in the longitudinal study. Of those who were invited, 1,344 were willing to participate and 1,263 completed the baseline measurement wave. Agreement to participate did not vary by smoking history, race/ethnicity, or parental smoking, but girls were slightly more likely to agree to participate than boys. The students were enrolled into the longitudinal study after written parental consent, and student assent was obtained.

Participants for the current study were comprised of a subset of the participants from the overall longitudinal study invited to participate in the EMA study ($n = 461$). To be eligible for the EMA portion of the study, participants must have reported ever smoking within the past 12 months. Of those invited to participate in the EMA study, 92% agreed and enrolled. There were no significant differences between those who participated and nonparticipants on any demographic or smoking-related variables. To be included in the current analyses, examining the acute mood effects following smoking, participants had to record at least one EMA smoking event at baseline ($n = 234$). Approximately half of the participants in the current study were females (54%; $n = 127$); 47% were in 9th grade at baseline ($n = 111$), and 53% were in 10th grade at baseline ($n = 123$). At baseline, participants ranged in age from 14 to 17 years ($M = 15.7$, $SD = 0.62$). In terms of race/ethnicity, participants were Caucasian ($n = 140$, 60%), Hispanic ($n = 51$, 22%), African American ($n = 30$, 13%), Asian/Pacific Islander ($n = 5$, 2%), or Other ($n = 8$, 3%).

Procedures

Participants filled out "Paper and Pencil" questionnaire measures at baseline, 6 months, and 15 months. Participants received $20 for completion of each wave of questionnaire data.

Approximately one week later, selected participants partook in the EMA portion of the study. Participants were trained to

use the EMA device, a palmtop computer, before data collection for each measurement wave. Participants carried the device for 7 consecutive days each wave. The EMA device randomly prompted the participants approximately five times per day to answer questions about their mood, activity, companionship, presence of other smokers, where they were, and other behaviors (e.g., alcohol and drug use) immediately before the prompt. Additionally, participants event recorded smoking (immediately after a participant smoked, even a puff) and nonsmoking episodes (an occasion when the participant had the opportunity to smoke and decided not to or an opportunity when the participant wanted to smoke but did not have the opportunity to do so). The event-recorded smoking interview included the same questions as the random prompt with additional questions about participants' mood just prior to smoking, as well as specific questions about smoking (e.g., "Did you inhale deeply into lungs?"). Participants also had the option to "suspend" the random prompt function during situations if they could not attend to a prompt (e.g., during an exam and driving). The EMA device was turned off at night. Participants were paid $40 at the end of the baseline EMA data collection week and $50 at the end of the 6- and 15-month data collection weeks. The current study used EMA data from the event-recorded smoke episodes at baseline and 6 months only.

Measures: Questionnaire Measures

Demographics

Demographic information included gender and race/ethnicity.

Smoking Expectancies

Global smoking expectancies were measured with three subscales from the Smoking Expectancies scale, developed and validated on adolescents (Wahl et al., 2005) and originally based on the Smoking Consequences Questionnaire of Brandon and Baker (1991) . Respondents indicated their agreement with a series of 10 questions regarding smoking; sample questions include "When I'm feeling down, a cigarette can really make me feel good." Responses were made on a 4-point scale from 1 (disagree) to 4 (agree). The current study used the Negative Affect Management subscale (four items) and the Boredom Relief subscale (three items); the weight control subscale was not included in this study. Subscale scores were created by averaging the individual items within each subscale (coefficient α values > .91).

Nicotine Dependence

Nicotine dependence was measured with 10 items of the Nicotine Dependence Syndrome Scale (NDSS; Shiffman et al., 2004) and modified for use with adolescents based on input from the Tobacco Etiology Research Network (Nichter, Nichter, Thompson, Shiffman, and Moscicki, 2002). The full NDSS was reduced to 10 items for the current study based on psychometric analyses conducted on an adolescent sample from a previous study (Sterling et al., 2009), with items primarily reflecting the Drive/Tolerance subscale items of the original NDSS. Sample items include "Compared to when I first started smoking, I need to smoke a lot more now in order to be satisfied." Items in the current study were answered on a 4-point Likert-type scale ranging from 1 (not at all true) to 4 (very true). Scale scores were obtained by averaging responses to all items. The modified version demonstrated strong internal consistency with the current sample (coefficient $\alpha = .93$).

Number of Biological Parent Ever-Smokers

Adolescents were asked whether the participant's biological mother and/or father smoke cigarettes, are ex-smokers, or have never smoked. The number of biological parents who smoke was formed by combining parental ex-smoker and parental current smoker into one category and ranges from 0 to 2.

Current Smoking Behavior

For the current study, current smoking was assessed with number of days smoked in the past 30 days (nine ordinal response categories) and number of cigarettes smoked on the days smoked during the past 30 days.

Measures: EMA

Change in Mood

For each smoking event recorded on the EMA, participants first rated their mood "right now" (immediately postsmoking) on a 10-point scale (with a visual ladder) for a series of 17 adjectives. After completing all their "now" ratings, participants were asked, "Now think back to just before you smoked, how much did you feel . . ." and again rated the same set of adjectives to assess pre-event mood. Sample items included "Right now: I feel Sad" and "Before smoking: I felt Frustrated." The adjectives were selected based on prior extensive qualitative and quantitative work with similar aged adolescents (e.g., Mermelstein et al., 2007). We performed principal axis factoring, using oblimin rotation, on aggregated mood responses taken from random prompts at baseline. Factor analysis revealed that the adjectives fell into five factors: Positive Affect (Happy, Relax, Cheer, Confident, and Accepting), Negative Affect (Angry, Frustrated, Irritable, Sad, and Stressed), Tired and Bored (Tired, Bored, and Trouble concentrating), Social Isolation (Ignored, Left out, and Lonely), and Nervous/Embarrassment (Nervous and Embarrassed). The current study only includes Negative Affect, Positive Affect, and Tired/Bored factors. Changes in mood were calculated separately by creating postsmoke minus presmoke mood for each event and then averaged over the 7 days. Change in affect is a continuous scale ranging from −9 to 9. Negative numbers indicate a decrease in mood following smoking.

Results

Attrition

Of the 234 adolescents who provided EMA event-recorded smoking data at baseline, 22 participants (9.4%) did not complete the 6-month questionnaire and 37 participants (15.8%) had missing data for the expectancies questionnaire at 15 months. There were no significant differences between completers and noncompleters on gender, expectancies, mood change, nicotine dependence, or number of days smoked.

Event-Recorded Smoking Over Time

Of the 234 participants who recorded a smoke event at baseline, 128 of these also recorded a smoking event at the 6-month follow-up, while 106 recorded a smoking event at baseline only (baseline-only sample). These 128 participants who recorded a smoking event at both baseline and 6 months comprise the "extended-smoking sample" for replication analyses at 6 months. Using repeated measures analysis of variance, we examined differences between participants who provided smoke reports at

both baseline and 6 months (extended-smoking sample; $N = 128$) and those who provided smoke reports at baseline only (baseline-only sample; $N = 106$). Participants in the extended-smoking sample had higher expectancies (baseline $M = 2.58$; 6 months $M = 2.72$) than the baseline-only sample over time (baseline $M = 2.38$; 6 months $M = 2.01$; $F(1, 184) = 18.03$, $p < .001$), had higher levels of nicotine dependence (baseline $M = 1.90$; 6 months $M = 2.03$) than the baseline-only sample over time (baseline $M = 1.54$; 6 months $M = 1.31$; $F(1, 184) = 40.64$, $p < .001$), smoked more days in the last 30 days (baseline $M = 13.46$; 6 months $M = 15.48$) than the baseline-only sample over time (baseline $M = 8.75$; 6 months $M = 8.01$; $F(1, 186) = 53.58$, $p < .001$), and smoked more cigarettes/day (baseline $M = 2.61$; 6 months $M = 3.88$) than the baseline-only sample over time (baseline $M = 1.95$; 6 months $M = 2.90$, $F(1, 190) = 28.60$, $p < .001$).

Preliminary Analyses

Table 1 presents the means and standard deviations for variables over time. Post-hoc t tests comparing pre- and postsmoking moods at baseline indicated that adolescents experienced decreases in negative mood following smoking ($t(233) = 6.45$, $p < .001$) as well as increases in positive mood ($t(233) = -6.88$, $p < .001$; a similar pattern was found at 6 months) following smoking. Bivariate correlations among the baseline variables are shown in Table 2 (a similar pattern of correlations was found at 6 months).

Do Global Expectancies Correlate with Acute Magnitude of Mood Change?

Separate standard hierarchical regressions were used to examine how global NA expectancies were associated with in-the-moment positive and negative mood change following smoking. We included the following covariates: the number of biological parent ever-smokers, the number of days smoked in the last 30 days, nicotine dependence, and gender. At baseline, the full sample was included in the models; at the 6-month time point, only the subsample that provided smoke events at both baseline and 6 months was included.

NA Expectancies Predicting Magnitude of Negative Mood Change

As hypothesized, at baseline ($n = 234$), NA expectancies were significantly associated with the magnitude of negative mood change following smoking (see Table 3). Higher levels of NA expectancies were associated with a greater decrease in negative mood following smoking. None of the other variables were significant. These results were replicated with the data at 6 months using the subsample who provided EMA smoking events at both baseline and 6 months. Specifically, higher levels of NA expectancies were associated with a greater decrease in negative mood following smoking. Unlike our findings with the baseline data, gender was significantly associated with changes in negative mood following smoking such that boys had larger decreases in negative mood following smoking than girls. Additionally, having more biological parents who were ever-smokers was significantly associated with larger decreases in negative mood following smoking. Finally, among this subsample, as the number of days smoked increased, the magnitude of change in negative mood following smoking decreased.

NA Expectancies Predicting Magnitude of Positive Mood Change

As expected, at baseline, higher levels of NA expectancies were associated with a greater increase in positive mood following smoking (see Table 4), while more days smoked in the past 30 days was associated with smaller increases. The number of biological parent ever-smokers, nicotine dependence, and gender were not associated with changes in positive mood following smoking.

Analyses using the 6-month data found similar results: higher levels of NA expectancies significantly predicted larger increases in positive mood following smoking. In addition, there was an effect for gender; boys were more likely to have larger increases in positive mood following smoking than girls.

Does Acute Mood Change Predict Global NA Expectancies?

Standard hierarchical regressions were used to determine if the in-the-moment magnitude of positive and negative mood change following smoking at baseline would predict global expectancies at 6 months while controlling for baseline expectancies, the number of days smoked at baseline, gender, and nicotine dependence. Changes in neither positive nor negative mood following smoking at baseline predicted 6-month NA expectancies in either the full sample or the extended-smoking sample.

In an exploratory, post-hoc vein, we considered that expectancies might have more of a lag time in changing. Thus, we examined whether baseline mood change following smoking predicted NA expectancies at 15 months. Within the full sample ($n = 234$), changes in negative mood following smoking at baseline did not predict NA expectancies at 15 months when NA expectancies at baseline, number of days smoked, nicotine dependence, and gender were included in the model. However, among the extended-smoking subset, changes in negative mood following smoking at baseline did significantly predict future NA expectancies: greater reductions in negative mood following smoking at baseline predicted higher levels of reported expectancies at 15 months ($\beta = -.20$, $t = -2.59$, $p < .01$).

Positive Mood Change Predicting Future NA Expectancies

Within the full sample ($n = 234$), changes in positive mood following smoking at baseline did not predict NA expectancies at 15 months when expectancies at baseline, number of days smoked, nicotine dependence, and gender were included. However, when the analyses were run using the extended-smoking sample ($n = 128$), a similar pattern as seen with the negative mood change emerged. As hypothesized, greater increases in positive mood following smoking at baseline predicted higher levels of reported NA expectancies at 15 months even after controlling for gender, nicotine dependence, and baseline expectancies ($\beta = .23$, $t = 3.13$, $p < .01$).

Specificity of the Effect between NA Expectancies and Mood Change

To examine the specificity of the relationship between global NA expectancies and acute positive and negative mood change,

Table 1. Means and Standard Deviations of the Full Sample Variables Over Time

	Baseline			6 Month		
Variables	*N*	*M*	*SD*	*N*	*M*	*SD*
Nicotine dependence	232	1.74	0.82	209	1.75	0.86
Number of biological parent ever-smokers	225	1.12	0.74	202	1.08	0.77
Number of days smoked in last month	233	10.31	10.84	209	10.98	11.85
Number of cigarettes/day in the last month	234	2.15	2.52	212	2.92	4.00
Negative affect expectancies	232	2.49	0.96	209	2.44	1.01
Boredom relief expectancies	232	2.09	0.97	209	2.14	1.07
Number of EMA event-recorded smoking	234	4.88	5.94	128	5.60	6.64
Negative mood before smoking	234	3.98	2.10	128	3.77	2.16
Negative mood now	234	3.34	1.84	128	3.26	1.84
Change in negative mood	234	−0.64	1.53	128	−0.52	1.21
Positive mood before smoking	234	6.38	1.78	128	6.45	1.75
Positive mood now	234	7.06	1.63	128	6.95	1.64
Change in positive mood	234	0.68	1.51	128	0.50	1.16
Tired/bored mood before smoking	234	4.56	1.89	128	4.57	2.11
Tired/bored mood now	234	4.42	1.79	128	4.48	1.86
Change in tired/bored mood	234	−0.14	1.55	128	−0.09	1.43

we conducted separate analyses examining the association between boredom relief expectancies and changes in both boredom and negative mood following smoking. Standard hierarchical regressions were used controlling for number of biological parent ever-smokers, the number of days smoked in the last 30 days, nicotine dependence, and gender. Unlike the results with NA expectancies, boredom relief expectancies were not significantly associated with changes in either bored mood or negative mood following smoking in either the full sample at baseline or the extended-smoking sample at 6 months.

Standard hierarchical regressions were also used to examine whether either boredom or negative mood change following smoking predicted change in boredom expectancies at 15 months. Analyses controlled for baseline boredom relief expectancies, the number of days smoked at baseline, gender, and nicotine dependence. Neither negative mood change nor boredom mood change predicted boredom relief expectancies in the full sample or in the extended-smoking sample.

Discussion

The primary goal of the current study was to examine the relationship between global expectancies for NA relief from smoking and the in-the-moment magnitude of mood change following smoking among a sample of adolescent smokers. As expected, expectancies about the NA relief from smoking were positively and significantly associated with the magnitude of positive and negative mood change following smoking; adolescents who endorsed higher expectancies for NA relief experienced greater reductions in negative mood and greater increases in positive mood following smoking. This finding was consistent across both baseline and 6-month follow-ups. The 6-month data came from a subset of adolescents who smoked during the EMA data collection waves at both baseline and 6 months. The consistency of the relationship between expectancies and magnitude of mood change across time points and across both the full and the subsample speaks to the robustness of this finding. To our knowledge, these findings are the first to examine the relationship between global expectancies and in-the-moment mood change following smoking.

Table 2. Intercorrelations between Baseline Variables, Full Sample (n = 234)

Baseline variables	1	2	3	4	5	6	7
1. Change in positive mood	—						
2. Change in negative mood	−.58***	—					
3. Change in tired/bored mood	−.34***	.54***	—				
4. Negative affect expectancies	.17*	−.10	−.13*	—			
5. Boredom relief expectancies	.06	−.02	−.04	.53***	—		
6. Nicotine dependence	.09	.03	−.08	.70***	.52***	—	
7. Biological parent ever-smokers	.00	.13	.03	.07	.03	.09	—
8. Days smoked in last month	−.03	.11	−.01	.54***	.36***	.73**	.18**

Note. *$p < .05$; **$p < .01$; ***$p < .001$.

Table 3. Regression of Key Variables on Negative Mood Change

	B	*SE*	*T*	*p*
Baseline predictors, full sample ($n = 234$)				
Gender	−.10	.21	−1.55	.12
NA expectancies	−.22	.15	−2.37	.02*
Nicotine dependence	.06	.21	.54	.59
No. of biological parent ever-smokers	.10	.14	1.54	.13
No. of days smoked in last 30 days	.16	.01	1.58	.12
6-Month predictors, extended-smoking sample ($n = 128$)				
Gender	−.30	.21	−3.50	.001***
NA expectancies	−.32	.15	−2.78	.006**
Nicotine dependence	−.06	.20	−.42	.68
No. of biological parent ever-smokers	−.19	.14	−2.18	.03*
No. of days smoked in last 30 days	.31	.01	2.61	.01**

Note. Gender is coded as female = 1, male = 2; NA = negative affect; *$p < .05$; **$p < .01$; ***$p < .001$.

An advantage of the current EMA approach was our ability to assess more closely mood changes with smoking in real time and to separately assess global expectancies, thereby minimizing attribution and recall biases. Not all biases were eliminated, though, as "before smoking" mood was assessed after the smoking event occurred. However, our procedures for assessing "pre smoking" mood were designed to minimize potential recall and attributional biases and have been used successfully in prior studies (e.g., Hedeker et al., 2009; Mermelstein et al., 2007). For example, we minimized attributional biases by not including any comparative judgments about mood but, rather, by having participants provide absolute Likert scale ratings. As Mermelstein et al. discuss, there are several concerns with having adolescents record mood just prior to their smoking, among which is the very likely possibility that doing so interrupts the natural ecology of the moment and spontaneity of adolescent smoking. The recording of mood just prior to smoking is likely to change the social and mood dynamics of the situation among light and relatively inexperienced smokers. While recording "presmoke" mood immediately after the event is one way to reduce the potential reactivity of the assessment, it does not entirely eliminate reactivity and recall bias (for a complete discussion of the methodological issues in assessing pre- and postsmoking mood in adolescents, see Mermelstein et al.) .

Frequency of smoking was also a predictor of magnitude of both positive and negative mood change following smoking (see Tables 3 and 4). However, the relationship between frequency of smoking and mood change was variable and depended upon mood and sample analyzed. These results emerged after controlling for expectancies and other factors but were not present in the bivariate analyses suggesting a more complex relationship between expectancies, frequency of smoking, and mood change. Specifically, adolescents who smoked more frequently had a smaller magnitude of positive mood benefits than did less frequent smokers; this was not present with negative mood change except in the extended-smoking sample. This finding suggests that perhaps as smoking experience increases, there is a dampening effect on the magnitude of positive mood enhancement following smoking for most smokers, but the dampening effect for negative mood benefits only exists on the heavier, more frequent smokers. This finding is notable given the overall relative low frequency of smoking among our sample; at baseline, the adolescents who provided only baseline reports of smoking smoked on 7 days in the past 30 days, whereas those who event recorded smoking at both baseline and 6 months smoked about 13 days in the past 30 days. This finding suggests the development of tolerance to the positive mood benefits of smoking even at infrequent and low levels of smoking. However, these com-

Table 4. Regression of Key Variables on Positive Mood Change

	β	*SE*	*t*	*p*
Baseline predictors, full sample ($n = 234$)				
Gender	.05	.20	.80	.42
NA expectancies	.20	.15	2.09	.04*
Nicotine dependence	.12	.21	1.01	.31
No. of biological parent ever-smokers	.02	.14	.27	.79
No. of days smoked in last 30 days	−.22	.01	−2.19	.03*
6-Month predictors, extended-smoking sample ($n = 128$)				
Gender	.22	.20	2.50	.01**
NA expectancies	.34	.15	3.27	.001***
Nicotine dependence	.01	.19	.07	.94
No. of biological parent ever-smokers	−.06	.14	−.71	.48
No. of days smoked in last 30 days	−.20	.01	−1.60	.11

Note. Gender is coded as female = 1, male = 2; NA = negative affect; *$p < .05$; **$p < .01$; ***$p < .001$.

parisons are between-subject comparisons and not within-subject comparisons, and thus, the critical within-subject comparison of a change in mood effect over time is needed to address better the issue of the development of tolerance (Hedeker et al., 2009).

Possible Feedback Loop

Another goal of the current study was to examine whether in-the-moment mood change following smoking predicted future global NA expectancies about smoking-related NA relief. Contrary to hypotheses, mood change (neither positive nor negative) at baseline did not predict expectancies 6 months later. We considered the possibility that changes in global expectancies might result from an accumulation of experiences and may be slower to change and thus examined whether baseline mood changes predicted expectancies at 15 months. Indeed, mood change following smoking at baseline predicted NA expectancies at 15 months but only in adolescents who continued to smoke. Specifically, among adolescents who continued to smoke more frequently, larger increases in positive mood and larger decreases in negative mood following smoking predicted higher NA expectancies about the mood benefits from smoking. Thus, this suggestion of a reciprocal feedback loop existed only for the more frequent smokers: global positive smoking expectancies were associated with in-the-moment mood changes, and subsequent mood changes predicted future expectancies in adolescents who were smoking more often.

Specificity of NA Expectancies and Mood Change

Our findings provide evidence for the specificity in the relationship between global NA expectancies and the reinforcing effects of negative and positive mood change following smoking. Expectancies that smoking would relieve boredom were not associated with change in either negative mood or bored mood following smoking. Additionally, changes in neither negative mood nor bored mood were associated with subsequent changes in expectancies about boredom relief. Taken together, these findings suggest that NA expectancies have specific effects on negative and positive mood change in adolescent smokers and may not generalize to other dimensions of mood change or expectancies.

Conclusions

By integrating data collected from self-report questionnaires and EMA in the current study, we were able to capture the nature of the relationship between global representations of expectancies and in-the-moment mood change following smoking in adolescent smokers in a relatively novel way. The EMA methodology reduces retrospective bias about mood effects from smoking. In addition, having measures of expectancies and mood change separated retrieved through different self-report mechanisms helps to disentangle these relationships.

The current study is limited by the lack of a measure for the expectancies of *positive* mood benefits of smoking. Because positive and negative moods may be orthogonal (Watson and Tellegen, 1985), it may be important to assess separately expectancies about each mood dimension. Although the correlation between positive and negative change was strong ($r = -.58$), only assessing expectancies for NA relief may leave important information about positive moods and smoking among adolescents undetected.

Our study was also limited by our use of a mood change variable that was averaged over events attained over the course of a week. Although some stability of the mood change effect is achieved by this approach, we lose the ability to more closely examine within-subject mood change variability.

Our findings about the strong link between global NA expectancies and in-the-moment mood change following smoking in a relatively young and infrequent adolescent smoking sample are important for both understanding the development of dependence as well as for suggesting intervention possibilities. Global representations of NA expectancies mirror in vivo experience and may well be an important factor in escalation among adolescents. Assessing NA expectancies may provide an opportunity for identifying and intervening on adolescents who may be most at risk for smoking escalation.

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Declaration of Interests

The authors have no conflicts of interest, financial or otherwise, that would preclude a fair review or publication of the manuscript. The manuscript is not submitted for publication elsewhere, nor have any of the results been previously published.

References

Brandon, T. H., & Baker, T. B. (1991). The Smoking Consequences Questionnaire: The subjective expected utility of smoking in college students. *Psychological Assessment*, *3*, 484–491.

Chassin, L., Presson, C. C., Bensenberg, M., Corty, E., Olshavsky, R. W., & Sherman, S. J. (1981). Predicting adolescents' intentions to smoke cigarettes. *Journal of Health and Social Behavior*, *22*, 445–455.

Chassin, L., Presson, C. C., Sherman, S. J., Corty, E., & Olshavsky, R. (1984). Predicting the onset of cigarette smoking in adolescents: A longitudinal study. *Journal of Applied Social Psychology*, *14*, 224–243.

Copeland, A. L., Brandon, T. H., & Quinn, E. P. (1995). The Smoking Consequences Questionnaire-Adult: Measurement of smoking outcome expectances of experiences smokers. *Psychological Assessment*, *7*, 484–494.

Eissenberg, T., & Balster, R. L. (2000). Initial tobacco use episodes in children and adolescents: Current knowledge, future directions. *Drug and Alcohol Dependence*, *59*(Suppl. 1), S41–S60.

Eysenck, M. W., & Graydon, J. (1989). Susceptibility to distraction as a function of personality. *Personality and Individual Differences*, *10*, 681–687.

Gilbert, D. G., & Gilbert, B. O. (1995). Personality, psychopathology, and nicotine response as mediators of the genetics of smoking. *Behavior Genetics*, *25*, 133–147.

Hedeker, D., Mermelstein, R. J., Berbaum, M. L., & Campbell, R. T. (2009). Modeling mood variation associated with smoking: An application of a heterogeneous mixed-effects model for analysis of ecological momentary assessment (EMA) data. *Addiction (Abingdon, England)*, *104*, 297–307.

Hedeker, D., Mermelstein, R. J., & Demirtas, H. (2008). An application of a mixed-effects location scale model for analysis of ecological momentary assessment (EMA) data. *Biometrics*, *64*, 627–634.

Hine, D. W., McKenzie-Richer, A., Lewko, J., Tilleczek, K., & Perreault, L. (2002). A comparison of the mediational properties of four adolescent smoking expectancy measures. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors*, *16*, 187–195.

Kassel, J. D., Evatt, D. P., Greenstein, J. E., Wardle, M. C., Yates, M. C., & Veilleux, J. C. (2007). The acute effects of nicotine on positive and negative affect in adolescent smokers. *Journal of Abnormal Psychology*, *116*, 543–553.

Kassel, J. D., Stroud, L. R., & Paronis, C. A. (2003). Smoking, stress, and negative affect: Correlation, causation, and context across stages of smoking. *Psychological Bulletin*, *129*, 270–304.

Martens, K. M., & Gilbert, D. B. (2008). Marijuana and tobacco exposure predict affect-regulation expectancies in dual users. *Addictive Behaviors*, *33*, 1484–1489.

Mermelstein, R., Hedeker, D., Flay, B., & Shiffman, S. (2007). Real time data capture and adolescent cigarette smoking. In A. Stone, S. Shiffman & A. Atienza (Eds.), *The science of real-time data capture: Self-report in health research*. (pp. 117–135). New York, NY: Oxford University Press.

Mermelstein, R., Hedeker, D., & Weinstein, S. (2009). Ecological momentary assessment and adolescent smoking. In J. Kassel (Ed.), *Emotion and substance use*. (pp. 217–236). Washington, D.C.: American Psychological Association.

Nichter, M., Nichter, M., Thompson, P. J., Shiffman, S., & Moscicki, A. B. (2002). Using qualitative research to inform survey development on nicotine dependence among adolescents. *Drug and Alcohol Dependence*, *68*, S41–S56.

Ouellette, J. A., Gerrard, M., Gibbons, F. X., & Reis-Bergan, M. (1999). Parents, peers, and prototypes: Antecedents of adolescent alcohol expectancies, alcohol consumption, and alcohol-related life problems in rural youth. *Psychology of Addictive Behaviors*, *13*, 183–197.

Piasecki, T. M., Richardson, A. E., & Smith, S. M. (2007). Self-monitored motives for smoking among college students. *Psychology of Addictive Behaviors*, *21*, 328–337.

Shiffman, S., Waters, A. J., & Hickcox, M. (2004). The nicotine dependence syndrome scale: A multidimensional measure of nicotine dependence. *Nicotine & Tobacco Research*, *6*, 327–348.

Smith, G. T., Goldman, M. S., Greenbaum, P. E., & Christiansen, B. A. (1995). Expectancy for social facilitation from drinking: The divergent paths of high-expectancy and low-expectancy adolescents. *Journal of Abnormal Psychology*, *104*, 32–40.

Sterling, K. L., Mermelstein, R., Turner, L., Diviak, K., Flay, B., & Shiffman, S. (2009). Examining the psychometric properties and predictive validity of a youth-specific version of the Nicotine Dependence Syndrome Scale (NDSS) among teens with varying levels of smoking. *Journal of Addictive Behavior*, *34*, 616–619.

Wahl, S. K., Turner, L. R., Mermelstein, R. J., & Flay, B. R. (2005). Adolescents' smoking expectancies: Psychometric properties and prediction of behavior change. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*, *7*, 613–623.

Watson, D., & Tellegen, A. (1985). Toward a consensual structure of mood. *Psychological Bulletin*, *98*, 219–235.