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Alcohol Use as a Signal for Sensitivity to Nicotine Dependence among Recent Onset Smokers

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Abstract

Objective—This study evaluated the association between alcohol use, abuse and dependence and cigarette smoking to determine whether alcohol may signal greater sensitivity to nicotine dependence at very low levels of smoking.

Method—Data were drawn from five annual National Surveys on Drug Use and Health and included individuals age 12 to 21 who reported first exposure to smoking within the past two years and smoking at least once in the past month.

Results—Both alcohol abuse and alcohol dependence were associated with increased likelihood of symptoms that seem to tap tolerance for nicotine. These included items such as “the amount you smoke has increased”; “needing to smoke a lot more now in order to be satisfied”; and “smoking much more before starting to feel anything”. Alcohol dependence, but not abuse was associated with the remaining symptoms, “after not smoking for a while, needing to smoke to feel less restless and irritable”; “craving cigarettes after not smoking for a while”; and “worrying about running out of cigarettes”. All associations were not better accounted for by either alcohol use or amount smoked.

Conclusion—If causally associated, treatment of alcohol-use disorders may prevent or reduce the early emergence of nicotine dependence symptoms among new smokers, very early in the smoking uptake process. If instead alcohol disorders are a signal of sensitivity for nicotine dependence best accounted for by a third variable, then adolescents with alcohol dependence and/or abuse during early exposures to smoking represents an important subgroup that may benefit from interventions directly targeting this association.

Keywords

Alcohol; Smoking; Nicotine Dependence

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1.0 Introduction

One of the most potent risk factors consistently implicated in both the etiology of smoking behavior and the subsequent development of nicotine dependence is the use of alcohol. Research within adolescence and young adulthood has shown that drinking is associated with the initiation and escalation of smoking and vice versa (Dierker et al., 2006; Jensen et al., 2003). Notably, discussion of the mechanism of association between smoking and alcohol use has focused on the role of alcohol in elevating an individual's probability of smoking exposure, including increasing the likelihood of initiation, promoting earlier onset, and/or influencing the number of cigarettes or persistence of smoking. In other words, alcohol use is believed to promote increases in smoking *exposure* that in turn cause physiological adaptations leading to nicotine dependence symptoms (Pomerleau, 1995).

A complementary or alternate role that alcohol may play in increasing smoking behavior is as a cause or signal of greater sensitivity to nicotine dependence symptoms. That is, individuals drinking alcohol and/or experiencing alcohol use disorders may also be more likely to experience symptoms of nicotine dependence at low levels of smoking. These early emerging nicotine dependence symptoms may in turn more directly contribute to an increase in the likelihood of continued smoking and difficulty in quitting (Dierker & Donny, 2008). In a recent study based on a nationally representative sample of young adults from the National Epidemiologic Survey of Alcohol and Related Conditions, smokers with alcohol dependence showed elevated rates of DSM-IV nicotine dependence across daily smoking levels compared to individuals without alcohol dependence. Further, the prevalence of nicotine dependence among those with alcohol dependence was high (~80%) even at low levels of smoking (e.g., 1 to 5 cigarettes per day) (Dierker & Donny, 2008).

Although these findings suggest that rates of DSM-IV nicotine dependence are elevated among those with alcohol dependence over and above how much an individual smokes, a number of questions regarding this association remain unanswered. First, it is unclear whether it is uniquely the presence of alcohol *dependence* that signals a higher likelihood of nicotine dependence across levels of smoking or whether this association is also present among individuals with qualitatively (i.e., abuse) and quantitatively (i.e., binge drinking) different levels of alcohol use. If the association is unique to alcohol dependence, this may suggest a common etiology for both types of dependence (Bien & Burge, 1990; Collins, 1990; Littleton & Little, 2002; Prendergast, Rogers, Barron, Bardo, & Littleton, 2002). Alternately, if the association between alcohol and nicotine dependence is demonstrated at *quantitatively* different levels of alcohol use (binge vs. lower levels of drinking), a mechanism more centrally related to degree of use would be supported (Pomerleau, 1995).

A second unanswered question is whether alcohol use signals sensitivity to *individual* early emerging symptoms of nicotine dependence or whether the associations can be accounted for by a full diagnosis of dependence. Notably, those symptoms that have been found to be among the earliest emerging for novice smokers have included irritability after not smoking for a while and a loss of control over smoking (Rose, Dierker & Donny, 2010; DiFranza et al., 2000; Gervais, O'Loughlin, & Meshefedjian, 2006). While it is true that smoking exposure is a necessary requirement for nicotine dependence, accumulating evidence suggests that frequency and quantity of smoking are markedly imperfect indices for determining an individual's probability of developing nicotine dependence symptoms and that, for a subset of smokers, symptoms emerge very soon after smoking initiation and well before the onset of sustained, regular use (Dierker, Donny, Tiffany, Colby, Perrine & Clayton, 2007; DiFranza et al., 2000; O'Loughlin et al., 2003). Risk for the emergence of these early emerging symptoms may be elevated in the presence of co-occurring alcohol use irrespective of how much an individual smokes. While, alcohol dependence as a possible

signal for nicotine dependence has been demonstrated among daily young adult smokers (Dierker & Donny, 2008), this association, has not been examined among more novice smokers.

Data for the present study were drawn from five annual National Surveys on Drug Use and Health (NSDUH), one of the largest, nationally representative, epidemiologic studies available to date that includes substantial heterogeneity in adolescent nicotine exposure, as well as assessment of symptoms of nicotine dependence among adolescents as young as 12 years old. The aims of the study were to evaluate whether alcohol use, abuse, and/or dependence may signal a higher likelihood of nicotine dependence symptoms at low levels of smoking.

2.0 Methods

2.1 Participants

The sample, drawn from data combining five annual NSDUH surveys (2002–2006), consisted of N=6716 individuals age 12 to 21 who reported 1) drinking alcohol in the past year, 2) smoking at least once in the past month, and 3) their first exposure to smoking within the past two years. The NSDUH utilizes multistage area probability sampling methods to select a representative sample of the noninstitutionalized U.S. civilian population aged 12 or older. Persons living in households, military personnel living off base, and residents of noninstitutional group quarters including college dormitories, group homes, civilians dwelling on military installations, as well as persons with no permanent residence are included.

Half the sample was female (49%) and the mean age was 17 (SE=0.030). Racial/ethnic representation was 69% Nonhispanic White, 16% Nonhispanic Black, 10% Hispanic, and 5% Other. The majority (81%) were non-daily smokers. Participants smoked a mean of 12.1 of the past 30 days (SE=0.16, range 1–30). Half (50%) had been smoking for more than one but no more than two years, and the rest began smoking in the past year. Most non-daily smokers (62.7%) reported smoking no more than 1 cigarette on the days they did smoke and 95% reported smoking 5 or fewer cigarettes on the days they smoked.

2.2 Measures

Alcohol—Groups reflecting four mutually exclusive, current alcohol-use levels were created: 1) past year DSM-IV alcohol dependence; 2) past year DSM-IV alcohol abuse without dependence; 3) binge drinking in the past 30 days, without dependence or abuse and 4) any drinking in the past year that did not reach binge levels, abuse or dependence. Participants with alcohol dependence drank a mean of 10 days in the past month, drank and a mean of 7 drinks per drinking day. Those with alcohol abuse drank a mean of 8 days in the past month, drank and drank a mean of 6 drinks per drinking day. Binge drinkers drank a mean of 6 days in the past month and drank a mean of 6 drinks per drinking day. Alcohol users in the past 12 months drank a mean of 3 days in the past month and drank a mean of 2 drinks per drinking day.

Smoking—Participants were asked how many days they smoked cigarettes in the past 30 days. Smoking quantity was also assessed by asking participants to report the mean number of cigarettes they smoked on the days that they smoked cigarettes in the past 30 days. Length of exposure was calculated by subtracting the age at which participants first reported smoking a cigarette from their current age, and dichotomizing into one year or less vs. between one and two years.

Nicotine Dependence—The NSDUH includes 17 items measuring nicotine dependence symptoms. For the present analyses, the NDSS total scale was examined as well as 7 nicotine dependence symptoms that have been previously shown in this nationally representative sample of recent onset smokers to best represent the construct and discriminate well across different levels of nicotine dependence in both daily and non daily smokers (Rose & Dierker, 2010).

Items were rated according to how true each of the symptoms was during the past 30 days using the following response options: 1) not at all true, 2) sometimes true, 3) moderately true, 4) very true, and 5) extremely true. The four response options of “sometimes true” to “extremely true” were collapsed into a single category to generate a dichotomous variable for symptom endorsement (No - not at all true vs. Yes - any of the four positive responses). Dichotomizing the responses in this manner has been shown to increase model stability without a loss of information or reliability (Strong, Kahler, Colby, Griesler, & Kandel, 2009).

2.3 Analyses

Logistic and multiple regression analyses were conducted examining the association between alcohol use (4 mutually exclusive levels), and both the NDSS total score and each of the selected nicotine dependence symptoms, controlling for smoking frequency (number of days smoked in the past 30), smoking quantity (number of cigarettes on the days smoked in the past 30), length of smoking exposure (1 year or less vs. 1 to 2 years), drinking frequency (number of drinking days in the past 30 days), age and gender. All analyses used appropriate sample weights to correct for differences in the probability of selection, and adjusted for survey design effects to obtain accurate standard errors.

3.0 Results

Rates of nicotine dependence symptoms for each level of alcohol use are shown in Table 1. Figures 1 through 7 illustrate rates of nicotine symptom endorsement by smoking frequency and alcohol group. In each model, alcohol use was significantly associated with the probability of endorsing individual nicotine dependence symptoms after controlling for smoking, drinking, age, and gender. Across all levels of smoking, paired comparisons further showed a greater likelihood of endorsement for each of the nicotine dependence symptoms among those with alcohol dependence compared to past year drinkers and binge drinkers. Further, those with alcohol dependence were more likely to endorse the symptoms 1) *smoking much more before starting to feel anything* 2) *feeling irritable after not smoking for a while*, 3) *craving cigarettes after not smoking for a while*, 4) *strong cravings that feels like you are in the grip of a force you cannot control* and 5) *worrying about running out of cigarettes* compared to those with alcohol abuse. There was no difference in rates of nicotine symptom endorsement between those with alcohol dependence and abuse for the remaining two symptoms 1) *since you started smoking, the amount you smoke has increased* and 2) *compared to when you first started smoking, you need to smoke a lot more now in order to be satisfied*.

Paired comparisons between nicotine dependence symptoms for those with alcohol abuse vs. lower levels of use showed that the nicotine dependence symptoms 1) *since you started smoking, the amount you smoke has increased* 2) *compared to when you first started smoking, you need to smoke a lot more now in order to be satisfied*; and 3) *smoking much more before starting to feel anything* were more likely to be endorsed by those with alcohol abuse compared to both binge and past year drinkers. Additionally, 1) *a strong craving that feels like you are in the grip of a force you cannot control* and 2) *worrying about running out of cigarettes* were more likely to be endorsed by those with alcohol abuse compared to

binge drinkers. Finally, with the exception of strong craving that was reported by binge drinkers more often than past year drinkers, these two groups reported similar rates of nicotine dependence symptoms.

4.0 Discussion

The present study examined whether alcohol is associated with the experience of nicotine dependence symptoms in novice smokers. After statistical control for smoking and drinking, the alcohol construct including dependence, abuse, binge drinking, and past 12 month drinking was found to be associated with the individual nicotine dependence symptoms. In general, the data suggested that the presence of alcohol dependence and abuse may serve as signals for enhanced sensitivity to nicotine dependence above and beyond both amount of smoking and alcohol use. The examination of individual symptoms of nicotine dependence showed that both alcohol abuse and alcohol dependence were associated with increased likelihood of those symptoms that seem to tap tolerance for nicotine when compared to binge drinking and drinking in the past year. These included “since you started smoking, the amount you smoke has increased”; “compared to when you first started smoking, you need to smoke a lot more now in order to be satisfied”; and “smoking much more before starting to feel anything”. Alcohol dependence but not alcohol abuse was associated with elevated rates for all of the remaining symptoms.

Historically, the link between alcohol use and smoking has most often been discussed in terms of the role of each behavior in increasing risk of exposure to the other substance or as general markers of risk taking (Jessor & Jessor, 1977). While alcohol use is associated with elevated levels of smoking behavior, the present findings add to accumulating evidence that the association may stem from the role of alcohol use disorders as a cause and/or signal for sensitivity to nicotine dependence symptoms over and above level of smoking and at remarkably low levels of non-daily smoking exposure. One possible mechanism that may explain the association between alcohol and nicotine dependence is that the neurobiological changes associated with the emergence of alcohol disorders may increase the propensity for similar changes related to nicotine dependence. For example, preclinical data suggest that the induction of tolerance to alcohol results in cross-tolerance to nicotine. That is, animals that develop tolerance to the effects of one substance may also become tolerant to the effects of the other as demonstrated with behavioral data (Funk, Marinelli, & Lê, 2006). Another possibility is that a third factor is related to risk for both alcohol and nicotine dependence (Li, Volkow, Baler, & Egli, 2007). For example, data from inbred mouse strains suggests that breeding animals for sensitivity to one substance results in heightened sensitivity to the other substance, suggesting that shared genetic risk factors may account for the covariance in reactivity to the two substances (Bien & Burge, 1990; Collins, 1990; Littleton & Little, 2002; Prendergast, Rogers, Barron, Bardo, & Littleton, 2002). The present findings confirm that alcohol use disorders likely play a role in the experience of nicotine dependence either as a *cause and/or signal* of sensitivity to nicotine dependence symptoms, at remarkably low levels of exposure to nicotine, and much lower levels than have been previously demonstrated.

Strengths and Limitations

The current findings should be interpreted within the context of study limitations. First, past 30 day quantity and frequency of smoking and time since initiation may be an incomplete measure of smoking exposure. For example, studies of smoking topography, comprised of variables such as maximum puff velocity, puff volume, and number of puffs, reveal that smokers vary considerably in the amount of smoke they inhale when they smoke a cigarette (Kozlowski, O'Connor, & Sweeney, 2001). Consequently, the number of cigarettes smoked over a given period is not strongly related to total nicotine exposure for that same period.

Additionally, the general assessment of consumption does not operationalize differences in nicotine exposure that are related to individual differences in nicotine metabolism (Malaiyandi, Sellers, & Tyndale, 2005). Thus, it is also possible that variability in nicotine dependence at similar levels of smoking between those with or without alcohol use disorders may still be based on variability in levels of nicotine exposure not captured by the present measure of the construct. Alternately, differences in rates of nicotine dependence may be driven by systematic differences in subjective evaluations of nicotine dependence symptoms rather than physiologic differences in sensitivity. That is, there may be biases in the way those with alcohol abuse or dependence respond to questions about nicotine dependence. Future research utilizing both experimental and epidemiologic methods is needed to support or reject these alternative explanations.

Given the cross-sectional nature of the data, it is important to note that the present findings also have limited implications in terms of understanding the relationship between the emergence of alcohol and nicotine dependence. Additional longitudinal work will be needed to more clearly establish the role of nicotine and alcohol in the emergence of dependence symptoms. Given the relatively low base rates of nicotine dependence and alcohol-use disorders as well as the variability in age of onset and period of risk for established smoking and alcohol use behaviors, this work will need to be carefully targeted at high risk samples that maximize the number of informative cases in order to provide adequate power for disentangling the specific associations.

Despite study limitations, the present investigation has practical implications that will guide future research. First, the major strength of the NSDUH study is that it provides the opportunity to examine a large and representative sample of recent onset smokers assessed for several nicotine dependence symptoms. Further, we were able to examine relatively early emerging symptoms that have been established in previous work to best measure nicotine dependence among smokers who have initiated within the past two years.

As the major dependence producing agent in cigarettes, nicotine is believed to play the pivotal role in keeping smoking rates stable. While chronic smoking is believed to be a key feature, the present study adds to accumulating evidence showing substantial individual variability in nicotine dependence symptoms based on the presence or absence of alcohol use disorders, not accounted for by variability in smoking exposure (Dierker & Donny, 2008). If causally associated, these findings would suggest that treatment of alcohol use disorders may prevent or reduce the early emergence of nicotine dependence among novice smokers. If instead, alcohol disorders are a signal of sensitivity for nicotine dependence, best accounted for by a third variable, then adolescents with alcohol dependence and/or abuse during their early exposures to smoking represents an important subgroup that may benefit from intervention that directly targets this association (Kalman, Kim, DiGirolamo, Smelson, & Ziedonis, 2010).

Research Highlights

Both alcohol abuse and alcohol dependence were associated with increased likelihood of tolerance for nicotine. This association was found over and above both nicotine and alcohol exposure. Alcohol dependence, but not abuse was associated with the remaining nicotine dependence symptoms, “after not smoking for a while, needing to smoke to feel less restless and irritable”; “craving cigarettes after not smoking for a while”; and “worrying about running out of cigarettes”

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Figure 1.
Rate of endorsement of feeling irritable after not smoking for awhile by smoking frequency.

Figure 2.
Rate of endorsement of craving cigarettes after not smoking for awhile by smoking frequency.

Figure 3. Rate of endorsement of craving that feels like you are in the grip of a force that you cannot control by smoking frequency.

Figure 4.
Rate of endorsement of worrying about running out of cigarettes by smoking frequency.

Figure 5.
Rate of endorsement of the amount you smoke has increased by smoking frequency.

Figure 6.
Rate of endorsement of need to smoke a lot more in order to be satisfied by smoking frequency.

Figure 7.
Rate of endorsement of smoking much more before starting to feel anything by smoking frequency.

Table 1
Nicotine Dependence Score and Design Adjusted Symptom Item Response Rates by Alcohol Use Group.

	Alcohol Dependence (N=707)	Alcohol Abuse (N=1189)	Binge Drinking (N=2222)	Drinking in past 12 mo. (N=2598)	Main Effect of Alcohol Use
After not smoking for a while, you need to smoke to feel less restless and irritable	60.0% ^a	53.0% ^b	44.5% ^b	49.7% ^b	$\chi^2(3)=18.26$, $p=0.0004$
When you don't smoke for a few hours, you start to crave cigarettes	47.1% ^a	40.7% ^b	34.1% ^b	37.6% ^b	$\chi^2(3)=21.85$, $p=0.0001$
You sometimes have strong cravings for a cigarette where it feels like you are in the grip of a force that you can't control	44.2% ^a	37.0% ^b	27.6% ^c	30.5% ^b	$\chi^2(3)=42.30$, $p=0.0001$
You sometimes worry that you will run out of cigarettes	38.2% ^a	32.6% ^{a,b}	24.0% ^b	24.7% ^b	$\chi^2(3)=32.11$, $p=0.0001$
Since you started smoking, the amount you smoke has increased	61.3% ^a	57.4% ^a	45.5% ^b	45.8% ^b	$\chi^2(3)=32.19$, $p=0.0001$
Compared to when you first started smoking, you need to smoke a lot more now in order to be satisfied	41.6% ^a	37.9% ^a	28.1% ^b	27.0% ^b	$\chi^2(3)=40.88$, $p=0.0001$
Compared to when you first started smoking, you can smoke much, much more now before you start to feel anything	57.5% ^a	48.0% ^b	37.3% ^c	38.6% ^c	$\chi^2(3)=35.55$, $p=0.0001$

^aRates within row with different superscripts illustrate significant differences according to paired comparisons.