

Original Investigation

Mediating Influences of Negative Affect and Risk Perception on the Relationship Between Sensation Seeking and Adolescent Cigarette Smoking

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Abstract

Introduction: A substantial number of adolescents are current and regular cigarette smokers, and there is a need to better understand factors that contribute to smoking behavior during these years. Sensation seeking (SS) is one factor that has consistently been associated with smoking, but less is known about mechanisms that may explain this relationship.

Methods: The present study tested the hypothesis that high school students high in SS would report heavier cigarette smoking and that this relationship would be mediated by negative affect and by perceptions about the risks of smoking. Students ($n = 1,688$) participated in an annual survey of substance use and related attitudes and characteristics.

Results: As expected, higher SS was associated with greater levels of past 30-day (odds ratio [OR] = 1.46, $p = .004$) and lifetime (OR = 1.37, $p = .004$) smoking, particularly for males. Multiple mediation models indicated that effect of SS on both 30-day (combined indirect effect $z = 5.38$, $p < .001$) and lifetime ($z = 6.14$, $p < .001$) smoking was mediated by both negative affect and risk perception.

Conclusions: These findings suggest a need for increasing the sensation value of anti-tobacco messages to increase their efficacy for high SS youth. High SS youth may also benefit from prevention efforts designed to teach healthy ways of coping with negative affect.

Introduction

Although adolescent cigarette smoking rates have been in gradual decline since 1997, national data suggest that 20% of high

school seniors have smoked in the past 30 days, and 11% are daily smokers (Johnston, O'Malley, Bachman, & Schulenberg, 2009). Additionally, evidence suggests that a substantial number of young adults initiate smoking after leaving high school (Costa, Jessor, & Turbin, 2007; Myers, Doran, Trinidad, Klonoff, & Wall, 2009). These data suggest a continuing need to better understand factors that contribute to cigarette use among adolescents and young adults.

One factor that has been linked to cigarette smoking is impulsivity (Doran, Cook, McChargue, Myers, & Spring, 2008; Doran, Spring, McChargue, Pergadia, & Richmond, 2004; Mitchell, 1999, 2004). Impulsivity has been conceptualized as a broad personality trait subsuming several related but distinct constructs, including sensation seeking (SS), urgency (the tendency to act impulsively during positive or negative affect), lack of premeditation, and lack of perseverance (Cyders et al., 2007; Whiteside & Lynam, 2001). While "impulsivity" has at times been used to describe each of these constructs, recent work suggests that they may influence smoking and other risky behaviors in distinct ways (Cyders & Smith, 2008; Cyders et al., 2007; Doran, Cook, McChargue, & Spring, 2009). Consequently, it is important to specifically identify and assess the different components of impulsivity being studied in order to understand the role of this risk factor in the emergence and persistence of smoking and to best inform interventions.

The SS component of impulsivity has been associated with smoking in both adults (Carton, Jouvent, & Widlocher, 1994; White, Pandina, & Chen, 2002) and adolescents (Lejuez et al., 2003; Schepis et al., 2008). SS is conceptualized as a personality trait reflecting a tendency to seek out novel, rewarding situations and stimuli, and a willingness to take risks in doing so; the construct also reflects heightened susceptibility to boredom and

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disinhibition (Zuckerman, 1994, 2005). The construct predicts various youth cigarette smoking behaviors. For example, a longitudinal study of a college sample indicated that those high sensation seekers were more likely to initiate smoking and more likely to still identify themselves as smokers 20 years later (Lipkus, Barefoot, Williams, & Siegler, 1994). Additionally, studies suggest that adult never-smokers higher in SS derive greater subjective reinforcement from nicotine (Perkins, Gerlach, Broge, Grobe, & Wilson, 2000). Finally, SS has been associated positively with cigarette consumption and negatively with quitting success and compliance with a cessation protocol (i.e., decreased use of nicotine replacement therapy and behavioral cessation skills) in adult samples (Kahler, Spillane, Metrik, Leventhal, & Monti, 2009; Kassel, Shiffman, Gnys, Paty, & Zettler-Segal, 1994). Similarly, higher SS is associated with heavier smoking and lower likelihood of quitting in adolescent samples (Helstrom, Hutchison, & Bryan, 2007; Hu, Davies, & Kandel, 2006). In sum, SS may heighten subjective reinforcement from smoking, increasing the likelihood that youth will try smoking and progress toward dependence, and may inhibit cessation.

SS may also influence smoking behavior indirectly. For example, although findings are mixed, some studies have indicated that youth high in SS and similar constructs (e.g., impulsivity, behavioral undercontrol) report more negative affect (Emmons & Diener, 1986). Wills and colleagues, in a cluster analysis using personality and substance use variables, found that teens with the highest levels of substance use tended to also be characterized by high levels of novelty seeking and negative affect (Wills, Vaccaro, & McNamara, 1994). Additionally, in adolescent samples, SS (Cooper, Agocha, & Sheldon, 2000; Cooper, Frone, Russell, & Mudar, 1995; Magid, MacLean, & Colder, 2007) and behavioral undercontrol (Hussong & Chassin, 1994; King & Chassin, 2004) have been associated with avoidance coping, coping motives for substance use, and a heightened tendency to engage in risky behaviors during negative affect or with the intention of alleviating negative affect.

Adolescents high in SS may also tend to expect cigarette smoking to provide greater negative reinforcement compared with other youth (Urban, 2010). Similarly, we have previously found that college students with higher scores on a generalized impulsivity measure expected greater negative affect relief from cigarettes (Doran, McChargue, & Cohen, 2007) and that among adult smokers higher impulsivity predicted greater subjective reductions in negative affect from smoking following a negative mood induction (Doran et al., 2006). A subsequent study found that exposure to cigarette cues elicited disproportionate increases in negative affect from adult smokers higher in SS (Doran et al., 2008). A recent study suggests a reciprocal relationship between cigarette smoking and negative affect during adolescence, such that elevated negative affect during early adolescence predicts smoking progression in later adolescence, and smoking progression in turn is associated with stabilization of negative affect (Audrain-McGovern, Rodriguez, & Kassel, 2009). Taken together, these studies suggest that negative affect may play an important role in linking SS and adolescent cigarette smoking. Youth high in SS may be particularly likely to experiment with cigarettes, at least partly due to elevated expectancies of negative affect relief. Continued smoking may in fact contribute to a dampening of negative affect symptoms, thence prompting continued or increased smoking as a means of self-medication.

SS may further contribute indirectly to smoking via perceptions of the risks smoking confers. Youth perceive risky behaviors, including smoking, as less harmful than adults do (Cohn, Macfarlane, Yanez, & Imai, 1995) and may be less concerned about the risk of dependence (Arnett, 2000). Additionally, lower perception of risk in nonsmoking youth is associated with a greater risk of smoking initiation (Schmid, 2001). SS has been shown to be inversely related to adolescents' perceptions of the risks of dangerous behaviors (Ravert et al., 2009), including alcohol (Arria, Caldeira, Vincent, O'Grady, & Wish, 2008; Cherpitel, 2006) and tobacco use (Greening & Dollinger, 1991), although some studies have found no association (Urban, 2010; Zuckerman, Ball, & Black, 1990). SS is also positively associated with teens' perceptions of the benefits of risky behaviors (Zimmerman, 2010). These data indicate that SS may also promote youth initiation and maintenance of smoking indirectly through lower perceptions of risk.

In sum, previous research suggests that SS in youth is associated positively with perceptions about the extent to which cigarettes dispel negative affect, and negatively with perceptions about the risks of cigarette smoking. These differing perceptions may in part explain why SS adolescents are more likely to smoke: they perceive smoking as providing more benefits and conferring fewer risks than other adolescents do. To the extent that they are more likely to smoke, SS youth are at greater risk for eventual nicotine dependence and poorer health outcomes. The primary purpose of the present study was to test the hypothesis that adolescents high in SS be more likely to smoke compared with their peers and that this association would be partially accounted for by higher levels of negative affect and lower perceptions about risks from smoking among high sensation seekers.

Methods

Sample

In the spring of 2009, 7,267 high school students in the San Diego metropolitan area participated in the study as a part of a survey assessing substance use-related attitudes and behaviors. Of the students who attended school on the survey day, 92% participated; nonparticipation was due to either parent (3%) or student (5%) refusal. To increase the number of variables assessed, students completed one of three different survey forms; the present study includes only those who completed the survey version that included SS items ($N = 1,785$). Additionally, 97 (5%) of these participants were excluded because they endorsed use of a fictitious substance or provided inconsistent data (e.g., endorsed recent but not lifetime use), yielding a final sample of 1,688. The final sample was 51% female and 58% self-identified as non-Hispanic Caucasian, 13% as Hispanic or Latino, and 11% as Asian American. Participants were relatively evenly distributed across grades, with 26% in 9th grade, 26% in 10th grade, 25% in 11th grade, and 22% in 12th grade. Participants' mean age was 15.8 years ($SD = 1.2$).

Measures

Sensation Seeking

SS was assessed using four items from the Behavioral Inhibition/Activation System Fun-Seeking Scale (Carver & White,

1994): “how often do you do dangerous things for fun?,” “how often do you do exciting things, even if they are dangerous?,” “I like new and exciting things, even if I have to break the rules,” and “I prefer friends who are exciting and unpredictable.” The first two items were scored on a 0 (not at all) to 4 (very often) scale; the latter two were scored on a scale from 0 (strongly disagree) to 4 (strongly agree). The four items were aggregated to create a single SS score (range 0–16). The scale had strong internal consistency ($\alpha = 0.87$).

Negative Affect

Negative affect was assessed using six items from The Center for Epidemiological Studies Depression Scale (Radloff, 1977). Items assessed frequency of sadness, fatigue, sleep disruption, hopelessness, nervousness, and worrying within the past year on a scale from 0 (not at all) to 4 (all the time). These items were summed to create a negative affect score (range 0–16). This modified scale demonstrated good internal consistency ($\alpha = 0.85$).

Smoking Risk Perceptions

Two questions addressed perceptions about smoking risk: “how much of a physical or other risk is occasional smoking?” and “how much of a physical or other risk is smoking 1–2 packs per day?” These items were based on risk perception items in the *Monitoring the Future* survey (Johnston, O’Malley, Bachman, & Schulenberg, 2010), in which respondents are asked the risk of physical or other harm from trying cigarettes once or twice, occasional smoking, and regular smoking. In the present study, the two items appeared to be related but distinct ($r = .51, p < .001$). Both items were rated on a scale from 0 (no risk) to 3 (great risk) and summed to create a single score for the perceived risk of smoking (range 0–6).

Cigarette Consumption

Participants were asked how many times they had smoked “a whole cigarette” in the past 30 days and in their lifetimes. Response options were never, 1 time, 2 times, 3 times, 4–6 times, 7–10 times, 11–50 times, 51–100 times, and >100 times. A total of 16.4% participants endorsed any smoking in the past 30 days, and 27.0% reported any lifetime smoking. Among the participants who reported any smoking in the past 30 days, 24.9% reported one use, 13.9% two uses, 25.3% three uses, 13.2% 11–50 uses, and 22.8% 51–100 uses. For those who reported any lifetime smoking, 13.0% reported one use, 6.1% two uses, 5.6% three uses, 11.2% four uses, 10.4% seven to ten uses, 23.8% 11–50 uses, 8.9% 51–100 uses, and 21.2% more than 100 uses. Because both variables were positively skewed with most observations at the distributions’ floor (zero uses), they were analyzed as dichotomous variables coded as 0 = no uses and 1 = 1 or more uses.

Procedure

Using a parental consent procedure approved by the University of California, San Diego IRB, California State Department of Education and each school, letters describing the survey were mailed to parents. Parents could request that their child not participate by returning a prestamped and addressed post card or by E-mail or telephone. Trained proctors surveyed classrooms on days when typical absences were expected and for which no vacations or holidays occurred within the 30 prior days. Prior to administration, proctors verbally reviewed the survey procedures with those allowed to participate and obtained student assent.

Analytic Plan

All analyses were conducted using Intercooled Stata 9.0 (Stata-Corp LP, College Station, TX) unless otherwise noted. Binary logistic regression models were used to determine the effects of SS, negative affect, and perceptions of risk from smoking on past 30-day and lifetime smoking. Ordinary least squares (OLS) regression was used to assess the relationships between SS, negative affect, and risk perceptions. These analyses were used to evaluate whether SS was associated with smoking and to generate parameter estimates and standard errors (SEs) for mediational analyses. Because SS (Roth, Hammelstein, & Brahler, 2007) and negative affect (Weinstein, Mermelstein, Hankin, Hedeker, & Flay, 2007) may vary by sex, each analysis included sex as a covariate. Similarly, because SS may vary by race/ethnicity (Clayton, Segress, & Caudill, 2007) and because smoking prevalence increases for older students (Johnston et al., 2009), race/ethnicity and grade were included as covariates. Due to small cell sizes for some racial/ethnic groups, participants were coded as either: (1) non-Hispanic White ($n = 991$), (2) Hispanic/Latino ($n = 226$), (3) Asian American ($n = 181$), or (4) other/multiethnic ($n = 290$).

To assess whether negative affect and risk perception separately mediated the associations between SS and smoking, we used the *ab* product-coefficient method (MacKinnon, Fairchild, & Fritz, 2007). This entails calculating the product of two coefficients: that SS regressed onto the mediators (negative affect and risk perception; the *a* path) and that of the mediators regressed onto the dependent variables (past 30-day and lifetime smoking; the *b* path). Standardized coefficients for OLS and logistic models were used (MacKinnon & Dwyer, 1993). Coefficients and SEs were entered into the PRODCLIN2 program (MacKinnon, Fritz, Williams, & Lockwood, 2007), yielding 95% confidence intervals (CIs) indicating whether mediation was significant (i.e., CI did not contain 0). Standard errors for indirect effects were calculated using the first-order test (Sobel, 1982). Mediation was first assessed separately for both mediators and both dependent variables, yielding four analyses. Finally, using MPLUS 5.1 (Muthén & Muthén, Los Angeles, CA), we tested a multiple mediation model for each outcome that included both negative affect and perceived risk, allowing us to assess for conditional effects of the mediators (MacKinnon, 2000; Preacher & Hayes, 2008).

Each analysis included only participants with complete data for the five primary variables. SS was missing for 4.2% of participants, compared with 3.6% for negative affect, 5% for risk perceptions, 0.3% for past 30-day smoking, and 0.2% for lifetime smoking. All five variables were present for 90.3% ($n = 1,524$) of participants, excluding those who endorsed use of a fictitious substance or provided inconsistent data. To estimate an overall response rate (i.e., proportion of potential participants who provided usable data), we multiplied this figure by the 92% nonrefusal rate for all versions of the survey, yielding an estimated total response rate of 83.1%. All hypothesis tests used an alpha level of .05.

Results

Preliminary Analyses

We first examined relationships between smoking outcomes and demographic variables. Logistic regression showed that

males were more likely to endorse past 30-day (odds ratio [OR] = 1.46 [95% CI 1.13, 1.89], $p = .004$) and lifetime smoking (OR = 1.37 [1.10, 1.70], $p = .004$), and that both 30-day (OR = 1.48 [1.31, 1.67], $p < .001$) and lifetime smoking (OR = 1.42 [1.28, 1.57], $p < .001$) increased with grade. Race/ethnicity was not associated with 30-day smoking but was related to lifetime smoking (OR = 1.09 [1.00, 1.20], $p = .049$), such that Asian Americans were less likely than others to endorse ever having smoked. Descriptive statistics for SS, risk perceptions, and negative affect are shown in Table 1. Male participants reported higher levels of SS but lower levels of both risk perceptions and negative affect. Freshmen had lower levels of SS compared with juniors and seniors and lower levels of negative affect compared with sophomores and juniors. There were no grade differences in risk perceptions. Asian Americans reported lower levels of SS compared with other participants, whereas Hispanic students perceived smoking as least dangerous. There was no association between race/ethnicity and negative affect. Because of the associations between demographic variables and our primary variables, hypothesis tests using the full sample included interactions between SS and sex, grade, and race-ethnicity. Nonsignificant interactions were removed and the model was re-fit.

SS and Smoking

Logistic regression indicated that the interactions between SS and grade and race/ethnicity were not significant. However, the sensation seeking \times sex interaction was significant for both 30-day (OR = 0.89 [0.82, 0.97], $p = .008$) and lifetime (OR = 0.92 [0.86, 0.99], $p = .027$) smoking. After stratifying the sample by sex to interpret these interactions, we found that SS was significantly associated with smoking for both sexes and that the association tended to be stronger for males (30 day: OR = 1.39 [1.30, 1.49], $p < .001$; lifetime: OR = 1.36 [1.28, 1.44], $p < .001$) than for females (30 day: OR = 1.24 [1.18, 1.30], $p < .001$; lifetime: OR = 1.25 [1.19, 1.30], $p < .001$). For males, increasing SS by one point and one SD increased the odds of past 30-day smoking by 39% (lifetime, 36%) and 253% (lifetime 250%), respectively; a male participant with the maximum SS score of 16 was about 192 (lifetime 131) times more likely to have smoked in the past 30 days than one with the minimum score of 0. For females, one point and one SD increases in SS were associated

with 24% and 138% increases in the probability of past 30-day smoking and 25% and 147% in the probability of lifetime smoking. A female participant with the maximum SS score was 29 times more likely to have smoked in the past 30 days and 34 times more likely in her lifetime, than one with the minimum score.

Simple Mediation Models

Results from the simple mediational models are shown in Table 2. For both 30-day smoking models, the *a* (associations between SS and mediators) and *b* (associations between mediators and smoking) paths were significant. We found that both negative affect ($ab = 0.11$, 95% CI 0.09, 0.14) and risk perceptions ($ab = 0.06$, 95% CI 0.03, 0.09) were significant mediators of the relationship between SS and past 30-day smoking. For lifetime smoking, the *a* and *b* paths were again significant for both models. Additionally, negative affect ($ab = 0.05$, 95% CI 0.03, 0.06) and risk perceptions ($ab = 0.06$, 95% CI 0.04, 0.08) each mediated the relationship between SS and lifetime smoking.

Multiple Mediation Model

To assess the effects of negative affect and risk perceptions together, we then fit multiple mediation models for both 30-day and lifetime smoking (see Table 3 and Figure 1). For past 30-day smoking, the specific indirect effects of both negative affect ($z = 3.40$, $p < .001$) and risk perceptions ($z = 4.33$, $p < .001$) were significant. The combined indirect effect was also significant ($z = 5.38$, $p < .001$). Similarly, for the lifetime smoking model, indirect effects of negative affect ($z = 3.25$, $p = .001$) and risk perceptions ($z = 4.51$, $p < .001$) and the combined indirect effect ($z = 6.14$, $p < .001$) were all significant. The indirect effects of negative affect and risk perceptions were not significantly different from each other in either model.

Because both 30-day and lifetime smoking varied across sex, race/ethnicity, and grade, we then tested for moderated mediation by refitting the multiple mediation models after including interactions between SS, risk perceptions, and negative affect and sex, race/ethnicity, and grade. The interactions were small (ab 's < 0.02) and nonsignificant (p 's $> .33$), indicating that the direct and indirect effects were similar across these groups.

Table 1. Associations Between Demographic Factors, Sensation Seeking, Mediators, and Outcomes

Factor	Sensation seeking— <i>M</i> (<i>SD</i>)	Risk Perceptions— <i>M</i> (<i>SD</i>)	Negative Affect— <i>M</i> (<i>SD</i>)	Endorsed 30-day smoking (%)	Endorsed lifetime smoking (%)
Male	7.2 (4.1) _a	4.3 (1.5) _a	5.7 (3.9) _a	19.0 _a	23.9 _a
Female	6.3 (3.5) _b	4.7 (1.4) _b	8.1 (3.8) _b	13.8 _b	30.1 _b
Freshmen	6.2 (4.1) _a	4.5 (1.6) _a	6.4 (4.0) _a	8.3 _a	16.6 _a
Sophomores	6.8 (3.7) _{a,b}	4.5 (1.6) _a	7.4 (4.1) _b	13.6 _b	24.5 _b
Juniors	7.0 (3.9) _b	4.5 (1.4) _a	7.1 (4.0) _b	21.9 _c	32.4 _c
Seniors	7.0 (3.7) _b	4.6 (1.3) _a	6.8 (3.9) _{a,b}	22.8 _c	36.4 _c
Caucasian	6.9 (3.8) _a	4.6 (1.2) _a	6.7 (4.0) _a	16.9 _a	26.4 _a
Hispanic/Latino	6.9 (3.7) _a	4.1 (1.3) _b	7.3 (4.2) _a	18.8 _a	38.0 _b
Asian American	5.1 (3.6) _b	4.7 (1.5) _a	7.4 (3.6) _a	10.4 _b	13.7 _c
Other/Multiethnic	6.8 (4.0) _a	4.4 (1.6) _{a,b}	7.0 (4.4) _a	16.0 _a	29.0 _a

Note. Means in the same column and for the same demographic variable that do not share subscripts differ at $p < .05$ on Tukey's honestly significant difference test or a χ^2 test of proportions. For sensation seeking and negative affect, range = 0–16; for risk perceptions, range = 0–6.

Table 2. Mediation Models for Past 30-Day and Lifetime Smoking

Effect	Past 30-day smoking			Lifetime smoking		
	Coefficient	SE	95% CI	Coefficient	SE	95% CI
	Negative affect					
<i>a</i>	0.24	0.02	0.20, 0.30	0.24	0.02	0.19, 0.28
<i>b</i>	0.48	0.02	0.42, 0.54	0.19	0.02	0.13, 0.28
<i>ab</i>	0.11	0.01	0.09, 0.14	0.05	0.01	0.03, 0.06
	Risk perceptions					
<i>a</i>	-0.22	0.01	-0.29, -0.15	-0.22	0.01	-0.27, -0.16
<i>b</i>	-0.27	0.06	-0.35, -0.20	-0.27	0.05	-0.35, -0.19
<i>ab</i>	0.06	0.01	0.03, 0.09	0.06	0.01	0.04, 0.08

Note. SE = standard error; CI = confidence interval. *a* Indicates the relationship between sensation seeking and the mediator; *b* indicates the relationship between the mediator and the smoking outcome; *ab* indicates the mediated or indirect effect.

Discussion

As predicted, we found that high school students higher in SS were more likely to report having smoked cigarettes in the past 30 days and in their lifetimes. Additionally, the relationships between SS and both smoking outcomes were partially mediated by participants' self-reported negative affect and perceptions of the risks of smoking. These data are consistent with previous findings, suggesting that SS youth are at heightened risk for smoking (Carton et al., 1994; Lejuez et al., 2003). The findings also suggest mechanisms that may contribute to this increased vulnerability. Participants higher in SS perceived the risks of smoking as lower, and this latter construct mediated a substantial proportion of the effect of SS on smoking outcomes. Adolescents high in SS may be less attentive to messages (e.g., public service announcements, advice from parents and other authority figures) about risky behaviors that do not stimulate affective or physiological arousal (Donohew et al., 2000). Consequently, they may be less likely to encode the message that smoking is harmful compared with others who more closely attend to such messages. The combination of a propensity to pursue novel, rewarding stimuli and failure to encode messages about the risks associated with smoking seems likely to result in increased probability of experimenting with cigarettes.

In combination with previous studies of the effectiveness of health-related messages in youth, these findings suggest that

“sensationalizing” health-related messages may increase their reach and effectiveness for high sensation seekers. For example, public service announcements eliciting arousal, sensory, and affective responses have been shown to be more effective for adolescents independent of SS. However, announcements that fail to elicit such responses may be less effective for high versus low sensation seekers (Donohew, Lorch, & Palmgreen, 1991; Palmgreen et al., 1995; Strasser et al., 2009).

It is also possible that the link between SS and lower perceptions of smoking risk is a function of dissonance reduction. Evidence suggests that high SS youth are more likely to initiate smoking (Dalton et al., 2003; Sargent et al., 2005). Like adults, adolescent smokers endorse disengagement beliefs or rationalizations, such as “I know smokers who have lived a long time” (Kleinjan, van den Eijnden, & Engels, 2009). Disengagement beliefs are thought to reduce the motivational tension arising from holding two dissonant cognitions (e.g., “I smoke cigarettes” versus “Cigarette smoking is harmful”) (Chapman, Wong, & Smith, 1993; Festinger, 1957). In the context of the current study design, it is not possible to determine whether the relationship between SS and perceptions of smoking risk preceded or succeeded smoking initiation. To the extent that SS increased the risk of initiation, it is plausible that risk perceptions declined after initiation to minimize dissonance between participants' knowledge of the health effects of smoking and their knowledge of their own smoking status.

Table 3. Multiple Mediation Model of the Indirect Relationship Between Sensation Seeking and Past 30-Day and Lifetime Smoking

	30-Day smoking		Lifetime smoking	
	Point estimate	95% CI ^a	Point estimate	95% CI ^a
NA	0.017**	0.007, 0.028	0.016**	0.007, 0.026
RP	0.026**	0.015, 0.036	0.027**	0.015, 0.038
Total	0.043**	0.028, 0.058	0.043**	0.028, 0.057
Contrast				
NA vs. RP	-0.009	-0.030, 0.010	.010	-.024, .042

Note. CI = confidence interval; NA = negative effect; RP = risk perceptions.

^aBootstrap bias corrected and accelerated CIs (1,000 resamples).

* $p < .05$, ** $p < .001$.

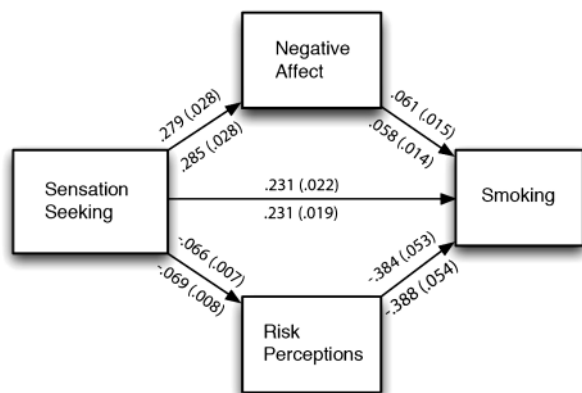


Figure 1. Indirect effects of sensation seeking on past 30-day and lifetime smoking through negative affect and risk perceptions. *Note:* Regression coefficients (standard errors) depicted above each arrow are for past 30-day smoking; coefficients (standard errors) below each arrow are for lifetime smoking. All $ps < .001$. All regressions were run with race/ethnicity, grade, and sex as covariates.

Negative affect also mediated the relationships between SS and both smoking outcome variables in the mediation models, suggesting that SS youth may be disproportionately likely to smoke partly due to heightened negative affect. There are at least two possible mechanisms by which high sensation seekers may experience heightened negative affect. First, it may be that a common biological cause predisposes individuals to both SS and negative affect. For example, low platelet MAO activity has been linked to both SS and internalizing psychopathology (Georgotas et al., 1986; Howard, Cowley, Roy-Byrne, & Hopfenbeck, 1996; Ruchkin, Kuposov, af Klinteberg, & Oreland, 2005). Alternatively, given that high sensation seekers are disproportionately willing to take risks in the pursuit of novel and exciting experiences (Zuckerman, 1994), it is plausible that heightened negative affect may result from negative consequences of risky behavior.

The finding that negative affect mediated the relationships between SS and smoking outcomes is consistent with previous studies indicating that disinhibited, impulsive individuals may engage in risky behaviors with the intention of obtaining negative reinforcement (Cooper et al., 2000; Doran et al., 2006). One implication of this finding is that teaching youth high in SS how to calm negative affect may reduce smoking risk in situations in which they are experiencing negative affect. This may be a particularly important self-regulatory skill for high SS adolescents to develop, given that negative affect predisposes youth to multiple risk behaviors (e.g., McNamara, Swaim, & Rosén, 2010; Zaitsoff & Grilo, 2010).

Notably, in the multiple mediation model, negative affect mediated a relatively small proportion of the overall effect of SS on smoking. Previous research has typically examined broader constructs (e.g., impulsivity) that include not only SS but also related constructs, and recent studies indicate that impulsivity includes subtraits that specifically reflect disinhibited behavior in response to positive and negative affect. These subtraits (positive and negative urgency) are related to but distinct from SS (Cyders et al., 2007; Whiteside & Lynam, 2001). Additionally, our measure of negative affect was generic and did not specifically assess negative affect in the context of smoking.

Certain characteristics of the present study may limit generalizability. First, all variables were measured concurrently, weakening our ability to identify causal relationships. For example, the data do not allow us to determine whether experimenting with smoking may have led to increased SS and negative affect and decreased risk perceptions, rather than the reverse. Additionally, the study from which our evaluation was drawn was designed to gather information about a wide range of constructs, limiting the number and specificity of items that were used to assess each individual construct and potentially limiting variance in the variables of interest. This study design only allowed us to assess the presence or absence of lifetime and past 30-day smoking. Further research is needed to determine how these factors may influence smoking behavior over time, as well as to examine other smoking measures (e.g., quantity/frequency). Further, this sample was not composed of heavy smoking adolescents; of those who endorsed smoking, approximately 30% reported more than 20 lifetime uses. This relatively low rate of smoking could explain the inverse relationship between SS and risk perceptions. Finally, due to small cell sizes, we chose to group African American, American Indian, and multiethnic participants together. Given that youth smoking rates tend to be lower than the general population in African Americans (Johnston, O'Malley, Bachman, & Schulenberg, 2010) but higher in American Indians (Wallace et al., 2003) and multiethnic youth (Unger, Palmer, Dent, Rohrbach, & Johnson, 2000), this group may have been somewhat heterogeneous and less representative of those individual groups.

The current study suggests that SS is an important correlate of adolescent cigarette smoking. This relationship was mediated by negative affect and by adolescents' perceptions of the risks of smoking. These findings suggest a need for altered or additional anti-smoking messages that more effectively communicate the negative consequences of smoking to youth with high levels of SS. SS youth may also benefit from interventions that teach adaptive means of coping with negative affect. Further research that utilizes a longitudinal approach and assesses these variables in greater detail is needed to continue to improve our understanding of the role of SS in youth smoking.

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Declaration of Interests

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