

Sensation Seeking and Adolescent Drug Use: The Mediating Role of Association With Deviant Peers and Pro-Drug Discussions

Itzhak Yanovitzky

*Department of Communication
Rutgers, The State University of New Jersey*

In this study, I examined direct and indirect influences of sensation seeking, a personality trait, on adolescent drug use. I hypothesized that some or even most of the contribution of sensation seeking to drug use by adolescents is mediated through association with deviant peers and communication with peers that is favorable toward drug use. I examined the role of additional risk or protective factors in facilitating or impeding association with deviant peers, pro-drug communication, and marijuana use as well. The results of analyzing nationally representative cross-sectional data from the evaluation of the National Youth Anti-Drug Media Campaign support the study's hypotheses and suggest that different factors may protect high sensation-seeking adolescents from using drugs or engaging in activities (e.g., association with deviant peers) that may increase their risk for drug use. I discuss the theoretical, methodological, and practical implications of these findings to the design of health communication interventions.

The primary goal of this study was to demonstrate that sensation seeking, an individual intrapersonal trait, contributes to the likelihood of drug use by adolescents both directly and indirectly through the way it shapes social interactions with peers in the context of drug use. With few exceptions (e.g., Donohew, Hoyle, et al., 1999), the available scientific literature has focused on (and has generally supported) the proposition that high levels of sensation seeking are directly linked to

increased likelihood of adolescent drug use (Arnett, 1990; Newcomb & McGee, 1989; Palmgreen, Donohew, Lorch, Hoyle, & Stephenson, 2001; Sheer & Cline, 1994; Zuckerman, Ball, & Black, 1990). However, to the extent that sensation-seeking tendencies influence other known causes of adolescent drug use such as association with drug using or deviant peers, current research may be underestimating the contribution of sensation seeking to this problem. Moreover, if both direct and indirect influences of sensation seeking on drug use exist, it is important (both theoretically and from an intervention point of view) to identify additional elements, risk and protective factors, that may facilitate or impede this effect on adolescent drug use. I tested these propositions empirically with data collected from a large national sample of adolescents through the National Survey of Parents and Youth, an instrument used in the evaluation of the National Youth Anti-Drug Media Campaign.

SENSATION SEEKING AND SOCIALIZATION AS DETERMINANTS OF ADOLESCENT DRUG USE

Research that has addressed adolescents' motivation to use drugs has given rise to theories that have emphasized personality traits, in particular sensation seeking, as major factors affecting drug use (Newcomb & Earleywine, 1996). Sensation seeking is identified by a drive for varied, novel, complex, and intense experiences and the willingness to take risks to obtain those experiences (Zuckerman, 1979, 1994). This intrapersonal trait has been found to be a strong positive predictor of adolescent drug use (Donohew, Hoyle, et al., 1999; Hornik et al., 2001) and other risky behaviors such as smoking (Zuckerman et al., 1990), alcohol use (Donohew, Hoyle, et al., 1999; Newcomb & McGee, 1989), drinking and driving (Arnett, 1990), and risky sexual behavior (Sheer & Cline, 1994). The fact that sensation-seeking tendencies intensify during adolescence (although they level off in the late 20s) may explain the tendency of adolescent drug use to increase with age (Hornik et al., 2001; Zuckerman & Neeb, 1979). Current literature has offered several explanations for the association between sensation-seeking tendencies and drug use by adolescents. One explanation is that, for the high sensation-seeker adolescent, drug use involves taking illegal risks that the adolescent finds stimulating (Zuckerman, 1994). Another explanation is that high sensation-seeking adolescents use drugs to experience the neurological stimulation associated with the substance itself (Segal, Huba, & Singer, 1980). It has also been suggested that high sensation seekers underestimate the risks associated with drug use compared to their low sensation-seeking counterparts and are, therefore, less likely to consider drug use to be a risky behavior (Hovarth & Zuckerman, 1993; Hoyle, Stephenson, Palmgreen, Puzles Lorch, & Donohew, 2002).

The mounting evidence that links sensation seeking to drug use seems to undermine traditional claims that drug use by adolescents is primarily initiated and maintained through socialization by peers (Miller, Alberts, Hecht, Trost, & Krizek, 2000). Association with drug-using peers is one of the strongest single predictors of substance use among youth and adolescents (Bauman & Ennett, 1994; Hawkins, Catalano, & Miller, 1992; Kandel, 1985; Kandel & Davies, 1991; Kaplan, Johnson, & Bailey, 1987). Adolescent drug use often occurs in a peer context, particularly in the presence of overt or covert pressure from peers to use drugs (Oetting & Beauvais, 1986). Dinges and Oetting (1993), for example, found a relation between the particular substances used by youths and their peers. In their study, 41.6% of nonusing youth had friends who used marijuana compared to 97.5% of marijuana users who had friends using marijuana. On the other hand, relationships with prosocial peers (peers who have positive social and psychological capabilities and responsibilities) may protect adolescents from drug use (Hurrelmann, 1990). Catalano, Kosterman, Hawkins, Newcomb, and Abbott (1996), for example, found a significant relation between adolescent abstinence from drug use and involvement with prosocial peers and prosocial activities (see also Maxwell, 2002).

Several theories have been utilized to explain peer influences in the context of adolescent drug use (Petraits, Flay, & Miller, 1995).¹ Two of these, social control theory and problem behavior theory, focus on the degree of attachment to peers and other positive or negative social influences. According to social control theory (Hirschi, 1969), weak attachment to family, school, and the community leads to association with deviant peers, which in turn leads to drug use. Erickson, Crosnoe, and Dornbusch (2000), who tested this proposition, found that strong social bonds indirectly reduced adolescents' drug use by decreasing associations with deviant peers and by decreasing susceptibility to the negative influences of peers. Similarly, problem behavior theory (Jessor & Jessor, 1977) posits that an adolescent's proneness to drug use will be a function of the balance between protective and risk factors—some of which are proximal (immediate), whereas others are distal (indirect influences)—that is unique to each adolescent and the extent to which the ado-

¹It is worth noting that peer influence occurs at different levels of social relationships. In fact, the term *peer group* may refer to four types of groups that are nested within each other (Miller et al., 2000): the peer cohort (individuals who are the same age as the adolescent); the reference group (adolescents in the cohort such as "cool kids" with whom the adolescent identifies most); the peer cluster (small and cohesive group of close friends who tend to share similar values, beliefs, attitudes, and behaviors); and finally, the dyad (best friends pairs). Thus, for example, the peer cohort is influential in establishing an adolescent group norm with regard to drug use. Perceptions (or misperceptions) of the prevalence of drug use among adolescents in general and the extent to which other members of the cohort approve this behavior is an important determinant of actual drug use by adolescents (Berkowitz, 1992). Similarly, Maxwell (2002) found that both reference groups and peer clusters exert considerable pressure on their members to use or avoid drugs.

lescent's overall lifestyle favors engagement in unconventional behavior over conventional behaviors. Specifically, weak attachment to parents and conventional (nondeviant) peers and strong attachment to deviant peers were found to predict a constellation of deviant behaviors, including substance use (Jessor, Turbin, & Costa, 1998).

Other theories have focused on social learning of drug use through social interaction with deviant peers. Differential association theory (Sutherland, 1947) postulates that adolescents are socialized into delinquency through intimate social relationships with deviant peers. Through these associations, the adolescent acquires an excess of attitudes and beliefs favorable to using drugs. On the other hand, adolescents who primarily associate with prosocial (or normative) peers are likely to hold beliefs and attitudes that are opposed to drug use (Dinges & Oetting, 1993). Similarly, peer cluster theory (Oetting & Beauvais, 1986) posits that drug use occurs in the presence of peers (particularly, the most important peers or the peer cluster). Peers encourage adoption and ongoing use by tolerating drug use, providing emotional support, furnishing education about drugs, and making drugs available. Members of the peer cluster are not passive participants who are influenced by others but themselves contribute to development of peer clusters' norms and behaviors in the context of drug use.

Direct and Indirect (Mediated) Effects of Sensation Seeking on Adolescent Drug Use

Within the adolescent literature, then, the independent impact of sensation seeking and association with deviant peers on drug use has been well established. What is not entirely clear, however, is whether or not the impact of sensation seeking on adolescent drug use is independent of the impact that association with deviant peers has on this behavior. Donohew and colleagues (Donohew, Clayton, Skinner, & Colon, 1999; Donohew, Hoyle, et al., 1999) have examined this question from the primary socialization theory's point of view (see Oetting & Donnermeyer, 1998). According to this theory, personal characteristics and personality traits (including sensation seeking) affect drug use only indirectly through their effect on association with primary socialization agents, including deviant peers. This view is also shared by peer cluster theory according to which psychosocial factors influence the choice of peers, and only the association with members of the peer cluster affects drug use directly (Dinges & Oetting, 1993). A subsequent empirical test with longitudinal data collected from adolescents in Kentucky (Donohew, Hoyle, et al., 1999) gave some support to this proposition and demonstrated that adolescents selected to associate with peers who had similar sensation-seeking tendencies and that the sensation-seeking level of these peers tended to influence marijuana and alcohol use. On the other hand, Wills and Cleary (1999) reported that socialization with drug using peers predicted personal use and that there was little evidence of

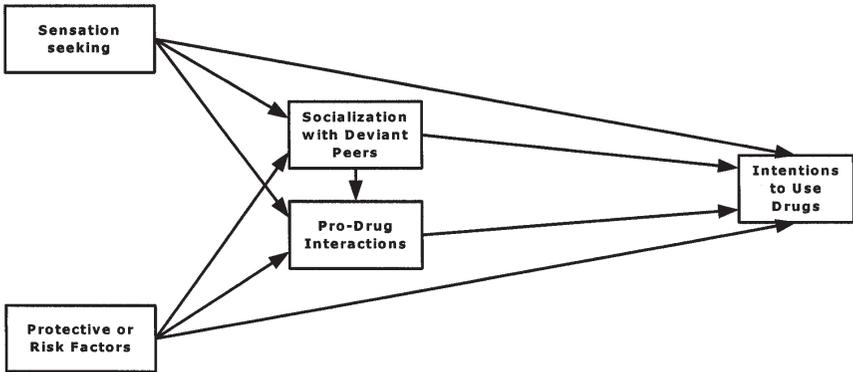


FIGURE 1 Direct and mediated effects of sensation seeking on adolescent drug use.

personality-based peer selection in their longitudinal data (although sensation seeking was not one of the personality traits examined in that study). One way to reconcile this contradictory evidence is to argue that although sensation seeking may affect adolescent drug use directly, some of this effect is mediated through the selection of and association with deviant peers. The model in Figure 1 captures this basic idea.

The model in Figure 1 describes a hypothesized process (or causal chain) that links sensation seeking and association with deviant peers to adolescent drug use (specifically, intentions to use drugs). According to this model, sensation seeking may be contributing to adolescent drug use in one of three ways. The most obvious route of effect, and the one most established in current literature, is a direct effect of sensation seeking on drug use. The two remaining routes of effects suggest that sensation seeking may be contributing to drug use indirectly through its impact on association with deviant peers and having pro-drug interactions with peers.² Sensation seeking is hypothesized to affect an adolescent's selection to associate with deviant peers either because sensation seekers tend to associate with other high sensation seekers who then engage in drug use to meet the collective need for stimulation (Donohew, Hoyle, et al., 1999) or because the mere association with deviant peers, whether high sensation seekers or not, provides opportunities for the high sensation-seeking adolescent to engage in activities that will satisfy that same need. Association with deviant peers, in turn, may lead to drug use directly (as has been suggested by the literature reviewed previously) or indirectly by increasing

²The term *deviant peers* refers to peers who are engaged in activities (including drug use) that are viewed by prevailing social norms as unacceptable or nonnormative. Still, deviance is relative to the norms of the specific groups in which the individual is a member. In other words, for a high sensation seeker, an association with other high sensation-seeking peers who engage in nonnormative or nonconventional behaviors may be a normative act.

the likelihood that the adolescent will have interactions with peers (e.g., discussions) that are favorable toward drug use.

The final path through which sensation seeking may affect adolescent drug use involves a direct impact of sensation seeking on the likelihood that an adolescent will have pro-drug interactions with peers (presumably because high sensation seekers may be more motivated than low sensation seekers to initiate discussions with peers that favor drug use) that, in turn, increase the likelihood of actual drug use. The influence of sensation seeking on the likelihood of having pro-drug discussions may also be indirect to the extent that sensation-seeking tendencies motivate the adolescent to associate with deviant peers and this association, in turn, provides the setting for holding discussions that are favorable to the notion of drug use by group members.

Following the existing literature on adolescent drug use, the model in Figure 1 postulates that in addition to sensation seeking and association with deviant peers (including pro-drug interactions), other risk or protective factors may facilitate or impede adolescent drug use either directly or through their influence on an adolescent's likelihood of associating and having pro-drug discussions with deviant peers. For example, demographic characteristics such as age, gender, and race affect the likelihood of drug use directly but also determine selection into and by peer groups (Kandel, 1985). Similarly, other socialization influences, of which the family is primary (Miller et al., 2000), may shape adolescents' decisions to use drugs directly (through modeling and nurturing) or by influencing patterns of socialization with peers by setting rules or monitoring children's activities (Aseltine, 1995; Kandel & Andrews, 1987; Maccoby & Martin, 1983; Miller et al., 2000; Warr, 1993).

HYPOTHESES

To summarize, this study was designed to test two main hypotheses. The first is that sensation seeking contributes to adolescent drug use both directly and through the mediation of association with deviant peers. This proposition will be supported if it is shown that, controlling for other risk and protective factors, (a) sensation seeking is an independent predictor of adolescent drug use (intentions to use drugs, in this case), frequency of association with deviant peers, and frequency of pro-drug discussions with peers; (b) frequency of association with deviant peers is predictive of both pro-drug discussions with peers and intentions to use drugs; and (c) pro-drug discussions about drugs are predictive of intentions to use drugs.

The second hypothesis is that other risk or protective factors may increase or decrease the likelihood of adolescent drug use by influencing either one or all of the three endogenous variables in Figure 1 (i.e., association with deviant peers, pro-drug discussions with peers, and intentions to use drugs). Specifically, other

known risk factors of adolescent drug use (e.g., age, unsupervised time spent with peers, and inconsistent school attendance) are expected to increase the likelihood of (a) association with deviant peers, (b) having pro-drug discussions with peers, and (c) actual drug use, whereas protective factors (e.g., positive family relationships, parental monitoring, religiosity, and involvement in prosocial activities) are expected to decrease the likelihood of the same variables.

METHOD

Data

In 1998, the Office of National Drug Control Policy launched the National Youth Anti-Drug Media Campaign (see Crano & Burgoon, 2002). The specific goals of this ongoing campaign are preventing and reducing drug use among youth and encouraging parents to play a more active role in this process (primarily through monitoring and talking to their children). The data used to test this study's hypotheses were collected by the Westat Corporation through the National Survey of Parents and Youth (NSPY) that was developed for the purposes of evaluating the campaign's ability to meet these goals (see Hornik et al., 2001). The first three waves of data collection (November 1999 to May 2000, July to December 2000, and January to June 2001) included interviews with a sample of 8,134 youth aged 9 to 18. Questionnaires were administered in respondents' homes on touch screen laptop computers and included extensive measurement of youth exposure to the campaign messages and other anti-drug messages; their beliefs, attitudes, intentions, and behaviors with regard to drugs; and a wide variety of related factors, including sensation seeking, deviant behavior, and association with deviant peers. Response rate among selected youth across all three waves was approximately 91% to 92%.

Variables

The dependent variables in this study are the three endogenous variables in Figure 1: association with deviant peers, pro-drug interactions with peers, and intentions to use drugs (marijuana). A measure of an adolescent's frequency of association with deviant peers was generated by adding responses on four items that inquired about the number of times (none, once, twice, 3 times, 4–5 times, 6–7 times, and more than 7 times) in the previous week that the adolescent got together with friends who (a) get in trouble a lot, (b) fight a lot, (c) steal, and (d) smoke cigarettes or chew tobacco. The resulting index had an acceptable level of internal consistency ($\alpha = .74$) and contained values ranging from 0 (*no association*) to 24 (*highest degree of association*) with a mean of 3.54 ($SD = 0.06$), which is equivalent to 2.5 times per week.

The frequency of having pro-drug discussions with peers was estimated through the multiplication of two variables. Respondents were first asked to indicate the frequency in which they have discussed drugs with friends in the past 6 months using a 6-point scale ranging from 1 (*never*) to 6 (*more than 10 times*). Next, they were asked a set of three questions about the content of these discussions (i.e., “that marijuana use isn’t so bad,” “specific things I can do to stay away from drugs,” and “bad things that happen if you use drugs”) for which answers were dichotomized (“yes” or “no”). The last two items were reverse coded before adding responses to all three items to construct a measure of having discussions that are pro-drug use in nature ($\alpha = .63$). To create the actual measure of the frequency of having pro-drug discussion with peers, the reported frequency of discussion with peers about drugs (the first measure) was weighted (through multiplication) by the extent to which these discussions were pro-drug (the second measure). The resulting variable ranged from 0 (*no pro-drug discussions*) to 18 (*frequent pro-drug discussions*), with a mean of 4.45 ($SD = 4.6$).

Intentions to use drugs (marijuana) was measured using an adolescent’s self-reported intention to use marijuana even once or twice over the next 12 months, measured on a 5-point Likert-type scale ranging from 1 (*definitely not*) to 5 (*definitely yes*) as a proxy of future behavior. Although the study did ask respondents directly about marijuana use, it did so in relation to the previous 12 months. Given that in addition to exogenous variables, the two remaining endogenous variables in Figure 1 (i.e., association with deviant peers and frequency of having pro-drug discussions about drugs) are hypothesized to cause actual drug use (and thus should precede the occurrence of this variable timewise), using a retrospective measure of drug use was logically incompatible with the model portrayed in Figure 1. As behavioral intentions are the immediate antecedent and the single best predictor of actual behavior (Fishbein et al., 2001), the use of this variable here seemed reasonable.

The primary independent variable in this study is an adolescent’s level of sensation seeking. An adolescent’s sensation seeking is typically estimated using Form V of the Sensation Seeking Scale (Zuckerman, 1994), which consists of 40 forced-choice items measuring thrill and adventure seeking, experience seeking, disinhibition, and boredom susceptibility. More recently, Hoyle et al. (2002) sought to develop and test a brief sensation seeking scale based on a subset of the original 40 items that would correspond to the original measure and be sufficiently brief to be included in lengthy, large-scale surveys such as NSPY. Hoyle et al.’s Brief Sensation Seeking Scale included eight items with an acceptable level of internal consistency ($\alpha = .76$) that performed well in subsequent tests. For reasons of space and cost, in this study I used only four of these items. Specifically, respondents were asked to indicate their agreement on a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) with the following statements: “I would like to explore strange places”; “I like to do

frightening things”; “I like new and exciting experiences, even if I have to break the rules”; and “I prefer friends who are exciting and unpredictable.” Responses to these four items (which had an internal consistency of $\alpha = .80$) were then summed and averaged into a single measure ranging from 1 to 5 with a mean sensation seeking score of 2.68 ($SD = .94$).

Exogenous variables other than sensation seeking included demographic controls and a number of risk and protective factors. Demographic controls included age, gender, and race (White, African American, Hispanic, and other). All three demographic variables have been shown to be associated with drug use (Newcomb & Felix-Ortiz, 1992), sensation seeking (Hoyle et al., 2002), and association with deviant peers (Haynie, 2001). Based on previous research (e.g., DeWitt, Silverman, Goodstadt, & Stoduto, 1995; Newcomb & Felix-Ortiz, 1992), a number of risk and protective factors were included in the study as additional predictors of the three dependent variables. Protective factors included religiosity, school performance, positive family relationships, perceived parental monitoring, and involvement in prosocial activities.

Religiosity was estimated by adding two items (“How often do you attend church, synagogue, mosque, or other religious services?” and “How important is religion in your life?”) measured on a 4-point scale ranging from 1 (*never*) to 4 (*about once a week or more often*) for the first item and from 1 (*not important*) to 4 (*very important*) for the second item, which correlated strongly ($\gamma = .64, p < .001$). School performance was measured by self-reported average grade in school ranging from 1 (“D”) to 9 (“A”), with a mean of 6.2 or “B” ($SD = 2.16$). Positive family relationship was measured by asking respondents about the extent to which they agree on a 5-point scale ranging from 1 (*never or almost never true*) to 5 (*always or almost always true*) with the following statements referring to the previous month: (a) “I really enjoyed being with my parents,” (b) “There was a feeling of togetherness in our family,” and (c) “I fought or argued with one of my parents” (which was reverse coded to fit the direction of the scale on the previous two items). Each adolescent’s responses to these items were then added into a single index ($\alpha = .71$) ranging from 3 to 15 with a mean of 11 ($SD = .04$), indicating an overall positive experience in the previous month. An additive index of perceived parental monitoring was constructed from two items (“In general, how often does at least one of your parents or caregivers: (a) know what you are doing when you are away from home? (b) have a pretty good idea of your plans for the coming day?”) measured on a 5-point scale ranging from 1 (*never or almost never*) to 5 (*always or almost always*) with a significant bivariate association ($\gamma = .67, p < .001$). This index ranged from 2 (*very low parental involvement*) to 10 (*very high parental involvement*) with a mean of 7.6 ($SD = .03$). Finally, involvement in prosocial activities was estimated from respondents’ answers (“yes” or “no”) to a set of five questions regarding their involvement in different types of social activities in or outside of school (arts,

sports, youth clubs, religious-sponsored youth groups, and volunteer work), which were added into a single index ranging from 0 to 5 with a mean of 2.2 activities in the previous year ($SD = 1.3$).

Risk factors included unsupervised time spent with peers and frequency of school absences in the last 30 days. Respondents' answers to the question "How often do you spend your free time in the afternoons hanging out with friends without adults around?," measured on a 5-point scale ranging from 1 (*never*) to 5 (*always or almost always*), were used as a measure of unsupervised time spent with peers. Number of school absences was estimated from responses to the question "During the last 30 days, about how many whole days of school have you missed because you 'skipped' or 'cut' school?" (excluding days in which school was not in session).

Sample Characteristics

For the purposes of this study, only data collected from youths aged 12 to 18 were used ($N = 5,141$). The primary reason for this decision was the lack of sufficient variance on the dependent variables (and some independent variables) among 9- to 11-year-olds. Of the respondents included in this study, 51.3% were male, 66.6% White, 14.7% African American, and 14.6% Hispanic. The median age of the respondents in the sample was 14. Sample weights were developed to adjust for differential probabilities of selection, differential response rates, demographic differences, and the complex sample design (see Hornik et al., 2001). The data used in all analyses reported following were therefore appropriately weighted to generate efficient and nearly unbiased estimates of variables among youth nationwide. The variables included in this study had a very small number of missing values (ranging from 13 to 134) compared to the total size of the sample and therefore, a listwise deletion procedure was used to handle missing values (effective $N = 5,007$).

RESULTS

Correlations between all variables in the analysis, controlling for age, gender, and race differences, are summarized in Table 1. The pattern of correlations in this table was consistent with both the hypothesized relations described in Figure 1 and the study's general hypotheses. First, as expected, sensation seeking had a substantial, statistically significant correlation with each of the dependent variables: association with deviant peers ($r = .38$), frequency of having pro-drug discussions with peers ($r = .38$), and intention to use marijuana ($r = .33$). In addition, association with deviant peers had equally substantial correlations with frequency of having pro-drug discussions and intention to use marijuana ($r = .37$ and $r = .35$, respec-

TABLE 1
 Partial Correlation Matrix of All Variables Controlling for Age, Gender, and Race

<i>Variable</i>	<i>M</i>	<i>SD</i>	2	3	4	5	6	7	8	9	10	11
1. Sensation seeking	2.68	.94	.38**	.38**	.33**	.08*	.27**	-.13**	-.08*	-.36**	-.26**	.002
2. Association with deviant peers	3.54	.06		.37**	.35**	.17**	.32**	-.11**	-.20**	-.34**	-.28**	-.08**
3. Pro-drug discussions with peers	4.45	4.6			.45**	.018*	.21**	-.19	-.04**	-.31**	-.23**	-.12**
4. Intention to use marijuana	1.32	.70				.15**	.20**	-.24**	.15**	-.26**	-.27**	-.13**
5. School absences	.19	.72					.08**	-.15**	-.13**	-.08**	-.13**	-.09**
6. Unsupervised time with peers	2.9	1.2						-.12**	-.12**	-.19**	-.25**	-.04
7. Religiosity	5.9	1.8							.17**	.11**	.13**	.32**
8. School performance	6.2	2.16								.11**	.21**	.20**
9. Positive family relationships	11	.04									.40**	.004
10. Parental monitoring	7.6	.03										.10**
11. Pro-social activities	2.2	1.3										

Note. $N = 5,007$.

* $p < .05$. ** $p < .001$.

tively), and pro-drug discussions were even more strongly associated with intention to use marijuana ($r = .45$). This analysis, however, does not account for indirect influences of sensation seeking on intention to use marijuana that are mediated by association with deviant peers and pro-drug discussions as suggested by the study's hypotheses and therefore may be underestimating the actual contribution of this variable to future marijuana use.

The study's hypotheses concerning the direct and mediated effects of sensation seeking on adolescents' intentions to use drugs were tested in three steps, each involving the use of a hierarchical regression analysis to predict one of the three dependent variables in Figure 1. In all hierarchical regression analyses, demographic controls (age, gender, and race) were entered first, followed by sensation seeking. Risk and protective factors were entered last in all models. In each case, the contribution of each predictor (or set of predictors) to the prediction of the dependent variable was assessed through the increment of change in the model's overall R^2 value in which a statistically significant increment indicates a statically significant contribution. No significant violations of the linear regression assumptions (i.e., linearity, multicollinearity, and heteroscedasticity) were detected in any of the three hierarchical regression models used.

In the first part of the analysis, I assessed the independent contribution of sensation seeking to the frequency of association with deviant peers. The results of this analysis are summarized in Table 2. In Step 1 of this analysis, the frequency of association with deviant peers was predicted from demographic controls alone. Consistent with findings from similar studies (see Haynie, 2001), the results indicated that the frequency of association with deviant peers increased with the age of the adolescent and was higher for males. Sensation seeking was entered as predictor in Step 2. As proposed by the first hypothesis, sensation seeking had a substantial independent contribution to the frequency of association with deviant peers ($\beta = .40$, $p < .001$). This contribution was also apparent in the significant increase in the R^2 value ($\Delta R^2 = .15$, $p < .001$). Risk and protective factors entered the model in Step 3, and their inclusion resulted in a significant increment to the R^2 value ($\Delta R^2 = .10$, $p < .001$). There was a statistically significant independent effect of both risk factors (school absences and unsupervised time with peers) and three protective factors (school performance, positive family relationships, and parental monitoring) on the frequency of association with deviant peers (in which risk factors increased this frequency and protective factors reduced it). More important, the impact of sensation seeking on association with deviant peers remained statistically significant after the inclusion of this set of variables (thus supporting the component of the first hypothesis arguing for an independent effect of sensation seeking on this variable), although it was significantly reduced in magnitude ($\beta = .40$ in Step 2 compared to $\beta = .26$ in Step 3). This reduction may be explained in part by the association of sensation seeking with the two other risk factors (see Table 1) but is primarily an outcome of the moderating impact of the protective factors (particularly school per-

TABLE 2
 Hierarchical Linear Regression Analysis for Variables Predicting Association With Deviant Peers Among Youth Aged 12 to 18,
 United States, 2000 to 2001

Variable	Step 1			Step 2			Step 3		
	B	SE B	β	B	SE B	β	B	SE B	β
Demographic									
Age	0.45**	.04	.18**	0.25**	.03	.10**	0.13**	.03	.05**
Male	0.64**	.14	.07**	0.29*	.13	.03*	0.01	.12	.001
White	0.26	.15	.03	-0.23	.14	-.02	0.06	.13	.006
Sensation-seeking tendencies				1.95**	.07	.40**	1.27**	.07	.26**
Risk factors									
School absences							0.37**	.08	.06**
Unsupervised time with peers							0.72**	.05	.19**
Protective factors									
Religiosity							0.001	.04	.001
School performance							-0.24**	.03	-.11**
Positive family relationships							-0.20**	.02	-.13**
Parental monitoring							-0.21**	.03	-.10**
Prosocial activities							-0.04	.05	-.01
Adjusted R ²	.04			.19			.29		
ΔR^2				.15**			.10**		

Note. $N = 5,007$. ΔR^2 = increment of change in R^2 value with the inclusion of each additional set of predictors.

* $p < .05$. ** $p < .001$.

formance, positive family relationships, and parental monitoring). Still, it is worth noting that of all variables included in the model, sensation seeking was the strongest predictor of association with deviant peers and that this finding was consistent with the notion of selection into peer groups based on similarity in sensation-seeking tendencies (cf. Donohew, Clayton, et al., 1999).

In the second part of the analysis, I assessed the extent to which sensation seeking contributes both directly and indirectly (through its impact on association with deviant peers) to the frequency of having pro-drug discussions with peers. The hierarchical regression analysis consisted of four steps: demographic controls were entered in Step 1, sensation seeking in Step 2, association with deviant peers in Step 3, and the set of risk and protective factors in Step 4. The results of this analysis are presented in Table 3. As expected, sensation seeking was an independent predictor of having pro-drug discussions with peers, controlling for all other predictors, including association with deviant peers (see results of the full model under Step 4 in Table 3). At the same time, association with deviant peers was the strongest statistically significant predictor of having pro-drug discussions with peers ($\beta = .24$; see results of the full model) and once included in the model in addition to sensation seeking (see Step 3), significantly reduced the impact of sensation seeking on this variable (from $\beta = .35$ in Step 2 to $\beta = .24$ in Step 3). These findings may be interpreted as evidence that sensation seeking affected the frequency of having pro-drug discussions both directly (by motivating high sensation-seeking adolescents to discuss drug use favorably with peers) and indirectly through its impact on association with deviant peers, which in turn independently increased this frequency. As in the previous analysis, protective factors (religiosity, school performance, positive family relationships, parental monitoring, and involvement in prosocial activities) acted to decrease the frequency of having pro-drug discussions with peers; however, the two other risk factors in the model (school absences and unsupervised time spent with peers) had no independent contribution to the variance in this variable frequency (perhaps due to their relation to sensation seeking and association with deviant peers).

In the final part of the analysis, I assessed the contribution of sensation seeking to the prediction of intention to use marijuana among adolescents (the primary dependent variable). The hierarchical regression analysis used in this case consisted of five steps: demographic controls were entered in Step 1, sensation seeking in Step 2, association with deviant peers in Step 3, pro-drug discussions with peers in Step 4, and the set of risk and protective factors in Step 5. The results of this analysis are summarized in Table 4. The overall pattern of findings observed in Table 4 is similar to the one observed in the previous analyses. First, controlling for all other variables (see Step 5), sensation seeking had a statistically significant independent contribution ($\beta = .11, p < .001$) to the explained variance in intention to use marijuana. Note, however, that the effect of sensation seeking on intention to use marijuana, controlling for demographic characteristics alone ($\beta = .33$ in Step

TABLE 3
Multiple Regression Analysis for Variables Predicting Pro-Drug Discussions With Peers Among Youth Aged 12 to 18, United States, 2000 to 2001

Variable	Step 1			Step 2			Step 3			Step 4		
	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
Demographic												
Age	0.63**	.04	.26**	0.48**	.04	.20**	0.41**	.04	.17**	0.37**	.04	.15**
Male	0.57**	0.16	.06**	0.16	.15	.017	0.07	.14	.008	0.13	.14	.014
White	1.19	.17	.12**	0.75**	.16	.08**	0.77**	.15	.08**	0.70**	.16	.07**
Sensation-seeking tendencies				1.75**	.08	.35**	1.18**	.09	.24**	0.92**	.09	.18**
Association with deviant peers							0.26**	.016	.28**	0.22**	.017	.24**
Risk factors												
School absences										0.04	.09	.006
Unsupervised time with peers										0.07	.07	.02
Protective factors												
Religiosity										-0.18**	.04	-.07**
School performance										0.11*	.03	.05*
Positive family relationships										-0.20**	.03	-.13**
Parental monitoring										-0.09*	.04	-.04*
Prosocial activities										-0.21**	.06	-.06**
Adjusted R ²	.087			.202			.267			.297		
ΔR^2				.115**			.065**			.03**		

Note. N = 5,007. ΔR^2 = increment of change in R² value with the inclusion of each additional set of predictors.

*p < .05. **p < .001.

TABLE 4
 Hierarchical Multiple Regression Analysis for Variables Predicting Intention to Use Marijuana in the Next 12 Months Among Youth
 Aged 12 to 18, U.S., 2000 to 2001

Variable	Step 1			Step 2			Step 3			Step 4			Step 5		
	B	SE B	β												
Demographic															
Age	.12**	.01	.28**	.09**	.01	.22**	.08**	.008	.21**	.06**	.009	.15**	.05**	.009	.14**
Male	.05	.38	.036	-.03	.04	-.002	-.007	.03	-.004	-.007	.03	-.005	-.05	.03	-.03
White	.09*	.04	.05*	.02	.04	.007	-.03	.04	-.002	-.04	.03	-.02	.02	.04	.01
Sensation seeking tendencies				.28**	.02	.33**	.19**	.02	.22**	.12**	.02	.13**	.10**	.02	.11**
Association with deviant peers							.04**	.003	.27**	.03**	.003	.17**	.02**	.004	.12**
Pro-drug discussions										.06**	.004	.34**	.05**	.004	.31**
Risk factors															
School absences													.05*	.02	.05*
Unsupervised time with peers													.01	.015	.02
Protective factors															
Religiosity													-.04**	.01	-.10**
School performance													-.02*	.008	-.06*
Positive family relationships													-.004	.006	-.02
Parental monitoring													-.03*	.008	-.08*
Prosocial activities													-.01	.013	-.02
Adjusted R ²	.093			.187			.246			.311			.351		
ΔR^2				.094**			.059**			.065**			.04**		

Note. $N = 5,007$. $\Delta R^2 =$ increment of change in R^2 value with the inclusion of each additional set of predictors.

* $p < .05$. ** $p < .001$.

2), reduced by about two thirds after controlling for both pro-drug discussions and association with deviant peers ($\beta = .13$ in Step 4). Second, both association with deviant peers and frequency of having pro-drug discussions with peers were also independent significant predictors of intention to use marijuana, with the latter having been the strongest predictor in the model ($\beta = .12$ and $\beta = .31$, respectively). Third, here too risk factors (school absences) acted to increase intention to use marijuana in addition to sensation seeking, association with deviant peers, and pro-drug discussions, whereas protective factors (religiosity, school performance, and parental monitoring) decreased intention to use marijuana. These findings supported the expectation that sensation seeking contributed both directly and (perhaps even more so) indirectly to adolescent drug use (using behavioral intentions as a proxy of future behavior).

CONCLUSIONS

Taken as a whole, then, the results of the hierarchical regression analyses provided strong support for the study's hypotheses. Consistent with the first hypothesis that argues for both direct and indirect contributions of sensation seeking to adolescent drug use, the results convincingly show that sensation seeking tendencies increased the risk of adolescent drug use not only directly, as suggested by the existing literature, but also (or perhaps primarily) indirectly by motivating high sensation-seeking adolescents to associate with deviant peers and initiate discussions with peers that are favorable of drug use. Most striking is the fact that in all three regression models estimated, sensation seeking alone accounted for nearly one third or half of the explained variance in all three dependent variables (association with deviant peers, pro-drug discussions, and intention to use marijuana), controlling for demographic variables and additional risk or protective factors. This, in turn, suggests that the literature may have systematically underestimated the impact of this variable on adolescent drug use by focusing on its direct contribution to this behavior.

The results also support the second hypothesis according to which other risk or protective factors may increase or decrease the risk that adolescents (particularly those who are most prone to drug use, such as high sensation seekers) will engage directly in drug use or in activities (such as associating with deviant peers and having pro-drug discussion with peers) that will increase this risk. It is also clear that a different constellation of factors may be more or less effective in each case. For example, religiosity may protect adolescents from having pro-drug discussions with peers or from developing intention to use drugs but not from associating with deviant peers. Similarly, positive family relationships may protect against association and pro-drug interactions with deviant peers but not against actual drug use. On the

other hand, parental monitoring seemed to be an important protective factor in all three instances.

Although the results generally support the study's hypotheses, a number of limitations should be noted. Clearly, although the use of a large representative national sample of adolescents to test these hypotheses is one of the study's strengths, the cross-sectional nature of this sample did not permit sound causal inferences regarding the relations of interest. Of particular concern in this respect is the actual causal direction between variables included in this study and the ability to eliminate alternative hypotheses to the observed relations. Causal direction has primarily to do with establishing temporal precedence between variables. Although sensation seeking and demographic attributes were clearly causally prior to all other variables including the dependent variables (association with deviant peers, frequency of having pro-drug discussions with peers, and intention to use marijuana), the causal direction between the remaining variables was less clear and in some instances, may have been reversed to the hypothesized relation (see DeWitt et al., 1995). For example, actual drug use may cause poor school performance, frequent school absences, negative family relationships, and increased parental monitoring rather than being caused by these factors. To some degree, the problem of temporal precedence was addressed in this study by designating as predictors those variables that measure habitual behavior (e.g., parental monitoring, unsupervised time spent with peers, and attendance at religious services) or prior behavior (e.g., involvement in prosocial activities in the previous year and number of school absences in the previous month) to predict dependent variables that are closer to the time of data collection (e.g., frequency of association with deviant peers in the previous week) or that relate to future behavior (i.e., intention to use marijuana). Moreover, similar results were reported by at least one additional study (Donohew, Hoyle, et al., 1999) that tested a similar hypothesis using panel data. Many researchers would therefore agree that the process or the causal chain described in Figure 1 (and supported by the available data) is most likely credible.

Still, causal claims based on observational data primarily involve the elimination of alternative explanations of observed associations, which in turn requires controlling for the effect of all or most external factors that may intervene in this relation. This ability is somewhat diminished in this study given that only a small fraction of the large number of risk and protective factors considered by previous studies (see DeWitt et al., 1995; Newcomb & Felix-Ortiz, 1992) were examined. This, in turn, is evident by the fact that the explained variance in the dependent measures in all three regression models did not exceed 35%. However, given that particularly strong predictors of adolescent drug use, such as age, gender, race, peer influence, family relationship, and parental monitoring (see Miller et al., 2000), were controlled for in all analyses, there seems to be no reason to assume that conclusions about the direct and indirect contribution of sensation seeking to adolescent drug use are fundamentally flawed.

This study has a number of implications—theoretical, methodological, and practical—for research on adolescent drug use and the development of effective interventions in this problem. Theoretically, the study demonstrated the importance of studying both direct and indirect influences of variables that either increase or decrease the risk of drug use, particularly those (such as sensation seeking, association with deviant peers, and family relationships) that are consistently shown to be important predictors of adolescent drug use. It also drew attention to the importance of clarifying the actual processes that link variables to adolescent drug use and identifying the particular circumstances under which these factors are likely to be more or less important in the process of developing or preventing drug use. For instance, the results of this study show parental monitoring was an important factor protecting against association with deviant peers, pro-drug interactions with peers, and actual drug use, whereas religiosity was only important in protecting against the latter two. It is also likely that processes of effect and the relative importance of each risk and protective factor will vary by the type of drug used and the frequency and intensity with which the same drug is used (DeWitt et al., 1995). For example, existing evidence suggested that sensation seeking may be a stronger predictor of marijuana use than peer influence, whereas peer influence is a stronger predictor of alcohol use (Donohew, Hoyle, et al., 1999). One explanation of this may be that many adolescents are socialized into alcohol use by peers regardless of their sensation seeking tendencies, whereas in the case of marijuana (a substance used by a significantly smaller number of adolescents), sensation seeking drives association with drug-using peers. Similarly, peer-related variables seem to be powerful predictors of all levels of drug use (i.e., trial, use, misuse, abuse, and dependence), whereas positive family relationships may protect against experimenting with drugs (DeWitt et al., 1995).

The primary methodological ramification of the theoretical approach discussed previously is that influences of key risk and protective factors on adolescent drug use should be examined independently of less important factors. No doubt the risk factor approach (DeWitt et al., 1995; Newcomb & Felix-Ortiz, 1992) that advocates the inclusion of many potential factors in a single index with the goal of improving prediction of drug use, generates an excellent instrument for diagnosing adolescents at risk for use of a certain type of substance or a particular level of intensity of drug use but does little to advance the understanding of how and under which circumstances specific key factors contribute to this risk directly or indirectly. Although longitudinal designs (particularly the use of panel data) may be better equipped to model and examine direct and indirect processes of influence such as the one modeled in this study, the use of cross-sectional data in this study and others may be of great value in identifying potential for such relations between key dependent and independent variables, providing that certain provisions are made (such as concerted efforts to establish temporal order between variables).

Finally, although all the relations examined in this study proved to be linear in nature, researchers should anticipate nonlinear relations. This may be particularly true regarding the potential for interaction effects. For example, all three regression models used in this study (see Tables 2–4) indicated that age was an independent predictor of association with deviant peers, frequency of having pro-drug discussions with peers, and intention to use marijuana. Evidence in the literature also has suggested that sensation-seeking tendencies increase during the adolescent years in a linear fashion (Donohew, Hoyle, et al., 1999). Thus, it is likely that the direct effect of sensation seeking on each of these variables will vary by age group. This proposition was tested by repeating the exact regression analyses summarized in Tables 2 through 4 (excluding age as a predictor) for three different age groups: 12- to 13-year-olds ($N = 2,439$), 14- to 15-year-olds ($N = 1,322$), and 16- to 18-year-olds ($N = 1,380$). Results indicate that the direct effect of sensation seeking on the frequency of association with deviant peers, controlling for all other variables, increased in a linear fashion with the age of the adolescent (for the 12–13 age group, $\beta = .22, p < .001$; for the 14–15 age group, $\beta = .25, p < .001$; for the 16–18 age group, $\beta = .31, p < .001$). In contrast, the direct effect of sensation seeking on the frequency of having pro-drug discussions with peers across age groups was curvilinear (for the 12–13 age group, $\beta = .19, p < .001$; for the 14–15 age group, $\beta = .16, p < .001$; for the 16–18 age group, $\beta = .20, p < .001$) and inverted for intention to use marijuana (for the 12–13 age group, $\beta = .22, p < .001$; for the 14–15 age group, $\beta = .12, p < .001$; for the 16–18 age group, $\beta = .10, p < .001$). This suggests that age and sensation seeking interacted in different ways depending on the outcome examined and that, in each case, a different mechanism explained the nature of the interaction (e.g., the importance of sensation seeking in terms of peer selection increased with age, whereas sensation seeking became less influential in terms of decisions to use drugs as the adolescent aged, possibly because peer influence played a more important role during the later years of adolescence).

Finally, on a practical note, the approach taken in this article may benefit the design and evaluation of future interventions in adolescent drug use by drawing attention to the unique combination of protective factors that is likely to prevent direct and indirect influences of risk factors from being realized in each case. For instance, research focusing on the direct contribution of sensation seeking to drug use has motivated an intervention approach that seeks to tailor anti-drug messages to sensation seekers by using high-sensation-value public service announcements (see Palmgreen et al., 2001). This study, which focused on indirect influences of sensation seeking on drug use, suggested that some (or perhaps most) of the influence of sensation seeking on adolescent drug use was mediated through association with deviant peers and having pro-drug interactions with peers. Therefore, interventions that minimize the risk that high sensation seekers will associate with deviant peers (such as encouraging parents to monitor their adolescents more closely and minimizing unsupervised time spent with peers) may supplement ef-

forts to address the problem posed by sensation seeking directly (i.e., through tailored mass media advertisements). Similarly, interventions designed to increase exposure of high sensation seekers to normative peers (e.g., by engaging them more frequently in prosocial activities) may act to suppress the potential for having interactions with peers that are favorable of drug use. The approach taken in this study, then, has significant potential in terms of developing more sophisticated and effective interventions in adolescent drug use to the extent it will continue to guide future research in this field.

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