



Childhood predictors of adolescent marijuana use: Early sensation-seeking, deviant peer affiliation, and social images

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ABSTRACT

This study examined psychosocial mechanisms by which children's early sensation-seeking may influence their later marijuana use. In a longitudinal study, 4th and 5th grade elementary school children ($N=420$) were followed until they were in 11th and 12th grades in high school with annual or biennial assessments. Sensation-seeking (assessed over the first 4 assessments) predicted affiliating with deviant peers and level of favorable social images of kids who use marijuana (both assessed over the subsequent 3 assessments). Affiliation with deviant peers and the growth in social images predicted marijuana use in 11th and 12th grades. Affiliation with deviant peers mediated the effect of early sensation-seeking on subsequent marijuana use. The theoretical and applied significance of this influence of early sensation-seeking is discussed.

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1. Introduction

Marijuana use among high school students has declined modestly over the past decade. Nevertheless, in 2006, nearly one half (42.3%) of 12th grade and one third (31.8%) of 10th grade students reported having tried marijuana at least once in their lives (Johnston, O'Malley, Bachman, & Schulenberg, 2007). Using marijuana in adolescence is associated with damaging consequences for later health and well-being including lower educational attainment, more high-risk sexual behavior, more delinquent behavior, and more problem use of cigarettes, alcohol, and marijuana (e.g., Brook, Balka, & Whiteman, 1999). Identification of psychosocial risk factors that predict marijuana use, and the processes leading to marijuana use, should be valuable for the development of prevention programs to target these mechanisms.

One well-established predictor of adolescents' engagement in risky activities, including substance-use, is sensation-seeking. This trait is defined by individual differences in seeking stimulation in the form of intense, novel sensations and experiences, and the willingness to take risks to obtain this stimulation (Roberti, 2003; Zuckerman, 1994). Levels of sensation-seeking increase in adolescence (Zuckerman, Eysenck, & Eysenck, 1978), which is also the period when risk taking increases (Arnett, 1992). Zuckerman's (1979) prediction that sensation-seeking would be associated with less prevalent and less socially acceptable forms of stimulation, such as substance-use, has been confirmed in subsequent research. Sensation-seeking has predicted adolescent marijuana use in cross-sectional (e.g., Kopstein, Crum, Celentano, & Martin, 2001; Martin et al., 2002) and prospective research (e.g., Crawford, Pentz, Chou, Li, & Dwyer, 2003; Donohew, Hoyle et al., 1999; Newcomb & McGee, 1991). In a comparative study, sensation-seeking predicted marijuana use more strongly than use of more normative substances such as cigarettes and alcohol (Crawford et al., 2003).

Given that a link between adolescent sensation-seeking and marijuana use is well-established, research is now focusing on the mechanisms that may account for this association. One such mediating mechanism may be affiliation with deviant peers. Peer influence is a strong etiological factor in adolescent substance-use (Bauman & Ennett, 1994; Oetting & Beauvais, 1986; Petraitis, Flay, & Miller, 1995), and associating with drug-using peers predicts first marijuana use (Kosterman, Hawkins, Guo, Catalano, & Abbott,

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2000). Children high in sensation-seeking will seek out environments that provide opportunities for novel, non-normative stimulation, and joining a deviant peer group is one way for sensation seekers to find a niche compatible with their traits (Caspi, Roberts, & Shiner, 2005). Indeed, high sensation-seeking adolescents are more likely to associate with deviant peers, who also are likely to be high sensation seekers (Donohew, Hoyle et al., 1999). Furthermore, a recent cross-sectional study found that affiliating with deviant peers mediated the influence of sensation-seeking on adolescents' intentions to use substances (Yanovitsky, 2005).

Because sensation-seeking is related to brain pathways involved in reward (Zuckerman, 1996), mediating mechanisms that incorporate positive affect are also promising candidates (Romer and Hennessy 2007). One affect-based mechanism is found in the Prototype/Willingness Model (Gibbons & Gerrard, 1995; Gibbons, Gerrard, & Lane, 2003; Gibbons, Gerrard, Blanton, & Russell, 1998). The Prototype/Willingness Model emphasizes an affect-driven, reactive pathway to substance-use initiation as compared to the more planned and reasoned pathway proposed by the Theory of Reasoned Action (Ajzen & Fishbein, 1980) and the Theory of Planned Behavior (Ajzen, 1991). According to the Prototype/Willingness Model, adolescents with more positive beliefs and feelings about other kids who use substances are more willing to try them themselves. These beliefs and feelings are referred to as social images (or "prototypes"); they incorporate evaluative beliefs about typical users (e.g., "cool," "exciting") and so have a strong affective component. Consistent with the theory, more favorable social images of substance users in general, and marijuana users specifically, have been associated prospectively with willingness to try and with actual use of substances (e.g., Gibbons, Gerrard, Cleveland, Wills, & Brody, 2004; Wills, Gibbons, Gerrard, Murry, & Brody, 2003). Moreover, Andrews and Peterson (2006) and Ge, Jin, Natsuaki, Gibbons, Brody and Cutrona (2006) have shown that children's social images of other kids who use illicit drugs such as marijuana become more favorable over early adolescence.

Integrating the three etiological factors of sensation-seeking, affiliation with deviant peers, and social images suggests the following developmental model. Children high in sensation-seeking will gravitate toward deviant peers and will tend to have more favorable social images of kids who use marijuana. Children who develop more favorable social images of other children who use marijuana, and children who affiliate with deviant peers, will be more likely to try marijuana themselves. This model was tested using Latent Growth Modeling (LGM). LGM is an extension of structural equation modeling that permits the modeling of change over time. In LGM, a latent growth construct is represented by two factors: the intercept (initial level) and slope (change over time).

Participants were members of the Oregon Youth Substance Use Project (OYSUP; Andrews, Tildesley, Hops, Duncan, & Severson, 2003) who were in the 4th and 5th grade (elementary school) at the beginning of the study and were followed until they were in the 11th and 12th grades (high school). This study represents an advance over previous similar research by testing hypotheses developmentally and prospectively. It was hypothesized that (1) children's sensation-seeking, affiliation with deviant peers, and social images, increase over time, (2) children with higher initial levels of sensation-seeking, and steeper growth in sensation-seeking, will be more likely to be using marijuana in adolescence, (3) initial levels and growth in childhood sensation-seeking will predict both initial levels and growth of later deviant peer affiliation and favorability of social images of marijuana users, and (4) these intervening variables were hypothesized to mediate the effect of sensation-seeking on marijuana use. Because boys typically have higher levels of sensation-seeking than girls (Zuckerman et al., 1978), and deviant peer affiliation may have stronger effects on girls than boys (Andrews, 2005; Gifford-Smith, Dodge, Dishion, & McCord, 2005), gender differences in this model were examined.

2. Methods

2.1. Overview of design

The OYSUP is a cohort-sequential longitudinal study of youth substance-use in which five grade cohorts (grades 1–5 at T1) were assessed annually for four assessments (T1–T4), and annually for a further four assessments (T5–T8) with an interval of two years between T4 and T5. At T1, a total of 1075 children consented to participate and 1070 completed the first assessment (T1). Because of the relatively low prevalence of marijuana use among the younger cohorts at T7, the analyses reported here used data from the first seven assessments and were limited to the two older cohorts (children who were in 4th and 5th grades at T1).

2.2. Participants

Children were recruited from 15 elementary schools in one school district of Western Oregon serving a predominantly working class community using stratified random sampling (see Andrews et al., 2003 for more details). The racial/ethnic composition of the sample was 86% Caucasian, 7% Hispanic, 1% African-American, and about 2% each of Asian/Pacific Islander, American Indian, or Alaskan Native, and other or mixed race/ethnicity. Approximately 71% of mothers and 66% of fathers had more than a high school education, and 7% of mothers and 11% of fathers had not graduated from high school. Forty percent of the sample was eligible for a free or reduced lunch under Title 1, an indicator of low family income. OYSUP participants were representative of other children in the school district in terms of race/ethnicity, participation in the free or reduced lunch program, and substance-use, but had slightly higher achievement test scores in reading and math.

At T1, there were 420 children in grades 4 and 5 combined (221 boys and 199 girls). At T7, 69 did not complete the assessment. Attrition analyses indicated that participants at T7 did not differ from non-participants on gender, eligibility for a free lunch at T1, or having tried marijuana at T1, but their mothers' level of education was higher ($t = -.2892$, $df = 389$, $p = .004$, $CI = -1.06, -.20$).

2.3. Measures

2.3.1. Sensation-seeking

Three forced-choice items from the thrill and adventure seeking subscale of the sensation-seeking scale for elementary and middle school children developed by Russo, Stokes, Lahey, Christ, McBurnett and Loeber (1993) were used (skiing, parachuting, and scary things). For each item, children chose the statement that was most like them. In addition, they chose one of five pictures of a stick figure jumping from a wall. The wall increased in height across the five pictures, and children chose the highest they would be willing to jump. This measure was developed by Bush and Iannotti (1992) to assess risk taking in elementary school children. Responses to this item were standardized, and then re-scaled to the mean and standard deviation of the mean of the three questionnaire items to create a 4-item scale. The mean of the re-scaled picture item and the three questionnaire items constituted the indicator of the latent construct of sensation-seeking at T1 ($\alpha = .58$), T2, ($\alpha = .59$), T3 ($\alpha = .64$), and T4 ($\alpha = .64$). The intraclass correlation for sensation-seeking within elementary schools at T1 was .03, indicating little clustering within school, so school was not included as a variable in our analyses.

2.3.2. Affiliation with deviant peers

Affiliation with deviant peers was measured using variables from multiple sources (participants, their parents, and their teachers) using scales developed by Westling, Andrews, Hampson, and Peterson (in press). Children and parents each completed six items based on externalizing items from the Youth Self Report and Child Behavior Checklist (Achenbach, 1991) that described deviant behaviors by the target child's friends (e.g., "Lies or cheats," "Steals things"). Responses ranged from 1 = *Not true* through 3 = *Very true*. No items referred to substance-use. When two parent reports were available, they were averaged. Teachers rated how often the child associated with "kids who misbehave in school", "kids who get into fights" and "kids who are well-behaved in school" using a 5-point scale where 1 = *Never* through 5 = *Always*. The latter item was reverse scored. A 3-item scale composed of the child, parent, and teacher reports was used as the indicator of affiliation with deviant peers at T4 ($\alpha = .61$), T5 ($\alpha = .61$), and T6 ($\alpha = .60$) to create a latent construct of deviant peer affiliation.

2.3.3. Social images of marijuana users

Participants were asked whether kids who use marijuana are "liked by other kids," are "exciting," and are "cool or neat" (0 = *No*, 1 = *Maybe*, or 2 = *Yes*). Andrews and Peterson (2006) showed that this scale was stable, valid, and unidimensional. The sums of these three items at each of T4, T5, and T6 were used as the indicators of the latent growth construct of social image of marijuana users.

2.3.4. Marijuana use

To assess prevalence at T7, children responded *Yes* or *No* to the question "Have you ever tried marijuana (pot or weed)?" In addition, at each assessment, participants were asked the extent to which they had smoked marijuana (pot or weed) in the last twelve months (0 = *Never*, 1 = *Once*, 2 = *A couple of times*, 3 = *Some each month*, 4 = *Some each week*, 5 = *Some each day*). Their responses to this question at T3 (to control for early use) and at T7 (the outcome variable) were used in the analyses.

2.4. Procedures

At T1, consenting students were assessed during the school day at school. In group sessions, participants completed a written questionnaire, which was read aloud to them by a trained monitor and another monitor answered any questions on an individual basis. At T2 through T7, students still attending school in the district were assessed at their school; if they lived outside the district but within driving range, they were assessed at Oregon Research Institute. Monitors were at hand to read the questions for those who could not read the questionnaire themselves. Students who lived further away were assessed by telephone. Teachers and parents completed questionnaires towards the end of the school year.

2.5. Statistical analyses

The analyses were conducted using the MPlus program, Version 4.1 (Muthén & Muthén, 1998–2004). Full maximum likelihood methods were used to estimate missing data (Enders, 2001). Three criteria were used to assess goodness of fit of the models (Duncan, Duncan, & Strycker, 2006). The χ^2 test compares the predicted and actual models: Small (i.e., non-significant) values indicate goodness of fit. However, the χ^2 test is more likely to be significant when samples are large, so additional criteria were also considered: The Comparative Fit Index (CFI), which should be at least .90, and the Root Mean Square Error of Approximation (RMSEA), which should be less than or equal to .05.

2.5.1. Latent constructs

Analyses were conducted to determine the best fitting measurement models for the latent constructs of sensation-seeking, deviant peer affiliation, and social images. For each construct, a latent growth model was evaluated initially. In each latent growth model, the factor loadings of the intercept on all indicators were set to 1. Factor loadings of the linear slope were set sequentially to 0, 1, 2, and 3 for the four indicators of sensation-seeking at T1–T4, and 0, 2, and 3 for the three indicators of deviant peer affiliation and social images at T4–T6 (to reflect the 2-year gap between T4 and T5). Correlations between indicators at the same or adjacent assessments were included if indicated by modification indices. To be modeled as latent growth constructs, in addition to adequate

model fit, the means and variances of both the intercept and slope should differ significantly from zero. If these criteria for slope are not met, this indicates no significant growth over time, and a one-factor model (intercept only) may be more appropriate. The effects of gender were evaluated using multiple sample analysis. Paths and correlations were initially fixed to be equal between genders but were freed iteratively if a gender difference was indicated through an examination of each modification index.

2.5.2. Structural models

In the direct model (hypothesis 2), it was hypothesized that sensation-seeking (an endogenous variable) would predict marijuana use at T7 (log transformed). In the indirect model (hypothesis 3), it was hypothesized that sensation-seeking would predict the deviant peer affiliation and social images, and that these constructs would predict subsequent marijuana use. To test for mediation, (hypothesis 4), the fit of models with and without the direct path between sensation-seeking and marijuana use was compared. To control for prior use, marijuana use at T3 was included in all the models. The effects of gender were evaluated using multiple sample analysis.

3. Results

3.1. Descriptive results

At T3, when children were in the 7th and 8th grades, 2.1% of girls and 6.6% of boys reported having ever tried marijuana, whereas by T7, when children were in 11th or 12th grades, these percentages had increased to 49.7% of girls and 50.0% of boys. There was no significant difference between boys and girls in their reported levels of marijuana use in the past 12 months at T3 or T7. The means and standard deviations for all the observed variables in the model, shown separately for boys and girls, are provided in Table 1. Boys' sensation-seeking scores were significantly higher than girls at each time of assessment (T1–T4). Boys' and girls' social images of marijuana users were not significantly different at T4, T5, or T6, and the favorability of these social images also appeared to increase over time. Boys had significantly higher affiliation with deviant peers than did girls at each time of assessment.

3.2. The latent constructs for sensation-seeking, affiliation with deviant peers, and growth of social images (hypothesis 1)

3.2.1. Sensation-seeking

The latent growth model for sensation-seeking, indicated by the sensation-seeking scale at each of T1–T4, had good model fit ($\chi^2=5.21$, $df=5$, $p=.39$, CFI=.999; RMSEA=.010, CI=.000–.069). For sensation-seeking, and for the other two latent constructs, no correlations between indices were required to improve model fit. The means of both the intercept ($M_i=1.51$, $t=155.28$, $p<.001$) and the slope ($M_s=.04$, $t=10.19$, $p<.001$), and the variance of the intercept ($D_i=.12$, $t=5.19$, $p<.001$), were significantly different from zero. However, the variance of the slope was not significant ($D_s=.00$, $t=1.36$, $p=.17$) indicating no individual differences in the rate of growth of sensation-seeking. Therefore, sensation-seeking was modeled as a stable latent construct with indicators measured at each time point (T1–T4). This model demonstrated excellent fit ($\chi^2=1.29$, $df=2$, $p=.53$, CFI=1.000; RMSEA=.000, CI=.000–.085), and the factor loadings of all the indicators were significant ($p<.001$). Multiple-group analysis showed good model fit with loadings for the indicators set to be equal for boys and girls, and the means and variances set to be equal ($\chi^2=15.04$, $df=11$, $p=.18$; CFI=.978; RMSEA=.042, CI=.000–.089). When the mean was freed, the model fit did not change significantly, but the mean for girls ($M=-.03$, $t=-2.89$, $p<.05$) was significantly lower than for boys (set at zero).

Table 1

Means and standard deviations of all observed variables

Variable	Boys		Girls		<i>t</i>	<i>df</i>	<i>p</i>	90% CI
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>				
Sensation-seeking								
T1	1.61	.30	1.44	.29	6.00	415	.00	.11, .23
T2	1.64	.28	1.49	.28	5.23	402	.00	.09, .20
T3	1.73	.26	1.60	.28	4.80	402	.00	.08, .18
T4	1.78	.28	1.67	.31	3.62	397	.00	.05, .16
Social images								
T4	.70	1.32	.74	1.26	-.34	397	.74	-.30, .21
T5	.94	1.42	.84	1.48	.59	352	.56	-.21, .40
T6	1.41	1.56	1.22	1.46	1.20	361	.23	-.12, .50
Deviant affiliation								
T4	3.27	1.69	2.63	1.87	3.58	395	.00	.29, .99
T5	3.31	1.62	2.83	1.94	2.54	356	.01	.11, .85
T6	3.16	1.56	2.66	1.70	2.97	366	.00	.17, .84
Marijuana use								
T3	.10	.45	.04	.28	1.79	399	.07	-.007, .141
T7	1.06	1.52	.86	1.29	1.34	347	.18	-.10, .50

3.2.2. Deviant peer affiliation

The latent growth model for deviant peer affiliation, indicated by the deviant peer affiliation scale at T4–T6, only satisfied one criterion (CFI) for goodness of fit ($\chi^2=8.05$, $df=1$, $p<.01$, $CFI=.982$; $RMSEA=.133$, $CI=.060-.224$). The mean ($M_i=2.99$, $t=32.92$, $p<.001$) and variance ($D_i=2.63$, $t=6.78$, $p<.001$) of the intercept were significantly different from zero. The variance ($D_s=.26$, $t=4.69$, $p<.001$) but not the mean ($M_s=-.01$, $t=-.33$, $p=.74$) of the slope was significantly different from zero. Given the non-significant slope suggesting an overall lack of growth in this construct and poor fit of the model, deviant peer affiliation was modeled as a stable latent construct (one-factor model), with indicators measured at each time point. Because there were only three indicators, this model was fully identified so no fit statistics were generated. However, good fit was indicated by the significance of the factor loadings of each indicator (all $ps<.001$). Model fit for the multiple-group analysis was good ($\chi^2=6.36$, $df=4$, $p=.17$, $CFI=.994$; $RMSEA=.054$, $CI=.000-.13$), with the mean for girls ($M=-.36$, $t=2.83$, $p<.01$) significantly lower than for boys (set at zero).

3.2.3. Social images

The developmental function for social images (T4–T6) was evaluated by a latent growth model including both intercept and slope. With the factor loadings of the linear slope set to 0, 2 and 3, the model fit was poor ($\chi^2=10.59$, $df=1$, $p<.01$, $CFI=.944$; $RMSEA=.155$, $CI=.080-.245$). With these loadings set to 0, 1 and 2, the fit was improved ($\chi^2=3.28$, $df=1$, $p<.001$, $CFI=.987$; $RMSEA=.075$, $CI=.000-.173$). Thus loadings for the final model were set to 0, 1 and 2. Multiple-group analysis indicated no differences for boys versus girls.

3.3. The direct model: predicting marijuana use at T7 from childhood sensation-seeking (hypothesis 2)

The direct model tested the prospective association between early sensation-seeking measured over T1–T4 and subsequent marijuana use at T7, controlling for T3 use. This model had excellent fit ($\chi^2=4.54$, $df=8$, $p=.81$, $CFI=1.000$; $RMSEA=.000$, $CI=.080-.036$). No modifications were required to improve model fit, and multiple-group analysis showed there model fit was not improved by freeing any structural paths for boys versus girls. This model confirmed that boys and

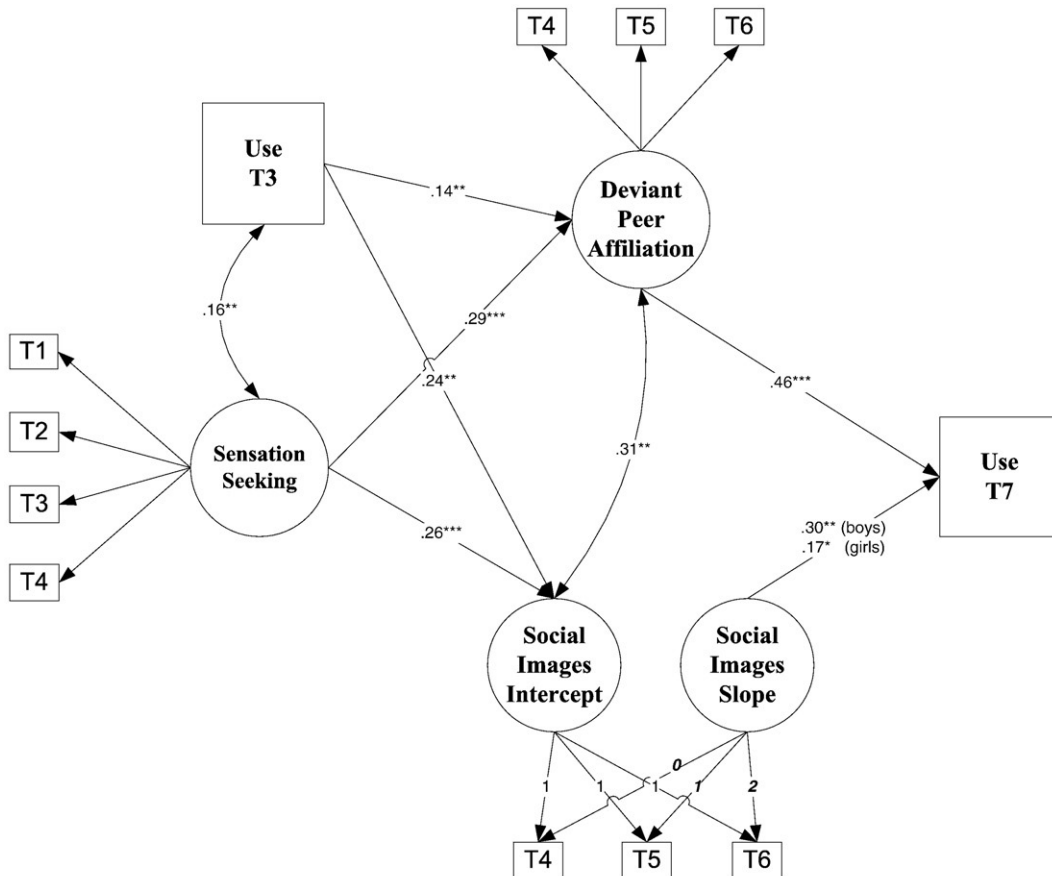


Fig. 1. The indirect model of predictors of marijuana use showing significant paths only (standardized path coefficients), * $p<.05$, ** $p<.01$, *** $p<.001$. Model fit: $\chi^2(44)=52.37$, $CFI=.992$, $RMSEA=.021$, (90% $CI=.000, .041$). Use at T3 and Use at T7=the level of marijuana use at the 3rd and the 7th assessments. The data for all paths are available from the authors upon request.

girls who had higher levels of sensation-seeking in elementary school were more likely to be using marijuana in high school ($\beta = .16$, $t = 2.71$, $p < .01$).

3.4. The indirect model: predicting marijuana use at T7 from sensation-seeking, affiliation with deviant peers, and social images

Here, we tested our full model of influences on extent of marijuana use (hypothesis 3). This model included the paths from sensation-seeking to deviant peer affiliation, and to the intercept and slope of social images, and also the paths from deviant peer affiliation, and the intercept and slope of social images, to marijuana use at T7. Fig. 1 depicts the model showing only the significant paths. No modifications were required, and excellent model fit was indicated on all criteria ($\chi^2 = 52.37$, $df = 44$, $p < .18$; CFI = .992, RMSEA = .021, (90% CI = .000, .041). This model confirmed some but not all of the expected paths. Sensation-seeking predicted deviant peer affiliation, which predicted marijuana use at T7. Sensation-seeking predicted the intercept but not the slope of social images, and the slope, but not the intercept, of social images predicted marijuana use at T7. Deviant peer affiliation was significantly correlated with the intercept of social images but not with the slope. Marijuana use at T3 was correlated with sensation-seeking, and predicted deviant peer affiliation and the intercept of social images. However, marijuana use at T3 did not significantly predict marijuana use at T7. Multiple sample analysis revealed one difference in the structural paths between boys and girls. The path between the slope of social images and marijuana use at T7 was stronger for boys than girls.

3.5. Testing for mediation (hypothesis 4)

Following the criteria set out by Baron and Kenny (1986), the pattern of findings established in these models indicated one potential mediated effect. That is, in the direct model, higher levels of sensation-seeking (T1–T4) predicted higher levels of marijuana use at T7. In the indirect model, children with a higher level of sensation-seeking had higher level levels of affiliation with deviant peers (T4–T6), and higher levels of deviant peer affiliation predicted more marijuana use at T7. Thus, the effect of sensation-seeking on later marijuana use may have been mediated by deviant affiliation. To test for mediation, following recommendations by Holmbeck (1997) and Frazier, Tix, and Barron (2004), the fit of the indirect model was compared with and without the direct path from sensation-seeking to marijuana use at T7.

When the direct path from initial level of sensation-seeking to marijuana use at T7 was added to the indirect model, the overall model fit was not significantly improved ($\chi^2_{diff} = .071$, $df = 1$), and the direct path from the intercept of sensation-seeking to marijuana use at T7 was non-significant. The indirect path from sensation-seeking through affiliation with deviant peers to marijuana use at T7 was significant, Sobel = 3.30, $p < .001$ (MacKinnon, Warsi, & Dwyer, 1995; Sobel, 1982), indicating that deviant peer affiliation mediated the effect of sensation-seeking on extent of marijuana use at T7.

4. Discussion

The goal of this prospective study was to examine psychosocial processes by which sensation-seeking, a well-established risk factor for substance-use, leads to adolescent marijuana use. Previous studies have established that sensation-seeking, deviant peer affiliation, and positive evaluation of substances are risk factors for marijuana use, and also that affiliating with deviant peers may mediate effects of sensation-seeking (Yanovitzky, 2005; Zuckerman, 1994). The present study advanced the understanding of these processes. The prospective nature of the present study enabled us to draw causal inferences about the relations among predictors of marijuana use, and modeling repeated assessments over time enabled us to evaluate developmental processes. After summarizing the present findings, their implications for current theories of adolescent marijuana use and for interventions to prevent adolescent marijuana use are considered.

Fifty percent of the boys and girls in OYSUP reported using marijuana by 11th or 12th grade in 2006, which is somewhat higher than the 42% of 12th graders reported by Johnston, O'Malley, Bachman, and Schulenberg (2007) using nation-wide data for 2006, the same year as the T7 assessment reported here. The West has been one of the regions of the US with higher rates of marijuana use (Wright & Sathe, 2005), although rates have declined over recent years (Johnston et al., 2007). There was no gender difference in extent of use between boys and girls, reflecting the national trend towards convergence in rates of use between boys and girls.

Consistent with past research, higher levels of sensation-seeking predicted more use of marijuana (Zuckerman, 1994). As expected, children with higher scores on sensation-seeking were subsequently likely to have more favorable social images of kids who use marijuana (i.e., see them as more "likable," "exciting," and "cool") and to affiliate with deviant peers. As they passed through early adolescence, their perceptions of marijuana users (i.e., favorable social images) became more favorable. Deviant peer affiliation predicted subsequent marijuana use, and the growth, but not the level, of social images predicted subsequent marijuana use. As predicted, a mediated pathway from early sensation-seeking to later marijuana use through affiliation with deviant peers was confirmed (Donohew, Hoyle et al., 1999; Yanovitzky, 2005). However, contrary to our hypothesis, social images did not mediate the influence of sensation-seeking. These findings were independent of any effects of prior marijuana use, and were equally applicable to boys and girls, despite boys having higher levels of sensation-seeking and deviant peer affiliation.

Based on their cross-sectional findings, Romer and Hennessy (2007) proposed that a surge in sensation-seeking in adolescence accompanied by an immature risk-evaluation process cause increases in adolescent substance use. Our longitudinal findings indicate that the level of early sensation-seeking, prior to adolescence, also influences adolescent marijuana use. Our study did not examine sensation-seeking beyond age 13–14 years, whereas Romer and Hennessy's (2007) participants

were aged 14–22 years. Therefore, it remains for future prospective research to determine whether rate of change of sensation-seeking becomes important later in adolescence as a predictor of increases in marijuana use, in addition to the effects of early sensation-seeking found here.

The present findings confirmed that sensation-seeking influenced marijuana use through the mediating mechanism of deviant peer affiliation. These findings provide prospective replication of comparable cross-sectional findings, and support for peer cluster theory (Dinges & Oetting, 1993) and primary socialization theory (Donohew, Clayton, Skinner, & Colon, 1999) that propose that sensation-seeking motivates adolescents to associate with deviant peers, which leads to marijuana use. Deviant peer affiliation was correlated with the initial level of social images, suggesting that being with deviant peers contributed to favorable perceptions of marijuana users, and that having favorable perceptions of marijuana users contributed to affiliating with deviant peers (Agrawal, Lynskey, Bucholz, Madden, & Heath, 2007; Yanovitzky, 2005).

However, social images did not mediate effects of sensation-seeking, although the increase in favorability of social images predicted marijuana use, particularly for boys. This latter finding is consistent with recent developments in risk perception that examine the role of feelings in appraising risk. There is an inverse association between positive affect and perceived risk: that is, the more that an activity is associated with positive affect, the less it is perceived as risky (Slovic, Peters, Finucane, & MacGregor, 2005). Hence if adolescents believe that an activity such as marijuana use is associated with favorable social images characterized by positive affect (e.g., being perceived as “cool,”), they will perceive marijuana as less risky and be more likely to use it.

Another construct with some conceptual similarity to social images is that of outcome expectancies. These are beliefs about the anticipated positive or negative personal effects of using a substance (Bandura, 1977) that may mediate the influence of more distal risk factors such as personality traits (Leventhal & Schmitz, 2006). Most prior work has been on alcohol expectancies (e.g., McCarthy, Miller, Smith, & Smith, 2001). However, one study of marijuana expectancies demonstrated that negative expectancies mediated the association between impulsivity and marijuana use in boys and girls. More impulsive children had fewer negative expectancies, and were more likely to use marijuana (Vangness, Bry, & LaBouvie, 2005). It may be valuable to include both expectancies and social images in future research on the influence of affective processes on substance-use.

Indeed, one limitation of this study was that only a subset of the many possible influences on adolescent marijuana use was examined. However, these did include two of the most prominent risk factors from previous research (sensation-seeking and deviant peer affiliation). Strengths of this study include the prospective examination of sensation-seeking beginning in elementary school, which is earlier than most previous studies. Affiliation with deviant peers was assessed by a combination of ratings of undesirable behaviors of the target child's friends from different sources (self, parents, teachers). These behaviors did not include substance-use, therefore increasing levels on this variable did not simply equate to increasing exposure to marijuana users. This study examined social images, which are a relatively new theoretical construct in substance-use research derived from the Prototype/Willingness Model, emphasizing an affect-driven, reactive pathway to substance-use.

Our study has implications for interventions to prevent or postpone marijuana use. The findings suggest that prevention efforts should begin earlier than is current practice. Findings for alcohol and tobacco use from the same study (OYSUP) have also pointed to the importance of early intervention to prevent the development of cognitive and behavioral risk factors leading to substance-use (Andrews, Hampson, Barckley, Gerrard, & Gibbons, 2008; Hampson, Andrews, & Barckley, 2007; Hampson, Andrews, Barckley, & Severson, 2006). Early prevention programs should be designed to be effective for sensation-seeking children, which may require greater use of novelty and content associated with positive risk taking to appeal to such children. For example, we are currently evaluating a computer-based tobacco prevention program for fifth grade students that uses a variety of exciting game-like activities designed with sensation-seeking children in mind. The games have been demonstrated individually to change mediating mechanisms such as intentions and willingness to use tobacco (Andrews et al., 2007). As the OYSUP participants complete high school and enter emerging adulthood, there will be increasing opportunities to evaluate the significance of early etiological mechanisms for later substance-use and abuse, contributing to the development of more effective early interventions.

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