



Sensation seeking as a predictor of treatment compliance and smoking cessation treatment outcomes in heavy social drinkers

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ABSTRACT

The personality trait of sensation seeking has been positively associated with risk of smoking initiation and level of tobacco use. However, its role in smoking cessation is much less established. This study examined the association between sensation seeking and smoking cessation among 236 heavy social drinkers participating in a clinical trial testing the efficacy of incorporating brief alcohol intervention into smoking cessation treatment. As hypothesized, higher sensation seeking predicted reduced odds of abstinence from smoking as well as greater alcohol use over 26 weeks of follow-up. Sensation seeking also significantly interacted with age, having a protective influence on smoking outcomes among the youngest participants and an increasingly negative effect on smoking outcomes with greater age. Compliance with nicotine replacement therapy and use of smoking cessation strategies (e.g., planning for high risk situations, thinking about the benefits of quitting, avoiding smoking situations) were negatively associated with sensation seeking and accounted for most of the main effect of sensation seeking on smoking outcomes. Findings suggest (a) that smokers high in sensation seeking may require a specific emphasis on treatment compliance and behavioral rehearsal of cessation strategies, and (b) that the significance of sensation seeking for smoking cessation may change with increasing age.

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Impulsivity has been described as a broad construct which encompasses at least five moderately related constructs including negative urgency, positive urgency, lack of planning, lack of perseverance, and sensation seeking (Cyders et al., 2007). Each of these impulsivity-like constructs may relate to risky behavior in different ways (Cyders and Smith, 2008; Cyders et al., 2007). Likewise, it has been noted that impulsivity has been broadly used to mean many different things including acting without forethought, sensation seeking, risk taking, susceptibility to boredom, adventuresome, and other constructs as well (Depue and Collins, 1999; Smith et al., 2007; Whiteside and Lynam, 2001). Therefore, it is important and necessary that research on impulsivity specify which specific trait one is studying (Smith et al., 2007).

The personality trait of sensation seeking indicates an individual's need for novel situations or stimulation (Zuckerman, 1994). Sensation seeking has been linked to various types of risky behaviors, including smoking initiation (Lipkus et al., 1994), initial sensitivity to nicotine (Perkins et al., 2000), level of tobacco use (Kassel et al., 1994), initiation of alcohol use (Zuckerman, 1994), and frequency of alcohol consumption (Cyders et al., 2007; Smith et al., 2007). Sensation seeking has

been found to differentiate smokers from non-smokers, with smokers having higher sensation seeking scores than non-smokers (Carton et al., 1994; Lejuez et al., 2003; Mitchell, 1999); however, it does not appear to predict level of nicotine dependence (Harmesen et al., 2006). The vast majority of the research on sensation seeking and risky behaviors has been conducted using samples of younger cohorts and has focused on smoking initiation and the uptake of smoking (Clayton et al., 2007), which precludes generalizing the results to older adults and to other aspects of smoking behavior, including smoking cessation.

There are a number of possible mechanisms that may explain the role of sensation seeking in smoking initiation. One such mechanism suggests that the novelty of smoking and/or the positive reinforcement the individual receives from smoking may attract an individual high in sensation seeking to start smoking (Clayton et al., 2007). However, as the individual continues to smoke, the novelty wears off and sensation seeking may become less relevant. As a result, the motivation for continuing to smoke may center on the avoidance of withdrawal symptoms and negative affect rather than on the stimulation received from smoking or positive reinforcement (Baker et al., 2004; Clayton et al., 2007). There is less known about the potential relationship between sensation seeking and smoking cessation. Thus, it is unclear how strong of an impact sensation seeking would have on quitting smoking.

There are a number of reasons to believe that sensation seeking may impede smoking cessation. First, Tiffany (1990) has proposed that

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smoking is an overlearned behavior that becomes automatic over time. Therefore, refraining from smoking, like refraining from any automatic behavior, requires controlled, nonautomatic processes (Tiffany, 1990). Consistent with this conceptualization, behavioral treatments for tobacco dependence typically involve counseling that focuses on planning for high-risk situations and intentional efforts to manage triggers and use planned quitting strategies. Individuals who are high in sensation seeking may have difficulty quitting smoking because they are dispositionally less inclined to engage in planned, consistent behaviors (Dom et al., 2007) such as avoiding potential relapse triggers or putting on the nicotine patch every day at the same time.

Sensation seeking also may contribute to smoking relapse because of boredom or low stimulation that is associated with maintenance of smoking abstinence. Piasecki et al. (2002) argue that cessation fatigue is one factor that may affect the success of smoking cessation attempts. They argue that although smoking cessation in the initial phase may be seen as a “new adventure,” the novelty of the cessation attempt may wane over time, which may contribute to individuals returning to smoking. This seems particularly relevant for high sensation seekers who possess a persistent need for stimulation or novel experiences. As the novelty of quitting smoking wanes, those high in sensation seeking may be increasingly attracted to the stimulation and positive reinforcement provided by cigarette smoking.

There have been few studies that have examined the relationship between sensation seeking and factors related to smoking cessation outcome. One study found that sensation seeking is not related to readiness to change smoking behavior (Harmsen et al., 2006) however, this study examined only the individual's readiness to change and not actual smoking cessation outcome. Results from a small study ($n = 25$) indicated that sensation seeking did not predict smoking outcome but was associated with greater affective blunting and anhedonia after quitting (Carton et al., 2000). Based on these results, Carton and colleagues argued that high sensation seekers may be particularly affected by emotional deficits during efforts to quit. Likewise, another small study ($n = 12$) found that sensation seeking was related to greater deficits in response inhibition following overnight smoking abstinence (Pettiford et al., 2007), which could relate to greater risk of smoking relapse.

Although the studies mentioned above did not demonstrate an effect of sensation seeking on smoking outcome, other impulsivity-related constructs have been found to predict smoking outcome in various samples. Delay discounting, considered a behavioral index of impulsivity which measures the relative value of immediate versus delayed rewards (Dougherty et al., 2008), predicted smoking outcome in a sample of pregnant smokers in smoking cessation treatment (Yoon et al., 2007). Greater delay discounting was associated with smoker status at 24 weeks postpartum. Similarly, another smoking cessation study found that adolescent smokers who were unable to achieve smoking abstinence exhibited more monetary discounting (i.e., greater inability to delay rewards) than those who were able to attain abstinence (Krishnan-Sarin et al., 2007). In addition, impulsivity has been found to predict smoking outcome in a group of adolescents receiving treatment for smoking cessation such that those individuals who were lower in impulsive sensation seeking (defined as a lack of planning and high experience seeking) showed a greater response to treatment than those who were high in impulsive sensation seeking (Helstrom et al., 2007). Finally, Doran et al. (2004) found that trait impulsivity (as assessed by a scale which reflects the ability to focus on tasks) predicted more rapid relapse, an effect that was not accounted for by affective responses to quitting or craving. These findings suggest that traits related to impulsivity may be relevant to smoking cessation.

The primary aim of the present investigation was to test the association between sensation seeking and smoking cessation outcomes in a randomized clinical trial that tested the utility of incorporating a

brief alcohol intervention into smoking cessation treatment for heavy social drinkers, a group for whom sensation seeking may be particularly relevant (Kahler et al., 2008). We first examined whether sensation predicted nicotine withdrawal symptoms. We then tested the hypothesis that greater sensation seeking would be associated with a lower odds of smoking abstinence. We further hypothesized that this effect would become stronger over time as the influence of cessation fatigue became more relevant. Also, as mentioned previously, much of the research on sensation seeking and smoking has been conducted in youth (Clayton et al., 2007), and therefore it is not clear whether the construct functions similarly in regards to substance use across the lifespan. Thus, a secondary aim of the current study was to examine how age may impact the relationship between sensation seeking and smoking outcome.

We also examined drinking outcomes. Overall, participants reduced drinking following smoking cessation treatment an average of 40% or more (Kahler et al., 2008). We hypothesized that greater sensation seeking would be associated with smaller reductions in drinking following smoking cessation treatment given high demand on planning and purposeful decision-making typically involved with changing one's alcohol use. Finally, we examined whether the effects of sensation seeking on smoking outcomes were accounted for by lower use of the nicotine patch and of smoking cessation strategies taught in the counseling sessions.

1. Method

1.1. Participants

Participants were 236 heavy drinking smokers seeking cessation treatment in a clinical trial comparing standard smoking cessation treatment to smoking cessation treatment that incorporates a brief alcohol intervention (see Kahler et al., 2008, for details of the clinical trial). Participants were recruited through postings on community bulletin boards and newspaper and radio advertisements, which asked for social drinkers who wanted to quit smoking. To be included, participants had to be at least 18 years of age; smoke at least 10 cigarettes a day but use no other tobacco products or nicotine replacement therapy; and currently drink heavily according to NIAAA guidelines (National Institute on Alcohol Abuse and Alcoholism, 1995). Participants were excluded if they met full DSM-IV criteria for current psychoactive substance abuse or dependence (excluding nicotine dependence and alcohol abuse); had a current affective disorder or were psychotic or suicidal; had an unstable medical condition contraindicated for the use of the nicotine patch; or were currently pregnant or lactating or intended to become pregnant. The sample was 45% female and 55% male. The mean age of the sample was 41.5 ($SD = 12.0$) years, the mean education was 14.0 ($SD = 2.6$) years, and 33.0% were married. Most participants (90.7%) identified themselves as non-Hispanic White. The sample was 3.8% African-American, 3.4% Hispanic/Latino, and .8% Asian American; 1.2% identified themselves as “other” or of mixed ethnic origin. At baseline, participants smoked an average of 21.3 ($SD = 9.4$) cigarettes per day and had been smoking for an average of 22.7 years ($SD = 11.5$). The sample mean on the FTND (Heatherly et al., 1991) was 5.0 ($SD = 2.2$). Participants reported that during the 8 weeks prior to treatment, they drank on 54.7% ($SD = 27.3$) of possible days and consumed an average of 16.5 ($SD = 11.9$) US standard drinks per week, which is equivalent to 231 g ($SD = 166.6$) of ethanol per week.

1.2. Procedure

Potential participants were screened by telephone before completing a baseline interview, at which they signed a statement of informed consent approved by the Brown University Institutional Review Board. One hundred and nineteen participants were

randomized to the standard treatment condition (ST), and 117 were randomized to standard treatment that incorporated a brief alcohol intervention (ST-BI). Treatment consisted of four individual counseling sessions over 3 weeks with the quit date occurring at session 2, 1 week after session 1. All participants received treatment with transdermal nicotine patch with the initial dose starting on quit date at 21 mg for 4 weeks, followed by 2 weeks of 14 mg patch, and then 2 weeks of 7 mg patch. We ran analyses testing interactions between treatment condition and sensation seeking for smoking and drinking outcomes; none were significant, so treatment condition effects are not discussed.

Participants completed brief assessments of smoking status, nicotine withdrawal symptoms, and alcohol use at each treatment session (i.e., through 2 weeks after quit date). In addition, follow-ups were conducted at 8, 16, and 26 weeks after quit date. Prior to all assessments, participants provided a breath sample to confirm that they were alcohol-negative. For more details on treatment, see Kahler et al. (2008).

1.3. Measures

Prior to treatment, participants provided demographic, smoking background (number of years of regular smoking and average number of cigarettes per day) and other clinically relevant information. Severity of nicotine dependence was assessed using the FTND (Heatherton et al., 1991), a well-validated 6-item measure. The 8-item Commitment to Quitting Smoking Scale (Kahler et al., 2007) was used at baseline to assess an individuals' commitment to quit smoking ($\alpha = .91$). This scale has good psychometric properties and predictive validity. Participants also rated on an 11-point scale (0 = *not at all important* to 10 = *extremely important*) the importance of cutting down on or avoiding drinking while quitting smoking.

1.4. Sensation seeking

Trait Sensation seeking (SS) was measured with a 4-item Brief Sensation Seeking Scale (Stephenson et al., 2003). The scale was developed by retaining the four items from the four subscales of the Form V of the Sensation Seeking Scale (Zuckerman et al., 1978) that corresponded to the key features of the construct: experience seeking, disinhibition, thrill and adventure seeking, and boredom susceptibility. The items were selected based on the highest item-total correlation and assessed with a five-point Likert scale anchored by "strongly disagree" and "strongly agree." This measure has good reliability and construct validity despite its brevity and had an α of .80 in the current sample. It is positively correlated with alcohol and tobacco use (Martins et al., 2008). We also included a brief measure of trait negative emotionality, the Stress Reaction subscale of the Multidimensional Personality Questionnaire (Tellegen, 1982).

1.5. Smoking outcome measures

1.5.1. Nicotine withdrawal

The 7-item Minnesota Nicotine Withdrawal Scale (Hughes and Hatsukami, 1986) was used to measure nicotine withdrawal at session 1, quit date (session 2), 1 week after quit date (session 3), and 2 weeks after quit date (session 4). Response options range from 0 = *none* to 4 = *severe*.

1.5.2. Smoking status

Outcome analyses were based on 7-day point prevalence abstinence (i.e., reported abstinence of at least 7 days prior to the assessment day) as assessed at 2 (end of psychosocial treatment), 8 (end of treatment with the nicotine patch), 16, and 26 weeks after each participant's quit date. Self-reported abstinence was verified by alveolar carbon monoxide (CO) using a Bedfont Scientific Smokelyzer[®]

breath CO monitor. At 16- and 26-week follow-ups, a saliva sample for cotinine level determination by enzyme immunoassay was collected from those reporting abstinence. Abstinence was confirmed by a combination of $\text{CO} \leq 10$ ppm and cotinine ≤ 15 ng/ml (SRNT Subcommittee on Biochemical Verification, 2002). Significant other report was used to verify smoking status for those who did not provide self-report data or did not provide biochemical verification of abstinence (4% of assessments). Complete smoking data verified either biochemically or by significant other report was obtained from 94.1%, 93.2%, 90.3%, and 94.1% of participants at the 2-, 8-, 16-, and 26-week follow-ups, respectively. Consistent with prior analyses of this clinical trial (Kahler et al., 2007, 2008), those with missing data were considered non-abstinent. However, we also ran analyses in which no assumptions were made about missing data using only available data for each participant. Results using no assumptions regarding missing data were highly concordant with those using a "worst-case" assumption and therefore are not detailed here.

1.6. Alcohol use

The Timeline Followback Interview (TLFB) (Sobell and Sobell, 1996), a well-validated daily calendar-assisted assessment of daily alcohol use, was used at baseline to assess alcohol use in the prior 8 weeks. TLFB also was conducted at sessions 3 and 4 and at each follow-up interval for the period since its last administration. The primary outcome variable was the number of US standard drinks (14 g of pure ethanol) consumed per week, which was calculated based on participants' daily reports of beverage type and amount consumed. Drinks per week after quit date was aggregated into thirteen 2-week blocks.

A total of 216 (91.5%; 106 in ST, 110 in ST-BI) participants provided at least some drinking data after quit date with 207 (87.7%) providing complete data through 8 weeks after treatment, and 200 (84.7%) providing complete data through 26 weeks. Analyses were conducted using all available data ($N = 216$). The TLFB also gathered daily reports on the use of nicotine patch. Percent days of using patch during treatment (i.e., the first 8 weeks after quit date) was used as the index of compliance with nicotine patch.

1.7. Smoking cessation strategies

At the 8-week follow-up, participants answered 8 questions regarding whether they engaged in 8 core smoking cessation strategies while quitting smoking: using substitutes for cigarettes, avoiding high-risk situations, planning for high-risk situations, getting rid of smoking cues, thinking about benefits of quitting, rewarding one's success, avoiding smoking places, and avoiding smoking people. Responses were on a 5-point scale from 1 = *strongly disagree* to 5 = *strongly agree*. Items were summed to form a single index of utilization of smoking cessation strategies ($\alpha = .78$). Data on this measure were available for 203 subjects.

1.8. Data analysis plan

As a first step, we examined the correlations between sensation seeking and demographics (gender, age, race, years of education, and marital status), smoking frequency, level of nicotine dependence, commitment to quitting smoking, and alcohol consumption. We then examined the correlation between SS and nicotine withdrawal symptoms on quit date, 1 week after quit date and 2 weeks after quit date, partialing out the effects of age, gender, level of nicotine dependence and treatment condition.

To examine the impact of sensation seeking on smoking and drinking outcomes, repeated measures analyses were conducted using generalized estimating equations (GEE; Liang and Zeger, 1986) using PROC GENMOD in SAS (SAS Institute Inc., 1997). A variable

carrying the linear effect of time was also included. For smoking outcomes, 7-day point prevalence abstinence at the four follow-ups was the dependent variable controlling for treatment assignment, gender, and level of nicotine dependence. SS, age, the SS×age interaction, and the SS×time interaction were also included as predictors in the model. SS, time, and age were centered so that main and interaction effects could be considered simultaneously. We used a negative binomial distribution and the logit link function for analyzing drinking outcomes. For drinking outcomes, gender, age, treatment assignment, average number of drinks consumed per week prior to treatment, and perceived importance of changing drinking were included as a covariates in the prediction of drinking outcomes.

Finally, we examined potential mechanisms that could explain the impact of sensation seeking on point prevalence smoking abstinence: use of nicotine replacement therapy and smoking cessation strategies. We examined the correlation between sensation seeking and compliance with nicotine patch (and separately use of smoking cessation strategies), partialing out the effects of age, gender, and treatment condition. We then ran GEE models predicting 7-day point prevalence smoking abstinence that included these variables as predictors. All analyses used a two-tailed alpha of .05.

2. Results

Sensation seeking was significantly negatively correlated with age ($r = -.31, p < .001$), and men had higher sensation seeking scores than women ($r = .20, p < .01$). Sensation seeking showed a small but significant positive association with Stress Reaction ($r = -.14, p < .05$) indicating somewhat greater negative emotionality in those high in SS. SS did not significantly correlate with education, race, FTND scores, number of cigarettes smoked per day, or commitment to quitting smoking. Higher SS was associated with a significantly greater number of drinks consumed per week prior to treatment ($r = .14, p < .05$) and with lower perceived importance of changing drinking while quitting smoking ($r = -.19, p < .01$).

2.1. Smoking outcome

2.1.1. Withdrawal

The partial correlation between SS and nicotine withdrawal was small but significant at 1 week after quit date, $r_p(196) = .15, p < .05$. However, the partial correlations between SS and withdrawal at quit date, $r_p(220) = -.02$, and at 2 weeks, $r_p(193) = .04$, were nonsignificant. Also, the partial correlations between nicotine withdrawal at 1 week and smoking abstinence at 2, 8, 16, and 26 were not significant, indicating that nicotine withdrawal at 1 week was not a strong predictor of later outcome.

2.1.2. Abstinence

GEE analyses predicting point prevalence smoking abstinence at 2, 8, 16, and 26 weeks are presented in Table 1. There was a strong significantly negative effect of time reflecting the fact that abstinence rates decreased markedly during follow-up. The overall main effect of

Table 1

GEE model predicting point prevalence smoking abstinence at 2, 8, 16, and 26 weeks.

Variable	Odds ratio	95% lower CI	95% upper CI	p-value
Time	.58	.51	.67	<.0001
Age	.99	.94	1.01	.46
BSSS-4	.73	.53	.99	.047
BSSS-4×Time	.86	.74	.99	.033
BSSS-4×Age	.97	.94	.99	.002

Note. All variables are centered so that main effects and interactions can be considered simultaneously. Analyses control for gender, FTND, and treatment condition. Odds ratios less than 1 indicate a lower odds of smoking abstinence. CI = confidence interval. BSSS-4 = Brief Sensation Seeking Scale, 4-item version.

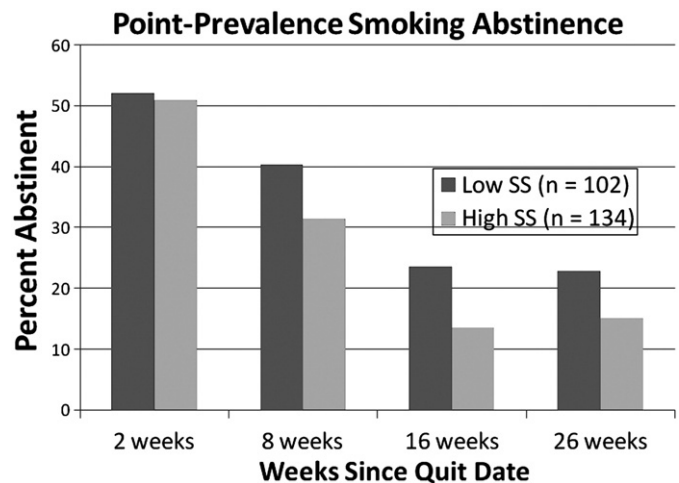


Fig. 1. Point prevalence smoking abstinence at 2, 8, 16, and 26 weeks by level of sensation seeking. Sensation seeking groups were formed by a median split. Low SS = low sensation seeking; high SS = high sensation seeking.

age on smoking outcome was not significant. As hypothesized, higher SS was associated with a significantly lower odds of smoking abstinence. In addition, the effect of SS was moderated by both time and age with the effect of SS being significantly more negative at later follow-ups and with increasing age. Follow-up analyses including Stress Reaction as a covariate indicated that Stress Reaction was not significantly associated with smoking outcome and that its inclusion had minimal impact on the main and interactive effect of SS. Thus, the effect of SS appeared independent of trait negative emotionality.

To illustrate the increasing effect of SS on smoking abstinence over time, we divided the sample by a median split on SS. Fig. 1 shows the point prevalence abstinence rates for low and high SS participants at 2, 8, 16, and 26 weeks. To further explore the interaction between SS and age, we divided the sample into 4 age groups: 18–29 years ($n = 39$); 30–39 years ($n = 64$); 40–49 years ($n = 77$); 50+ years ($n = 56$). We then ran GEE analyses of smoking abstinence within each age group controlling for gender, age, FTND, and treatment condition. For the youngest group, the effect of SS was in the unexpected direction, odds ratio (OR) = 2.40, indicating that higher SS was associated with higher odds of abstinence in this group. By contrast higher SS was associated with lower odds of abstinence for all other age groups: 30–39 years, OR = .69; 40–49 years, OR = .78; 50+ years, OR = .26.

2.2. Drinking outcomes

Negative binomial models of drinks per week during the 26 weeks after quit date indicated that higher SS was associated with significantly greater drinks per week, $\exp(B) = 1.25$, when controlling for age, gender, FTND, average number of drinks consumed per week prior to treatment, and treatment condition. This result indicates that with each additional point on the SS scale, the expected number of drinks per week increased by 25%. The effect of SS remained significant even when controlling for perceived importance of changing drinking while quitting smoking. The interactions between SS and both time and age were nonsignificant, $ps > .60$.

2.3. Behavioral mechanisms

Controlling for age, gender, and treatment condition, greater SS was significantly correlated with lower compliance with nicotine patch, $r_p = -.21$, and less utilization of smoking cessation strategies, $r_p = -.23$. These two variables were z-scored to allow for easier comparison of effect sizes and added to the GEE model predicting smoking abstinence. Both greater nicotine patch compliance

(OR = 2.23, $p < .0001$) and greater utilization of smoking cessation strategies (OR = 1.44, $p = .008$) were associated with significantly higher odds of smoking abstinence. When these two variables were in the GEE model, the main effect of SS was substantially reduced and nonsignificant, OR = .90, $p = .54$. The interactions between SS and time (OR = .83) and between SS and age (OR = .96) remained essentially unchanged and significant, however.

3. Discussion

The aim of this study was to examine the association between sensation seeking and smoking cessation treatment outcome in heavy social drinkers of various ages. Results showed that higher sensation seeking predicted reduced odds of abstinence. These findings are consistent with previous studies showing that individual differences in constructs related to sensation seeking (e.g., delay discounting, impulsivity) predict smoking cessation outcomes (Helstrom et al., 2007; Krishnan-Sarin et al., 2007; Yoon et al., 2007) and extend them to a sample of heavy social drinkers. By contrast, Carton et al. (2000) demonstrated no influence of sensation seeking on smoking outcomes after nicotine patch therapy. It is likely that the small sample size in Carton et al. ($n = 25$) did not provide adequate statistical power to detect the effect of sensation seeking on outcome given that the effect sizes observed in the present study were in the small to medium size range.

Moderation analyses showed that the effect of sensation seeking differed as a function of other variables. Specifically, sensation seeking's negative effect on smoking abstinence became stronger at later assessments. This is concordant with previous studies that have found that variation in constructs related to sensation seeking predict smoking outcome long after cessation (e.g., Yoon et al., 2007), although some short term effects of sensation seeking have also been reported (Krishnan-Sarin et al., 2007). These findings are consistent with the notion that high-sensation seeking smokers may be especially excited and motivated to achieve abstinence shortly after cessation, but these benefits may wear off later into the cessation attempt as the novelty and excitement of quitting dissipates.

Moderation analyses also showed that sensation seeking had a protective influence against relapse among younger individuals and a risk-enhancing effect on relapse among older individuals. Although this effect was not predicted a priori, it is unlikely that this was due to chance as the effect was highly robust ($p = .002$). It is possible that young adults may have more social outlets for alternative forms of reinforcement, which high sensation seekers could take greater advantage of than low sensation seekers. As a result, young individuals high in sensation seeking may be better equipped to cope with the reinforcement loss of quitting smoking, which could help maintain abstinence. By contrast, older individuals may lack such social outlets. Thus, older sensation seekers may have particular difficulty coping with the loss of reinforcement that occurs during cessation, and may therefore be vulnerable to relapse. Although this result is interesting and suggests that age plays an important role in the relationship between sensation seeking and smoking cessation, replication of this finding is needed.

Examination of the mechanisms linking sensation seeking and outcome demonstrated that higher sensation seeking was associated with worse compliance with respect to using the nicotine patch and less use of strategies such as planning for high risk situations, thinking about the benefits of quitting, and avoiding smoking situations. Greater sensation seeking also predicted smaller reductions in drinking following a quit smoking attempt. Of note, the relation between sensation seeking and outcome was eliminated when statistically controlling for the influence of nicotine patch use and planning for high risk situations, suggesting that these factors accounted for sensation seeking's effects on outcome. This is consistent with the hypothesis that individuals high in sensation

seeking are less able to engage in non-automatic planned strategies to avoid relapse. Accordingly, cessation treatments may be more effective if they attempt to buffer the influence of strategic processing deficits among smokers high in sensation seeking. By contrast, although sensation seeking was related to emotional symptoms in a previous study (Carton et al., 2000), withdrawal symptoms were weakly and inconsistently related to sensation seeking in the present investigation. This is concordant with a prior investigation demonstrating that the influence of trait impulsivity on outcome was not mediated by cessation-related changes in negative affect (Doran et al., 2004).

There were several limitations to this study. First, use of the BSSS-4 did not permit multi-dimensional analysis of sensation seeking on outcome. Accordingly, future investigations using comprehensive multi-factorial measures that assess the various subconstructs of sensation seeking (e.g., Disinhibition, Thrill and Adventure Seeking, Experience Seeking, and Boredom Susceptibility) may be informative. Second, this study used only a subjective indicator of sensation seeking. Given that subjective and behavioral measures of sensation seeking-related traits may be distinguishable (Dom et al., 2007) and have different effects on outcome (Krishnan-Sarin et al., 2007), their inclusion could have been informative. Third, although we are unaware of any reason to suspect that these findings would not generalize to non-drinking or alcohol-dependent samples, the results of this study should be interpreted with regards to the sample used, which included only heavy social drinkers. Also, because this clinical trial focused heavily on alcohol use and the efficacy of brief alcohol intervention in the context of smoking cessation, the substantial changes in drinking seen in the study and the effect of sensation seeking on those changes may not generalize to other settings in which alcohol use receives more limited attention. Finally, the assessment of nicotine patch use and smoking cessation strategies occurred simultaneously with the assessment of smoking outcomes. Thus, it could be that poor smoking outcomes led to less compliance or that less compliance led to poor smoking outcomes.

Despite limitations, there are several offsetting strengths of this study. To our knowledge this was the first study to demonstrate an effect of sensation seeking on smoking cessation outcomes. Additionally, this study elucidates some of the mechanisms underlying this effect (e.g., nicotine patch use, high risk planning), and the conditions upon which it depends on (i.e., older age, later in a cessation attempt). Thus, these findings point towards certain intervention strategies that may buffer the effects of sensation seeking on smoking relapse and the subgroups of individuals who may benefit most from them. For example, treatments that target rehearsal of planned behaviors and treatment compliance later in cessation and among older individuals may be useful to mitigate the negative influence of sensation seeking on smoking outcome.

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