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Impulsivity and smoking relapse

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Previous research has shown that elevated trait-impulsivity heightens the risk for initiating tobacco use and indicates that nicotine may be disproportionately rewarding for more impulsive persons. However, the influence of impulsivity on the ability to maintain nicotine abstinence has not been studied. The present study tested the hypothesis that a higher level of trait-impulsivity would predict a more rapid relapse to smoking following 48 hr of nicotine abstinence. Participants were euthymic, regular smokers ($N=45$), with a history of at least one major depressive episode, who participated in a paid smoking cessation study with biological challenge (tryptophan depletion). Treatment involved a 1-day skills training workshop followed by 48 hr of bioverified abstinence and weekly follow-up for 1 month. Regression analyses indicated that elevated impulsivity predicted shorter time to relapse following the workshop after controlling for treatment condition, baseline nicotine dependence, and age ($\beta = -.39$, R^2 change = .147, $p = .011$). Greater impulsivity predicted more rapid relapse to smoking, which mediational analyses indicated could not be explained by positive affect, negative affect, or craving. Findings suggest a need to identify alternative mechanisms to explain impulsive smokers' increased difficulty in maintaining abstinence and to develop targeted treatments that address the special needs of smokers high in impulsivity.

Introduction

Approximately 23% of U.S. adults are regular cigarette smokers (Center for Disease Control and Prevention [CDC], 2002). Although 70% of regular smokers report the desire to quit, few unassisted quit attempts are successful (CDC, 2002). Individual differences in some personality traits appear to increase susceptibility to relapse (e.g., Gilbert, Crauthers, Mooney, McClernon, & Jensen, 1999; Ward, Klesges, & Halpern, 1997). Traits that predispose toward negative affect have been the best explored, guided by the hypothesis that some smokers use nicotine to alleviate negative moods (e.g., Gilbert et al., 1998). Traits that predispose toward appetitive or rewarding behaviors have not been as well studied for their contribution to tobacco dependence. The aim of the present study was to examine the impact on

abstinence maintenance of one such trait, impulsivity, defined as a chronic difficulty delaying gratification or inhibiting response to rewarding stimuli (Monterosso & Ainslie, 1999).

Trait-impulsivity refers to a long-standing pattern of behaviors that reflect preference for readily available rewards (Bickel, Odum, & Madden, 1999; Mitchell, 1999; Monterosso & Ainslie, 1999) coupled with marked difficulty delaying or resisting response to such rewards (Arnett & Newman, 2000; Corr, Pickering, & Gray, 1995; Monterosso & Ainslie, 1999; Patterson & Newman, 1993). Some research suggests that highly trait-impulsive individuals are more likely to smoke cigarettes than are their less impulsive peers (Bickel et al., 1999; Kassel, Shiffman, Gnys, Paty, & Zettler-Segal, 1994; Mitchell, 1999). More impulsive people may experience the rewarding aspects of drug use more intensely than others do, as evidenced by the finding of a positive association between impulsivity and euphoric mood following cocaine administration (Cascella et al., 1994).

Related traits associated with a propensity toward approach behavior have been shown to be predictors of smoking initiation and escalation, but linkages to relapse have not been examined. For example, sensation seeking has been shown to predict smoking

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initiation and to be inversely related to the probability of spontaneous cessation (Lipkus, Barefoot, Williams, & Siegler, 1994). Sensation seeking also may moderate the association between social variables (e.g., peer pressure) and substance use (Slater, 2003). Smoking also has been associated with higher levels of novelty seeking (Heath, Madden, Slutske, & Martin, 1995; Tercyak & Audrain-McGovern, 2003).

Thus, the few extant studies are consistent with the premise that highly trait-impulsive people are initially drawn to use cigarettes for their rewarding properties. Little is known, however, about how impulsivity influences smoking cessation. Heightened relapse rates among impulsive smokers can be hypothesized on the grounds that impulsive smokers will have difficulty finding rewards that are as portable and as convenient to administer as cigarettes. The acute decrement in the level of reward access that immediately follows cessation should, therefore, place them at heightened risk of relapse. Accordingly, the primary aim of the present study was to test the hypothesis that smokers with higher trait-impulsivity would relapse more quickly than their less impulsive peers following a quit attempt.

We also tested hypotheses about three psychological mechanisms that might mediate disproportionately rapid relapse for impulsive smokers. Candidate contributors to relapse were decreased positive affect, increased craving, and increased negative affect. Because decreased reward consumption may lead to a drop in pleasant mood states (e.g., positive affect), trait-impulsive smokers may relapse disproportionately quickly at least partially as a result of decreased postquit positive affect.

Decreased reward consumption resulting from nicotine deprivation also may result in increased cigarette craving. Kruegelbach, McCormick, Schulz, and Grueneich (1993) found that among inpatient substance abusers, greater impulsivity was associated with higher drug cravings and with increased risk of relapse. Pharmacological challenges that interfere with the rewarding aspects of smoking have been found to elicit higher levels of craving among more impulsive smokers relative to other smokers (Reuter & Netter, 2001; Reuter et al., 2002). Consequently, we also posited that more impulsive smokers' quicker relapse would be at least partially mediated by disproportionately high levels of postquit craving relative to their less impulsive peers.

Nicotine abstinence is believed to be a stressor that activates depressive vulnerability (e.g., depression proneness), exacerbating withdrawal-related negative affect during the first 48 hr of abstinence and promoting smoking relapse (e.g., Lerman et al., 2002; Niaura, Shadel, Britt, & Abrams, 2002). It is unclear whether trait-impulsive smokers also are prone to experience heightened negative affect when stressed. Because trait-impulsivity has been traditionally viewed

as a predisposition toward appetitive behaviors (Monterosso & Ainslie, 1999), one might assume that trait-impulsive smokers would be motivated primarily to pursue reward and positive affect rather than to dispel withdrawal-related negative affect. However, evidence suggests that negative affect may influence the relationship between trait-impulsivity and smoking relapse. For example, among inpatients in a substance abuse clinic, negative affect was associated with especially strong drug craving and relapse for those high in impulsivity (Kruegelbach et al., 1993). Similarly, Hussong and Chassin (1994) found that more impulsive adolescents were especially likely to use drugs when they were experiencing elevated negative affect.

Relatively little research has explored the possibility that positive moods may be associated with smoking, perhaps because positive and negative affect have been conceptualized as opposite poles of a single continuum. Positive affect is conceptualized as a pleasant, energized mood state reflecting feelings of elation, excitement, enthusiasm, and peppiness (Watson & Tellegen, 1985). Although positive and negative affect are correlated, they appear to be distinct (Watson, Clark, & Tellegen, 1988) and to have different neural bases (Davidson, 1992) and psychological correlates (Watson et al., 1988). Consequently, secondary aims of the present study were to examine whether more rapid relapse among more impulsive smokers would be mediated partially by heightened postquit negative affect as well as by increased craving and decreased positive affect.

Method

Participants

The present research was part of a larger study designed to test the efficacy of a 1-day workshop intervention to promote tobacco abstinence. The intervention taught smoking cessation and mood management skills that were practiced during psychological and biological induction of transient negative mood via guided imagery and tryptophan depletion. Participants ($N=45$) were recruited from the community through radio advertisements and through flyers posted in the community and were paid to remain abstinent for 48 hr following the workshop. Abstinence was verified by expired carbon monoxide and salivary cotinine. The average participant was aged 41.02 years ($SD=12.4$, range=18–63); smoked approximately one pack per day ($M=19.57$, $SD=7.7$), had smoked for 23.16 years ($SD=12.3$); and reported moderate nicotine dependence, as measured by the Fagerström Test for Nicotine Dependence ($M=4.95$, $SD=2.3$). Owing to the constraints of the parent study, all participants had a history of at least one episode of major depression.

To be eligible, participants were required to be at least 18 years of age and to have smoked 10 or more cigarettes per day for the past year. Individuals receiving other smoking cessation treatment (e.g., other formalized treatment programs, nicotine replacement therapy, bupropion) were excluded, as were individuals currently experiencing an episode of major depression (as diagnosed by Structured Clinical Interview for DSM-III-R interview; Spitzer, Williams, Gibbon, & First, 1992). Candidates being treated with psychotropic medication other than antidepressants also were excluded from the study.

Procedure

The parent research, of which the present study was a component, was a treatment analogue study designed to explore whether the addition of mood management skills training and rehearsal to smoking cessation skills training would enhance abstinence. Participants were randomized to one of three treatments (tryptophan depletion plus mood management and cessation skills training, placebo depletion with mood management and cessation skills training, and cessation skills training alone), each of which involved participation in a 1-day group workshop facilitated by trained therapists (Spring, Pergadia, Richmond, McChargue & Doran, 2002). Workshops focused on training participants in the use of smoking cessation and mood management skills and included an experiential component in which skills were practiced.

Following the workshop, participants were paid to quit smoking for 48 hr. Participants visited the laboratory twice during the 48-hr period, to complete questionnaires and for verification of self-reported smoking status. Participants then returned to the laboratory weekly for 4 weeks to complete questionnaires and for assessment of smoking status.

Measures

Relapse to smoking. Relapse status was assessed at 24 and 48 hr postquit and at four weekly follow-up sessions. At each visit, participants reported the number of cigarettes smoked since the previous visit. Participants also provided a breath sample that was analyzed immediately for exhalation carbon monoxide with an Ecolyzer (Model EC-50, Vitalograph Corporation, Lenexa, Kansas). Finally, participants who reported abstinence at the second and fourth weekly follow-up visits provided saliva samples that were analyzed for cotinine, the major metabolite of nicotine. Saliva samples were analyzed via radio-immunoassay. Participants were judged to have relapsed if they reported any amount of smoking on 7 consecutive days or any smoking in each of 2 successive weeks. Participants also were considered to

have relapsed if they reported abstinence but had Ecolyzer values greater than 10 parts per million carbon monoxide or cotinine values greater than 20 ng/ml. Time to relapse was operationalized as the number of consecutive days between the day the participant attended the workshop and the day on which the criteria for relapse were met.

Nicotine dependence. The Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) is a self-report scale measuring level of nicotine dependence. Cumulative FTND scores range from 0 to 10, with values of 7 or higher suggestive of clinically significant nicotine dependence (Gilbert et al., 1998; Killen, Fortmann, Newman, & Varady, 1991). Previous research has shown an association between FTND scores and other measures of nicotine dependence (e.g., measures of nicotine and cotinine), providing support for the construct validity of the FTND (Heatherton et al., 1991).

Trait-impulsivity. The Barratt Impulsiveness Scale, version 11 (BIS-11; Patton, Stanford, & Barratt, 1995) provides a measure of trait-impulsivity. The BIS-11 is a self-report questionnaire that asks participants to rate how often a series of statements applies to them. Cumulative scores range from 30 (low in trait-impulsivity) to 120 (high in trait-impulsivity). The BIS-11 has been shown to be reliable in both clinical and community samples, with Cronbach's alpha coefficients ranging from .79 to .83 (Patton et al., 1995). The BIS-11 is structured to assess long-term patterns of behavior and has been used to assess trait levels of impulsivity across a variety of populations, including substance-dependent individuals (e.g., Mitchell, 1999; Moeller et al., 2002; Stanford, Greve, Boudreaux, Mathias, & Brumbelow, 1996). Previous research suggests that the BIS-11 may be a better predictor of the ability to delay smoking than other measures of impulsivity and related constructs (e.g., the impulsivity scale of the Eysenck Personality Inventory, the experience-seeking and thrill- and adventure-seeking subscales of the Sensation-Seeking Scale, or the novelty-seeking scale of the Tridimensional Personality Questionnaire; Mitchell, 1999). Research has shown that individuals who have heightened difficulty delaying gratification on laboratory measures of impulsivity tend to have elevated BIS-11 scores (Allen, Moeller, Rhoades, & Cherek, 1998; Cherek, Moeller, Dougherty, & Rhoades, 1997).

Cigarette craving. Cigarette cravings were assessed via the Questionnaire of Smoking Urges (QSU; Tiffany & Drobes, 1991). The QSU is a 32-item instrument

containing two subscales, one representing anticipation of deriving pleasure from smoking and the other anticipation of relief from negative affect and other symptoms of nicotine withdrawal (Davies, Willner, & Morgan, 2000; Tiffany & Drobes, 1991). The QSU has been shown to be sensitive to both abstinence and exposure to smoking cues (Morgan, Davies, & Willner, 1999), suggesting relatively high construct validity. The QSU was administered prior to the workshop to establish a baseline craving score and was readministered once on each of the 2 days immediately following the workshop.

Positive and negative affect. Positive and negative affect were assessed via the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971), a self-report questionnaire consisting of 65 mood-related adjectives. The “right now” version was used to determine participant moods at the time the test was administered. The POMS contains six subscales: Tension/anxiety, depression/dejection, anger/hostility, vigor/activity, fatigue/inertia, and confusion/bewilderment. All subscales have been shown to be internally consistent (Cronbach’s alpha coefficients approaching .90) and have evidence of construct and predictive validity (McNair et al., 1971). The POMS was administered three times (at breakfast, lunch, and dinner) over the course of 1 day prior to the workshop to obtain a baseline mood score and was administered an additional six times (at breakfast, lunch, and dinner) during the first 48 hr postquit. The vigor/activity subscale was used as the primary index of positive affect. Postcessation scores (three scores daily for 2 days) were averaged to increase reliability and create a composite postquit positive affect score. The tension/anxiety, depression/dejection, and anger/hostility subscales were combined to form an aggregate measure of negative affect. Postcessation scores were again averaged to increase reliability and to create a composite postquit negative affect score.

Data analyses

Residual change scores were used to assess changes in positive and negative affect and cigarette craving, because they provide a measure of the magnitude of change while controlling for baseline values. Preliminary analyses examined potential covariates, including nicotine dependence, treatment condition, age, ethnicity, gender, number of past depressive episodes, symptoms of depression at baseline, and POMS vigor and dysphoria at baseline. No evidence of multicollinearity was found. Variables associated with time to relapse or trait-impulsivity were entered as covariates in the analysis described below. All

hypotheses were tested via hierarchical regression. Mediating hypotheses were tested using the procedures recommended by Baron and Kenny (1986).

Results

The primary analysis tested the hypothesis that more impulsive participants would relapse more quickly than other participants. Time to relapse was entered as the criterion variable. Nicotine dependence, treatment condition, and age were entered on the first step, as covariates, and trait-impulsivity was entered on the second step. As expected, trait-impulsivity predicted time to relapse: More impulsive participants relapsed more quickly than other participants. Trait-impulsivity accounted for approximately 14.7% of the variance in time to relapse after controlling for age, treatment condition, and nicotine dependence ($\beta = -.39$, R^2 change = .147, $p = .011$; Table 1).

Contrary to expectations, the relationship between trait-impulsivity and time to relapse was not mediated by postquit change in craving or by postquit changes in either positive affect or negative affect. Postquit changes in positive and negative affect were not associated with either trait-impulsivity or time to relapse. Similarly, postquit changes in cigarette craving were independent of both trait-impulsivity and time to relapse. Each mediational analysis was run again after substituting difference scores (i.e., baseline–postquit) for residual change scores; these analyses also indicated that the relationship between trait-impulsivity and time to relapse was not mediated by postquit changes in craving, positive affect, or negative affect. Further analyses indicated that the association between trait-impulsivity and time to relapse was not mediated by residual change scores or difference scores in the individual negative affect subscales of the POMS (i.e., depression/dejection, tension/anxiety, and anger/hostility).

Finally, to enhance the clinical utility of the findings, we examined the sensitivity and specificity of a variety of BIS-11 cutoff scores in predicting participants’ relapse status 30 days after the workshop (Table 2). In the context of the present study,

Table 1. Hierarchical regression analysis examining the influence of impulsivity on time to relapse (criterion variable: days to relapse following the workshop).

Step	Predictor variable	Beta	R^2 change	F change	p value
1	Covariates		.113	2.35	.110
	Treatment condition	.06			.711
	Age	.12			.466
	FTND score	-.34			.039
2	Trait-impulsivity	-.39	.147	7.14	.011

FTND, Fagerström Test for Nicotine Dependence.

Table 2. Sensitivity and specificity of various cutoff scores on the Barratt Impulsiveness Scale (BIS-11) in predicting relapse status.

Cutoff score	Sensitivity	Specificity
60	.7692	.4118
62	.7308	.5882
64	.6538	.6471
66	.5769	.6471
68	.5000	.7647

The median BIS-11 score was 64.

sensitivity assesses the probability of predicting the relapses that occurred (i.e., the proportion of relapsed participants who had BIS-11 scores above the cutoff value), whereas specificity measures the probability of predicting the nonrelapses that occurred (i.e., the proportion of abstaining participants who had BIS-11 scores below the cutoff value). The results suggest that using a BIS-11 cutoff value of 64, which was the median BIS-11 score in the present sample, provides the best balance of sensitivity and specificity.

Discussion

The present study examined the influence of trait-impulsivity on the ability to maintain abstinence following a 1-day smoking cessation workshop. Results indicated that trait-impulsivity accounted for a significant portion of the variance in time to relapse following the workshop: more impulsive participants relapsed more quickly. We also examined whether the association between impulsivity and smoking relapse was mediated by changes from baseline to postquit in craving, positive affect, and negative affect. However, no such associations were found in the present sample.

To our knowledge, the present study is the first to examine directly whether impulsivity is associated with difficulty quitting smoking. Results indicate that smokers with higher levels of trait-impulsivity have greater difficulty maintaining abstinence than those with lower levels of trait-impulsivity. The findings are consistent with previous research indicating that more impulsive smokers have greater difficulty inhibiting smoking than other smokers (Mitchell, 1999). They also are consistent with work that describes self-control as a muscle with finite strength that cannot maintain strenuous effort indefinitely (Muraven & Baumeister, 2000). To the extent that more impulsive smokers are low in self-control strength, it follows that their ability to maintain abstinence (i.e., to use self-control to inhibit smoking) is likely to be depleted at a disproportionately high rate.

The adverse effect of impulsivity on abstinence was not attributable to heightened craving or negative affect or to decreased positive affect. In fact, more impulsive smokers relapsed more quickly even though

they showed no significant increase in negative affect during withdrawal. The pattern of findings therefore suggests that processes other than the craving and affective changes we studied may account for impulsive smokers' heightened difficulty maintaining abstinence. One plausible mechanism underlying the impulsive smoker's proneness to more rapid relapse might be a heightened reactivity to readily available, rewarding stimuli (Arnett & Newman, 2000; Fowles, 1987). However, that explanation remains speculative and in need of empirical investigation.

The present study had certain limitations. As noted earlier, negative affect did not increase after cessation in the manner usually observed among quitting smokers, perhaps limiting the generalizability of the findings. The mood management skills taught via the interventions in the parent study may have blunted the affective symptoms of nicotine withdrawal. Alternatively, subjective distress may have been lessened because participants knew they would be able to return to smoking after the 48-hr quit period without incurring a penalty. We find that interpretation unconvincing, however, because participants in most smoking cessation trials are able to resume smoking without incurring explicit penalties. Even though our protocol involved a paid quit period, most participants seem to have construed the experiment as an opportunity to try to remain smoke free, as evidenced by the fact that only two of the 45 enrollees resumed smoking within 4 days of the end of the paid quit period.

Also potentially limiting generalizability, owing to the constraints of the parent study, all participants had a history of at least one episode of major depression. The relationship between trait-impulsivity and major depression remains unknown, although the range of impulsivity reported in the present study is comparable with what has been reported among nonclinical samples (Stanford et al., 1996). Finally, the small sample size in the present study may have limited power to test the predicted hypotheses; however, Sobel tests (Baron & Kenny, 1986) indicated that in each case the degree of mediation was small ($z = -.12$ for negative affect, $z = .39$ for positive affect, $z = -.85$ for craving), suggesting that increased power may not have resulted in confirmation of the hypotheses.

The study's primary finding was that more impulsive smokers had greater difficulty maintaining abstinence than did their less impulsive peers. The impulsive smoker's heightened relapse proneness was not attributable to increased negative affect or craving or decreased positive affect after quitting. Because affect was assessed by averaging six scores over the first 48 hr after quitting, it could be argued that the present study did not allow a test of mediation that was sufficiently sensitive to temporal changes in affect to evaluate the mediational hypotheses. It may be

useful for future research to assess the mediational hypotheses via more sensitive measures of affect (e.g., ecological momentary assessment or laboratory measures). Alternatively, another mechanism may need to be identified to explain the link between impulsivity and relapse proneness. One possibility is that rewarding environmental stimuli, including cigarettes, may be especially salient for impulsive smokers, making such stimuli difficult to ignore and encouraging a response to smoking-related cues. To our knowledge, cue reactivity has not been examined in impulsive smokers, but the possibility of exaggerated cue reactivity warrants investigation.

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