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Impulsivity and the reinforcing value of cigarette smoking

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Abstract

The present study tested the hypothesis that impulsivity would predict perceptions of positive and negative reinforcement from smoking. The secondary hypothesis was that the relationship between impulsivity and smoking reinforcement expectations would be mediated by the character trait of self-directedness. College students ($n = 202$) who reported smoking cigarettes participated in the survey study. Hierarchical regression analyses confirmed that impulsivity predicted expectations about positive ($\beta = .22, p = .001$) and negative ($\beta = .25, p = .001$) reinforcement from smoking. These relationships were also mediated by self-directedness. Results suggest that impulsive smokers in the early stages of dependence may smoke because they expect smoking to be extremely pleasurable as well as to help dispel bouts with negative affect. Furthermore, their elevated expectations about smoking may be related to difficulties adapting to challenging environments and working toward long-term goals.

Keywords: Smoking, Impulsivity, Reinforcement, Learning, Personality, Mediation

1. Introduction

Cigarette smoking remains one of the foremost causes of preventable disease and death across the world. In the United States, approximately 23% of adults are regular smokers (Center for Disease Control [CDC], 2002) and smoking is associated with one in every five deaths (CDC, 1999). In the coun-

tries of the European Union, the prevalence of smoking among adults is over 39% and is associated with about 15% of all deaths, accounting for approximately 500,000 deaths annually (World Health Organization [WHO], 2003). Recent reports show that the quit rates reported in clinical trials are in decline and suggest that those smokers able to quit relatively easily have done so (Irvin & Brandon, 2000 and Irvin et al., 2003). Remaining smokers are believed to be those who are particularly dependent or have disproportionate difficulty quitting (Coombs, Kozlowski, & Ference, 1989). It has been suggested that the recalcitrant nature of remaining smokers reflects underlying psychological and biological factors rendering these individuals highly resistant to change and disproportionately prone to relapse following a quit attempt (Gilbert & Gilbert, 1995 and Gilbert et al., 1998).

Researchers examining such factors have often focused on those primarily characterized by negative affect, guided by the hypothesis that depression-prone smokers may smoke as a means of alleviating depressive symptoms (e.g., Niaura et al., 2002). Less attention has been paid to other factors that may also play an important role in determining smoking behavior as well as initiation of smoking and relapse following a quit attempt, such as impulsivity. Impulsivity, defined as a tendency to pursue rewarding environmental stimuli without regard for potential negative consequences (Barratt, 1994 and Evenden, 1999), has been shown to be associated with regular smoking (Kassel et al., 1994, Lipkus et al., 1994 and Zuckerman & Kuhlman, 2000), and may predict greater difficulty quitting smoking (Doran, Spring, McChargue, Pergadia, & Richmond, 2004). However, there has been little systematic exploration of mechanisms that may link impulsivity and smoking. The purpose of the present study was to examine expectations about reinforcement from smoking as a possible mechanism.

Previous research suggests that impulsive individuals may expect greater reinforcement (positive and negative) from drugs compared to their less impulsive counterparts. Most of this work has focused on the influence of impulsivity on the reinforcement value of alcohol. For example, in a large survey study, Cooper, Agocha, and Sheldon (2000) found that more impulsive and neurotic adolescents were disproportionately more likely to use alcohol as a means of coping with negative affect. Similarly, Hussong and Chassin (1994) reported that impulsive adolescents were more likely than others to use alcohol on days when they experienced more negative affect than usual. Finally, previous research has shown that individuals at high risk for future alcoholism, who also report heightened impulsivity (Finney et al., 1971 and Schwartz & Graham, 1979), have elevated expectations about the reinforcement obtained from alcohol use relative to their peers (Mann, Chassin, & Sher, 1987).

Some evidence also suggests that impulsive drug users may actually derive greater reinforcement from drug use than others. For example, Cascella, Nagoshi, Muntanger, and Walter (1994) found that heightened impulsivity was associated with greater feelings of subjective euphoria among male cocaine users following intravenous administration of cocaine. Additionally, studies examining the discounting of delayed rewards have shown that more impulsive drug users tend to be more likely than other drug users to prefer small, immediate drug rewards, including cigarettes, to larger, delayed monetary rewards (e.g., Bickel et al., 1999, Madden et al., 1997 and Mitchell, 1999).

In addition to examining the influence of impulsivity on smoking reinforcement expectations, we wanted to test process variables that may help explain the presumed relationship between impulsivity and smoking reinforcement expectations. Of particular interest was a person's ability to adapt to one's environment and work toward long-term goals, otherwise known as self-directedness (Cloninger, Svrakic, & Przybeck, 1993). Impulsivity may be viewed as reflecting deficits in self-directedness due to cer-

tain core characteristics that reflect longstanding behavior patterns. Specifically, acting without forethought (e.g., Tcheremissine, Lane, Cherek, & Pietras, 2003) and having difficulty delaying gratification when immediate reinforcement is available (e.g., Odum & Rainaud, 2003 and Petry, 2001) may be such characteristics. The ability to adapt to one's environment and work toward long-term goals may require delayed and thoughtful processes that lead to positive outcomes. In contrast, it has been suggested that more impulsive individuals may tend to seek immediate gratification via substance use, regardless of the consequences (e.g., Bickel et al., 1999). However, little is known about whether deficits in self-directed traits may underlie the presumed association between impulsivity and smoking reinforcement expectations. Thus, the present study was also designed to test whether self-directedness explains why highly impulsive smokers perceive smoking as highly reinforcing. In other words, do smokers with higher levels of impulsivity perceive smoking as more reinforcing than others because they have difficulty adapting to their environment and need an immediate escape during challenging situations?

Finally, previous research suggests that impulsive drug users expect, and may even receive, greater reinforcement from drugs than others. However, there have been few tests of this association among smokers. Consequently, the primary aim of the present study was to test the hypothesis that highly impulsive smokers expect greater reinforcement from smoking than others. The secondary aim was to test the hypothesis that the relationship between impulsivity and expectations about the reinforcement value of smoking is mediated by self-directedness. Specifically, we expected that the association between impulsivity and expectations regarding reinforcement derived from smoking would be at least partially explained by a tendency toward lower self-directedness among more impulsive smokers.

2. Methods

2.1. Participants

Participants ($n = 202$, 56.9% female) were undergraduate students at Texas Tech University who reported smoking at least 1 day per week and received course credit for their participation. Participants' mean age was 19.5 years ($S.D. = 2.0$). Approximately 87% classified themselves as "Caucasian" with 8% identifying as "Hispanic/Latino." Participants tended to be inexperienced smokers in the early stages of dependence, with 69.8% smoking 10 or fewer cigarettes per day. While approximately 54% of the sample reported smoking daily, they tended to have low levels of nicotine dependence as indicated by scores on the Fagerström Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991; $M = 3.1$, $S.D. = 2.5$).

2.2. Procedure

The present study was approved by the Institutional Review Board at Texas Tech University. After being screened by a survey administered to all introductory psychology students and contacted by telephone, those individuals who agreed to participate in the current study were asked to sign up for one of the available 2-h assessment sessions that were held twice weekly in a classroom on campus. Group size for each session ranged from 4 to 20. Assessment sessions were offered between 11:00 a.m. and 4:00 p.m. in order to accommodate students' class schedules. Before being given a questionnaire packet, in-

formed consent was obtained independently from all participants. Questionnaire packets were counter-balanced in terms of the order in which each measure appeared in the packet so as to reduce order effects. Upon completion of the questionnaire packet, participants were asked to turn in the packet to a research assistant present in the room. No identifiable information appeared on the questionnaire packets.

2.3. Measures

2.3.1. Impulsivity

The Barratt Impulsiveness Scale, version 11 (BIS-11; Patton, Stanford, & Barratt, 1995) provides a self-report measure of impulsivity. The BIS-11 is a self-report questionnaire that asks participants to rate how often a series of statements applies to them, and has been shown to be reliable in both clinical and community samples, with Cronbach's α 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 and Stanford et al., 1996).

2.3.2. Reinforcement from smoking

The Smoking Consequences Questionnaire (SCQ; Brandon & Baker, 1991) was used to evaluate positive and negative reinforcement expectations about smoking. This scale consists of 60 statements depicting a variety of consequences from smoking. Participants rated each of the statements on a 10-point Likert scale relative to how likely they believed each consequence was to occur. Four factors have been derived from the SCQ: negative consequences, positive reinforcement, negative reinforcement, and appetite-weight control. Only the positive reinforcement and negative reinforcement subscales were used in the current study.

2.3.3. Self-directedness

Self-directedness (SD) is one of seven primary scales of the Temperament and Character Inventory (TCI; Cloninger et al., 1993), a 226-item, self-report questionnaire. The SD scale of the TCI has 44 items and has been shown to have excellent internal consistency (Cronbach's $\alpha = .86$; Cloninger et al., 1993). Adequate construct validity is suggested by the finding that SD is moderately and negatively associated with TCI novelty-seeking ($r = -.26$) and relatively strongly associated with TCI persistence ($r = .47$) (Cloninger et al., 1993).

3. Results

3.1. Preliminary analyses

Prior to conducting the primary analyses we tested the whether age, gender, ethnicity, or nicotine dependence was significantly associated with each of the main variables of interest. Neither age nor gender was significantly associated with impulsivity, positive or negative reinforcement expectations, or self-directedness. Ethnicity was significantly associated with negative reinforcement expectations [$r(202) = .15$, $p = .046$], which was marginally associated with positive reinforcement expectations

$[r(202) = .13, p = .071]$, but was unrelated to impulsivity or self-directedness. Nicotine dependence was associated with positive $[r(201) = .47, p < .001]$ and negative $[r(201) = .31, p < .001]$ reinforcement expectations but not with impulsivity or self-directedness. Consequently, ethnicity and nicotine dependence were included as covariates in all analyses described below.

3.2. Primary analyses

Hierarchical linear regression was used to test the primary hypothesis that impulsivity is associated with expectations about the degree of positive and negative reinforcement derived from smoking. The covariates listed above were entered on the first step of each primary analysis, with impulsivity entered on the second step. Results indicated that impulsivity was a significant predictor of expectations about both positive reinforcement from smoking ($\beta = .22, R^2 \text{ change} = .047, p = .001$; Table 1) and negative reinforcement from smoking ($\beta = .25, R^2 \text{ change} = .064, p = .001$; Table 2). Specifically, more impulsive participants expected that smoking would provide greater positive and negative reinforcement compared to less impulsive participants.

3.3. Mediation analyses

We then conducted two mediational analyses to determine whether the associations between impulsivity and smoking reinforcement expectations were mediated by self-directedness. Tests of mediation were conducted using the criteria recommended by Baron and Kenny (1986). In each analysis, the covariates noted above were entered on the first step. To meet the criteria for mediation, the predictor or independent variable (impulsivity) must significantly predict both the mediator (self-directedness) and the criterion or dependent variable (positive or negative reinforcement expectations), and the mediator

Table 1. Hierarchical regression analysis testing the association between impulsivity and positive reinforcement expectations

Step	Predictor variable	β	$R^2 \text{ change}$	$F \text{ change}$	p
Criterion variable: Positive reinforcement expectations					
1	Covariates			.236	26.74
	Ethnicity	.11			< .001
	FTND	.47			.095
2	Impulsivity	.22	.047	11.40	< .001

FTND = Fagerstrom Test for Nicotine Dependence.

Table 2. Hierarchical regression analysis testing the association between impulsivity and negative reinforcement expectations

Step	Predictor variable	β	$R^2 \text{ change}$	$F \text{ change}$	p
Criterion variable: Negative reinforcement expectations					
1	Covariates			.118	12.06
	Ethnicity	.13			< .001
	FTND	.30			.053
2	Impulsivity	.25	.064	12.75	< .001

FTND = Fagerstrom Test for Nicotine Dependence.

must predict the criterion variable. Additionally, the degree to which the predictor variable predicts the criterion variable must be decreased when the mediator is added to the model.

As described above, impulsivity was a significant predictor of positive reinforcement expectations. Additionally, impulsivity predicted self-directedness ($\beta = .20$, R^2 change = .038, $p = .009$) and self-directedness in turn predicted positive reinforcement expectations ($\beta = -.27$, R^2 change = .074, $p = .001$). In other words, participants higher in self-directedness had lower positive reinforcement expectations. Finally, when the covariates were entered on the first step, self-directedness on the second step, and impulsivity on the third step, impulsivity was no longer a significant predictor of positive reinforcement expectations ($\beta = .09$, R^2 change = .007, $p = .264$). That is, self-directedness mediated the relationship between impulsivity and positive reinforcement expectations.

As previously noted, impulsivity was also a significant predictor of both negative reinforcement expectations and self-directedness. Self-directedness also predicted negative reinforcement expectations ($\beta = -.31$, R^2 change = .098, $p = .001$), indicating that more self-directed participants had decreased expectations about the negative reinforcement provided by smoking. Finally, when the covariates were entered on the first step, self-directedness on the second step, and impulsivity on the third step, impulsivity was no longer a significant predictor of negative reinforcement expectations ($\beta = .13$, R^2 change = .014, $p = .092$). In other words, self-directedness was also shown to mediate the relationship between impulsivity and negative reinforcement expectations.

In sum, higher levels of impulsivity were associated with greater expectations regarding positive and negative reinforcement provided by cigarette smoking. In both instances, the relationship was mediated by self-directedness, such that the relationships between impulsivity and positive and negative reinforcement expectations were explained by the fact that more impulsive participants tended to be lower in self-directedness.

4. Discussion

The present study indicates that, among college students who smoke, heightened impulsivity is associated with greater expectations regarding the positive and negative reinforcement value of cigarette smoking. Although this relationship has previously been found among other substance abusing populations, to our knowledge, the current study represents the first time it has been investigated among cigarette smokers. The current finding is consistent with previous research showing that smokers tend to be more impulsive than non-smokers (e.g., Kassel et al., 1994, Lipkus et al., 1994 and Zuckerman & Kuhlman, 2000) and that impulsive smokers have disproportionate difficulty quitting smoking (Doran et al., 2004). Furthermore, results from this study suggest that impulsive individuals who are not yet regular smokers, and who expect smoking to be more reinforcing, are more likely to engage in more frequent smoking behavior and therefore be more prone to becoming regular, dependent smokers. Additionally, heightened expectations about reinforcement from smoking would seem likely to inhibit cessation. That is, if impulsive smokers perceive smoking as more valuable than other smokers, they may be less motivated to quit and therefore less likely to succeed in their cessation efforts.

The relationship between impulsivity and smoking reinforcement expectations was mediated by self-directedness. More specifically, the link between impulsivity and reinforcement expectations was explained by the fact that more impulsive participants had lower levels of self-directedness than their less

impulsive peers. This finding is consistent with various definitions of impulsivity, which often include the tendency to act without forethought, or to pursue immediate reinforcement without regard for future consequences (Evenden, 1999). To be self-directed requires behavior that is likely to be particularly difficult for more impulsive individuals, such as adapting one's behavior to one's environment (e.g., accounting for future consequences of a behavior) and pursuing long-term goals (e.g., foregoing immediately rewarding behaviors in favor of behaviors that provide larger but delayed rewards). In other words, it may be that a lack of self-directedness is an important component of impulsivity with regard to substance abuse. Similar constructs have been discussed in previous research on impulsivity, such as lack of future orientation (Barratt, 1994 and Evenden, 1999). However, to our knowledge, the current study is the first to specifically implicate this aspect of impulsivity in substance abuse.

Certain aspects of the current study may limit the generalizability of the findings. First, participants were young, college students who generally exhibited low levels of nicotine dependence. Although it seems logical that similar findings would be observed among more regular, dependent smokers, we were unable to assess this due to the relatively low incidence of highly dependent smokers in this sample. Second, these results are based on regression analyses, limiting our ability to infer causality. Third, expectations about reinforcement may not necessarily be predictive of future dependence. However, this concern is partially eased by evidence that suggests expectations precede substance use (e.g., Christiansen, Smith, Roehling, & Goldman, 1989). In other words, certain expectations about the effects of a drug are predictive of continued use.

In sum, we found that impulsivity was associated with heightened expectations about the positive and negative reinforcement derived from cigarette smoking, consistent with findings from other substance using populations. Furthermore, we found that this relationship was mediated by self-directedness, such that more impulsive participants were lower in self-directedness, explaining their heightened reinforcement expectations. These findings implicate two specific aspects of impulsivity as playing a role in linking impulsivity and smoking: (1) the tendency to pursue immediately rewarding stimuli and (2) the tendency not to account for potential future consequences of present behavior. This, in turn, suggests that treatment approaches may prove more beneficial for impulsive smokers if they include training in response prevention. Such training may assist more impulsive smokers in refraining from smoking (a behavior that is immediately reinforcing) long enough to consider potential future consequences of their actions.

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