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THE RELATIONSHIP BETWEEN IMPULSIVITY, -TAKING PROPENSITY AND NICOTINE DEPENDENCE AMONG OLDER ADOLESCENT SMOKERS

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Abstract

Impulsivity and risk-taking propensity are neurobehavioral traits that reliably distinguish between smoking and non-smoking adults. However, how these traits relate to smoking quantity and nicotine dependence among older adolescent smokers is unclear. The current study examined impulsivity and risk-taking propensity in relation to smoking behavior and nicotine dependence among current older adolescent smokers (age 16–20 years; N = 107). Participants completed the Barratt Impulsiveness Scale–11 (BIS-11), the Balloon Analogue Risk Task (BART), and self-report measures of smoking behavior and nicotine dependence. Results indicated a significant positive relationship between nicotine dependence and the Attention subscale ($\beta = .20$, $t = 2.07$, $p < .05$) and the Non-planning subscale ($\beta = .19$, $t = 1.92$, $p < .06$) of the BIS-11. Contrary to expectation, the results also indicated a significant negative relationship between performance on the BART and nicotine dependence ($\beta = -.19$, $t = -2.18$, $p < .05$), such that greater risk-taking propensity was associated with less dependence. These data suggest that impulsivity and risk-taking propensity are related to older adolescent smoking but are separable traits with distinguishable associations to nicotine dependence among adolescents. These findings support the notion that impulsivity is related to heightened nicotine dependence, but suggest the relationship

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All authors contributed in a significant way to the manuscript. Dr. Carpenter designed the study and wrote the protocol. Dr. Ryan conducted the statistical analysis and wrote the first draft of the manuscript. Dr. MacKillop conducted literature searches and provided summaries of previous research studies and contributed to the interpretation of the findings. All authors contributed to the writing of the manuscript and have approved the final manuscript.

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between risk-taking propensity and nicotine dependence is more ambiguous and warrants further investigation.

Keywords

older adolescent smoking; impulsivity; risk-taking; nicotine dependence

1. Introduction

Smoking typically begins in adolescence, since almost 90% of adult smokers began smoking before age 21 (Giovino, 1999). Factors that moderate adolescent smoking behavior and onset of nicotine dependence are not entirely clear. While a number of studies have examined psychosocial correlates of smoking progression (Brook et al., 2008; Costello, Dierker, Jones, & Rose, 2008), few have examined neurobehavioral traits that also may relate to smoking behavior (e.g., Chassin et al., 2008; Audrain-McGovern et al., 2004).

Two specific neurobehavioral traits hypothesized to influence the onset and maintenance of cigarette smoking are impulsivity (Coggins, Murrelle, Carchman, & Heidbreder, 2009; Fields, Collins, Leraas, and Reynolds, 2009) and risk-taking propensity (Ida & Goto, 2009; Reyna & Farley, 2006). Impulsivity is a multidimensional construct that correlates with several aspects of behavior (Weafer, Milich, & Fillmore, 2010; Whiteside and Lynam, 2001) including impulsive personality traits (Whiteside and Lynam, 2001), behavioral inhibition, and ability to delay gratification (for a review, see de Wit, 2009). Across a number of studies using diverse measures, impulsivity is consistently higher among adult smokers vs. non-smokers (Bickel, Odum, & Madden, 1999; Bickel & Marsh, 2001; Heyman & Gib, 2006; Kassel, Shiffman, Gnys, Paty, & Zettler-Segal, 1994; Odum & Baumann, 2007; Reynolds, 2006; Reynolds, Richards, Horn, & Karraker, 2004). While there has been less research on the role of impulsivity in older adolescent smoking, one study demonstrated that adolescent smokers self-reported higher impulsivity and discounted more by delay than nonsmokers (Fields et al., 2009). Another study demonstrated that impulsivity significantly predicted the presence of symptoms of tobacco dependence among young adult smokers (Chase & Hogarth, 2011).

Risk-taking propensity, a person's inclination to engage in a behavior that involves the potential for both gain and loss (Jessor, 1998; Lejuez et al., 2002), has been conceptualized as an interaction between poor impulse control and heightened reward seeking (Casey, Getz, & Galvan, 2008; Steinberg, 2008, 2010). Imaging data suggest that over-use of reward systems and under-use of prefrontal systems may underlie risk-taking behaviors observed in adolescents (Galvan et al., 2006). Risk-taking has also been linked to smoking status (Lejuez et al 2003), though there has been little research on risk-taking among adolescent smokers. One study (Lejuez, Aklin, Bernalova, & Moolchan, 2005) found that both impulsive-sensation seeking and risk-taking were predictive of smoking status, and another demonstrated that adolescent smokers are more risky than nonsmokers (Schepis, McFetridge, Chaplin, Sinha, & Krishnan-Sarin, 2011), but had a very small sample size (N = 12).

Though it has been consistently shown that impulsivity and risk-taking can reliably distinguish smokers from nonsmokers, it is unclear if and how such traits impact early-stage smokers. We could find no studies that examine either impulsivity or risk-taking as they relate to the early course of smoking among older adolescents. A better developed understanding of how these neurobehavioral traits relate to ongoing smoking behavior and nicotine dependence among older adolescent smokers may inform both etiological models

and treatment interventions. Our purpose was to determine whether impulsivity or risk-taking is associated with smoking behavior among older adolescent early-stage smokers and, reciprocally, whether these associations are more strongly related to cigarette consumption or nicotine dependence. We hypothesized that higher levels of both impulsivity and risk-taking would be associated with greater smoking and nicotine dependence, but did not make specific predictions for which indices would be most robust, or offer differential associations with quantity versus dependence.

2. Methods

2.1 Participants

As part of a parent study examining stimulus control among early stage smokers, non-treatment seeking smokers ($n=107$) ages 16–20 were screened to meet criteria as either a current daily smoker or occasional smoker. Consistent with prior research (Shiffman, Krichner, Ferguson, & Scharf, 2009), a daily smoker was defined as smoking 5 cigarettes per day (cpd), on at least 26/30 days of each month for at least 6 months. Smoking status was confirmed upon initial study visit through carbon monoxide (CO) breathalyzer (Bedfont Scientific). An occasional smoker was defined as smoking 1 cigarette in each of the past 8 weeks, no more than 25 days of smoking per month. For the current study, daily and occasional smokers were combined to form one continuous group. There were no constraints on smoking prior to the baseline visit (i.e., no manipulation of nicotine withdrawal). Potential participants under age 18 were required to provide parental consent. Participants were recruited through newspaper advertisement and fliers at local universities and colleges. On average, the participants were 18.9 years old ($SD=.95$), smoked 21 out of 30 days ($SD=9.1$), and averaged 56.7 cigarettes/week ($SD=51.1$). They were primarily male (57.9%), Caucasian (83.2%), high school graduates (87.9%), many of whom completed some college/technical school (59.7%).

2.2 Measures

2.2.1 Smoking history—Participants were asked standard questions on current smoking patterns, smoking environment (e.g., # smokers in home) and previous quit history. From these questions, our analyses focused exclusively on the number of cigarettes smoked/week.

2.2.2 Barratt Impulsiveness Scale–11 (BIS-11)—The BIS-11 (Patton, Stanford, & Barratt, 1995) is a 30-item self-report assessment of impulsiveness. Items are on a 4-point scale (1=rarely/never to 4=almost always/always). Reliability for the total scale score was strong (cronbach alpha=.83). The BIS-11 comprises three subscales: 1) Motor impulsiveness (e.g., “I do things without thinking;” alpha = .70), 2) Attentional impulsiveness (“I concentrate easily;” alpha = .60), and 3) Non-planning impulsiveness (“I plan tasks carefully;” alpha = .66).

2.2.3 Balloon Analogue Risk Task (BART: Lejuez et al., 2002)—The BART, delivered via laptop computer, measured risk-taking propensity. A computer screen displayed a small balloon accompanied by a pump, a reset button, and a tally of points earned. Each click on the pump inflated the balloon incrementally. With each pump, points accumulated in a temporary bank. Balloons could ‘explode’ at any point, forcing the respondent to lose all points in the temporary bank. Within each trial, participants could stop inflation of the balloon and deposit all points into a bank. A new balloon appeared after each balloon explosion or upon depositing points in the bank, for a total of 20 balloons. The primary BART measure was the average number of pumps used only on balloon trials that were banked, excluding those balloons that exploded (Lejuez et al., 2002; Lejuez et al., 2003). Participants were awarded non-redeemable points only.

2.2.4 Autonomy Over Smoking Scale (AUTOS: DiFranza, Wellman, Ursprung, & Sabiston, 2009)—The AUTOS is a 12-item self-report measure of nicotine dependence that is a recent iteration of the Hooked on Nicotine Checklist (DiFranza et al., 2002). Like its predecessor, the AUTOS is thought to be somewhat distinct from smoking consumption and more sensitive to low rate smoking behavior (DiFranza et al., 2007; MacPherson, Strong, & Myers, 2008). Nicotine dependence was defined as symptom counts.

2.3 Data Analysis

A bivariate correlational matrix was first established for relevant demographics, a measure of smoking quantity (cigarettes/week), nicotine dependence, BIS subscale scores, and the BART. Multiple regression was used to simultaneously examine the association of impulsivity, risk-taking propensity, smoking quantity and nicotine dependence. Measures of nicotine dependence (AUTOS) and smoking quantity (cigarettes/week) were used as the dependent variables. Covariates were included in the regression model if they significantly related to the respective outcome as determined in the correlation analysis. Effect sizes were reported as correlation coefficients and standardized and unstandardized regression coefficients.

3. Results

3.1 Zero-Order Correlations

As expected, smoking-related variables were significantly intercorrelated, as were impulsivity subscales (Table 1). BIS subscales and BART performance were not associated. Significant positive relationships were present between nicotine dependence (AUTOS symptom summation) and the BIS-11 Attentional ($r=.29, p<.05$) and Non-planning subscales ($r=.23, p<.05$), respectively; however, smoking quantity (cigarettes/week) was not correlated with any of the BIS-11 factors. In contrast, there was a significant negative relationship between nicotine dependence and risk-taking (BART performance; $r=-.22, p<.05$). Risk-taking was unrelated to smoking quantity.

3.2 Hierarchical Regression

We ran separate regressions for both nicotine dependence (AUTOS) and smoking quantity (cigarettes/week), controlling for duration of smoking (Table 2). The model for nicotine dependence was significant ($p<.05, R^2=.28$), in which the Attentional subscale of the BIS-11 ($\beta=.20, p<.05$) was positively associated with nicotine dependence, as well as a trend towards significance for the Non-planning subscale ($\beta=.19, p<.06$). Performance on the BART was a significant negative predictor of dependence ($\beta=-.19, p<.05$). The regression model for smoking quantity ($p<.05, R^2=.19$), was also significant, only duration of smoking was a significant predictor. Generally, all effects were of medium size.

4. Discussion

This analysis examined both impulsivity and risk-taking in relation to smoking rate and nicotine dependence among older adolescent smokers. Based on previous studies on adults, we predicted positive associations for both traits. Consistent with this, greater impulsivity (non-planning, attention) was predictive of higher levels of nicotine dependence, but not smoking rate. This finding is consistent with a recent report showing that higher BIS-11 scores were predictive of endorsement of DSM symptoms of nicotine dependence (Chase & Hogarth, 2011). Notably, high scores on non-planning have been associated with greater impulsivity on a delay discounting task (de Wit, Flory, Acheson, McCloskey, & Manuck, 2007) and heavy levels of smoking (Skinner, Aubin, & Berlin, 2004). All significant associations herein were specific to nicotine dependence, not smoking rate. This suggests

that these relationships are etiologically relevant to the clinical syndrome and not only to the quantity and frequency of tobacco use.

Contrary to our hypothesis, our findings showed that greater risk-taking was predictive of *less* nicotine dependence. These results are somewhat counterintuitive and contrast with two previous observations of higher risk-taking among adult and adolescent smokers compared to nonsmokers (Lejuez et al., 2003; Lejuez et al., 2005), though another study found no significant differences between smokers and nonsmokers (Dean et al., 2011). Two recent studies have reported relationships between BART performance and alcohol misuse in a manner consistent with our results (Ashenhurst, Jentsch, & Ray, 2011; Courtney et al., 2011).

The finding that impulsivity and risk-taking relate to smoking behavior in opposing ways provides further evidence that these neurobehavioral constructs are separable characteristics that may have unique contributions to smoking behavior. This is consistent with a recent meta-analysis examining the relationship between self-report impulsivity measures in relation to behavioral tasks, which found negligible associations (Cyders & Coskupinar, 2011).

A number of methodological considerations constrain interpretation. Participants were given no instruction about smoking prior to the study visit and also were not assessed for withdrawal and time since last cigarette. Thus, the possible effects of nicotine withdrawal or nicotine-related performance enhancement is not known. Given no instruction, it is likely that participants smoked ad libitum and were neither under the influence of withdrawal nor excessive acute nicotine. Second, the study used established and psychometrically validated measures of impulsivity and risk-taking, but it was by no means a comprehensive battery of either. Impulsivity has been elsewhere assessed with behavioral tasks measuring delay of gratification (Bickel & Marsch, 2001; Reynolds, 2006) and behavioral inhibition (Schepis et al., 2011). As these indices of impulsivity are largely separate from personality measures (Cyders & Coskupinar, 2011), inclusion of behavioral tasks may have strengthened our understanding of the relationship between impulsivity and smoking behavior. Third, the study did not include tangible rewards for BART performance. A reinforcer of different magnitude or mode may have influenced the results. Fourth, the ideal design to examine the influence of neurobehavioral traits on early-stage smoking would entail a large, prospective analysis of adolescents at all stages of smoking (including non-smoking). The current study provided a cross-sectional analysis of older adolescent smokers across a continuum of cigarette use, which we believe offers an important contribution given the paucity of data while still suggesting a need study these variables systematically over time.

Taken together, these findings highlight the importance of impulsivity and risk-taking in smoking and nicotine dependence. Greater impulsivity was associated with greater nicotine dependence in this sample and may be an important factor in the development of nicotine dependence. The unexpected inverse relationship between risk-taking and nicotine dependence suggests that risk-taking may be related to smoking, but clearly requires further study.

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Highlights

- Impulsivity and risk taking propensity relate to smoking behavior in opposing ways in older adolescent smokers
- Higher attentional impulsivity related to greater nicotine dependence in older adolescent smokers
- Higher risk taking propensity related to less nicotine dependence in older adolescent smokers

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Table 1
Zero-order Correlations among Impulsivity, risk-taking Propensity, Smoking Variables and Demographic Variables;

Variable	Mean (SD)	1	2	3	4	5	6	7	8	9
1. Age	18.9 (.95)	-	-.21*	.21*	.13	.00	-.05	.09	.14	.03
2. Gender (1=male; 2=female)	58%/42%		-	-.11	.09	.05	.12	-.05	-.14	-.05
3. Smoking Duration (yrs)	3.4 (1.9)			-	.16	.08	.03	-.11	.40**	.40**
4. BIS-11 Motor	24.6 (5.4)				-	.38**	.45**	.04	.00	.11
5. BIS-11 Attention	20.7 (4.8)					-	.47**	-.07	.13	.29**
6. BIS-11 Non-Planning	26.4 (5.3)						-	.11	.09	.23*
7. BART: Adj Avg Pumps	32.3 (12.13)							-	-.10	-.22*
8. Cigarettes/week	56.7 (51.1)								-	.64**
9. AUTOS	15.42 (9.6)									-

*
p < .05;

**
p < .01.

Table 2

Multiple Regression Models using Smoking Duration, Impulsivity Subscales, and Risk-Taking in relation to Nicotine Dependence and Smoking Rate.

	AUTOS (N=107)			Cigarettes/Week (n=106)		
	Beta	β	95% CI	Beta	β	95% CI
Smoking Duration	.37	1.85	1.00–2.71**	.410	1.09	6.06–15.76**
BIS Motor	-.11	-.20	-.55–.14	-.150	-1.43	-3.39–.54
BIS Attention	.20	.41	.02–.80*	1.14	.11	-1.08–3.36
BIS Non-planning	.20	.35	-.01–.72 ⁺	.100	.96	-1.12–3.05
BART: Avg. Adj. Pumps	-.19	-.15	(-.28)–(-.01)*	-.049	-.21	-.97–.56

⁺ p=.06,

* p < .05;

** p < .01