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6-1-2017

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Preadolescent sensation seeking and early adolescent stress relate to at-risk adolescents' substance use by age 15

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Abstract

Background and aims—Substance use during adolescence can lead to the development of substance use disorders and other psychosocial problems. These negative outcomes are especially likely for individuals who use substances at earlier ages and those who engage in heavier use during adolescence, behaviors which are both more common among youth at higher risk for developing a substance use disorder, such as those with a family history of substance use disorders (FH +). Factors such as increased sensation seeking and greater exposure to stressors among FH + youth may influence these associations. Therefore, the aim of this study was to examine the relative and unique contributions of sensation seeking during preadolescence and exposure to stressors during early to mid-adolescence to cumulative substance use by mid-adolescence among FH + youth.

Methods—A total of 167 mostly Hispanic FH + youth (ages 12–15) who were participating in an ongoing longitudinal study were included in these analyses. Participants' data from biennial waves covering approximately 2.5 years were used. Self-reported sensation seeking, exposure to stressors, and substance use were compared.

Results—Higher sensation seeking during preadolescence and greater exposure to stressors during early to mid-adolescence were both associated with substance use by age 15. These factors differentiated Substance Users from Non-Users, and also related to level of substance use.

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Conflict of interest

All authors declare that they have no conflicts of interest.

Conclusions—Elevated sensation seeking and exposure to stressors are both associated with substance use by age 15 among high-risk youth. Additionally, these factors can distinguish youth who develop heavier substance use during this important developmental period.

Keywords

Adolescence; Longitudinal; Stress; Personality; Family history; At-risk youth

1. Introduction

According to a recent national survey, Alcohol is the mostly commonly used substance among adolescents, followed by marijuana and tobacco. Among high school seniors in that study, 35% reported using alcohol, 21% reported using marijuana, and 11% reported smoking cigarettes in the past month (Johnston, O'Malley, Miech, Bachman, & Schulenberg, 2016). The levels of use among these older adolescents is a concern, but even more worrying is the fact that many youths begin using during early or mid-adolescence. Another recent national study reports that 7.8% of 12 and 13 year-olds report ever using alcohol, rising to 50.8% among 16 and 17 year-olds. Rates of marijuana and tobacco use follow a similar pattern of increasing prevalence of use: 2.5% of 12 and 13 year olds and 30.9% of 16 and 17 year-olds report marijuana use, whereas 5.0% of 12 and 13 year-olds and 30.9% of 16 and 17 year-olds report tobacco use. (Center for Behavioral Health Statistics and Quality, 2016). Although much of this use may be experimental, the use of alcohol and illicit drugs, in particular, can nevertheless increase the risk that an adolescent develops a substance use disorder. In fact, a third recent national survey of adolescents found that the median age of onset for a DSM-IV-TR diagnosis of substance abuse is 14 years old (Swendsen, Burstein, & Case, 2012). This suggests that some substance-using adolescents are developing problematic patterns of alcohol or illicit drug use that are accompanied by significant impairment.

Previous research has demonstrated that youth who begin using alcohol and illicit drugs at earlier ages, and those who engage in more frequent use during adolescence have a greater risk of experiencing negative outcomes such as poor psychological development, psychiatric disorders, substance use disorders, disease, accidental overdoses, and suicide attempts (Fergusson, Horwood, & Swain-Campbell, 2002; Grant et al., 2006; Hawkins et al., 1997; Substance Abuse and Mental Health Services Administration, 2012; Schuckit & Russell, 1983). However, the variables that predict which youth will engage in early and/or frequent alcohol and illicit drug use during adolescence are not well understood. Therefore, it is important to identify factors that contribute to these high-risk patterns of substance use during adolescence. A better understanding of these factors could improve prevention and intervention services to reduce adolescent substance use.

One factor that increases an individual's risk for developing problematic alcohol or illicit drug use during adolescence is having a family history of substance use disorders (FH +). FH + youth engage in substance use at earlier ages than do youth without a family history of substance use disorders (FH −; Chassin, Curran, Hussong, & Colder, 1996). Additionally, this early use among FH + youth has been linked to the development of substance use

disorders (Warner, White, & Johnson, 2007; Dawson, 2000), which are more common among FH + individuals (Sher, Grekin, & Williams, 2005; Tarter et al., 2003). Although there is considerable evidence that FH + individuals are at increased risk for developing problematic substance use, the reasons for this association are not well understood.

Several explanations for the increased incidence of problematic substance use among FH + individuals have been suggested. Some research has suggested that FH + individuals are more likely to inherit traits, such as high sensation seeking, that contribute to their increased risk for developing a substance use disorder (Sher, Walitzer, Wood, & Brent, 1991; Tarter, 1988; Tarter, Kirisci, Habeych, Reynolds, & Vanyukov, 2004). Sensation seeking is defined as the tendency to pursue exciting, novel, and often risky experiences (Zuckerman, 1994), and cross-sectional research has found elevated sensation seeking among individuals who are frequent substance sers and those who have substance use disorders (Fischer & Smith, 2008; Gerra et al., 2004; La Grange, Jones, Erb, & Reyes, 1995). Additionally, studies focused specifically on adolescents have found that greater sensation seeking can predict higher levels of alcohol and marijuana use longitudinally (Crawford, Pentz, Chou, Li, & Dwyer, 2003; Pedersen, Molina, Belendiuk, & Donovan, 2012). Therefore, it stands to reason that elevated sensation seeking in FH + youth could contribute to their risk for developing problematic substance use.

Other research suggests that parental substance use disorders can increase the environmental stress that a family experiences, which in turn increases the likelihood of offspring developing a substance use disorder. Previous studies have established that FH + individuals report greater exposure to a variety of stressors during their childhood and adolescence, including major stressors such as exposure to violence (Anda et al., 2002) and more minor stressors such as academic problems (Charles et al., 2015). In particular, stressors in the domains of family, academics, peers, and finances are more common among FH + individuals (Charles et al., 2015; Hussong et al., 2008; Pillow, Barrera, & Chassin, 1998). Given that increased exposure to stressors has been associated cross-sectionally with substance use in adolescence and early adulthood (e.g., Anda et al., 2002; Charles et al., 2015; Pillow et al., 1998; Vermeiren, Schwab-Stone, Deboutte, Leckman, & Ruchkin, 2003) and reported retrospectively by substance-abusing adults (e.g., Anda et al., 2002; Dube, Anda, Felitti, Edwards, & Croft, 2002; Pilowsky, Keyes, & Hasin, 2009), one interpretation is that increased exposure to stressors among FH + individuals might play a role in their elevated risk for developing substance use disorders.

There is considerable evidence that sensation seeking and exposure to stressors are likely to contribute to the development of substance use disorders, and that this link may be especially apparent among high-risk groups such as FH + youth. However, previous research is limited in two primary ways. First, prior studies have primarily focused on individuals who already meet criteria for substance use disorders (e.g., Anda et al., 2002; Dawson, 2000; Dube et al., 2002; Pilowsky et al., 2009). Relatively less is known about how these disorders develop, including factors that may be important during adolescence. Second, we are not aware of any studies that have combined measures of exposure to stressors and sensation seeking in the same analysis. There is evidence that both factors are positively related to substance use (e.g., Anda et al., 2002; Tarter et al., 2004), but the relative strength of each as

a predictor of substance use during adolescence is unknown. A better understanding of this would be useful for shaping prevention and intervention efforts to reduce adolescent substance use. Therefore, the purpose of the current study is to examine how sensation seeking and exposure to stressors relate to substance use by age 15 in a sample of FH + youth enrolled in a longitudinal study of adolescent development.

2. Method

2.1. Participants

Participants were 167 youth (89 girls, 78 boys) selected from a larger cohort of 386 youth enrolled in an ongoing longitudinal study of adolescent development in a large southwestern U.S. city. Details about the sample characteristics of the larger study are described elsewhere (Ryan et al., 2016). Briefly, it should be noted that the larger study has equal numbers of boys and girls enrolled and that the sample is majority Hispanic, reflecting the demographics of the local area. The larger study also oversampled FH + youth, with about 80% of the sample coming from this high-risk group. The files of all 386 participants in the larger study were reviewed for inclusion into these analyses; the inclusion criteria for the present study were 1) being at least 15 years old at the most recent study visit, so that total substance use prior to age 15 was available and 2) having a family history of substance use disorders (FH +).

2.2. Screening & study procedures

Families were recruited to participate in the larger study between 2010 and 2012, when the youth were 10–12 years old, using radio and online advertisements. Youth and one parent completed consent/assent procedures together at enrollment but were otherwise kept in different testing rooms to complete self-report questionnaire and interview measures separately. Exclusion criteria for the larger study were: low IQ (< 70; Wechsler Abbreviated Scale of Intelligence; The Psychological Corporation, 1999); physical/developmental disabilities that would interfere with the ability to understand or complete study procedures; and current or past major depressive, bipolar, or psychotic disorders based on parent and child report on the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version (K-SADS-PL; Kaufman et al., 1997). Once enrolled, participants completed biannual follow up evaluations.

At enrollment, parents provided information about demographic characteristics, youths' developmental history, and current and lifetime psychiatric symptoms in the youth. In addition, family socioeconomic status was determined using parent report on the Four Factor Index of Socioeconomic Status (FFISS; Hollingshead, 1975), and family history of substance use and psychiatric disorders was assessed using parent responses on the Family History Assessment Module (FHAM; Janca, Bucholz, Janca, & Jabos-Laster, 1992). Youth were classified as FH + if they had at least a biological father with a past or present substance use disorder; additional diagnoses in parents or other relatives were not exclusionary. The criterion of a biological father with a substance use disorder has been used in previous research of this type (e.g., Clark, Cornelius, Kirisci, & Tarter, 2005; Tarter et al., 2004) because of the elevated risk for developing an SUD that has been documented among

the biological offspring of men with substance use disorders (Vanyukov & Tarter, 2000). All study procedures were approved by the Institutional Review Board of the university where data collection occurred.

2.3. Measures

2.3.1. Substance use—Youth were interviewed about their substance use at each study visit using a drug history interview based on the procedures of Sobell, Kwan, and Sobell (1995). This interview includes questions about use of a number of substances: alcohol, cannabis, hallucinogens, depressants, inhalants, narcotics, stimulants, tranquilizers, caffeine, nicotine, and other drugs. In addition, adolescents who reported substance use completed a timeline follow-back interview (TLFB; Sobell & Sobell, 1992). In this interview, youth reported the amounts and dates of use since the previous study visit using a calendar with key dates (e.g., school breaks) highlighted. Substance use data were not shared with the parent/legal guardian. Youth also provided expired-air samples to screen for recent alcohol use (AlcoTest® 7110 MKIII C, Draeger Safety Inc., Durango, CO) and urine samples to screen for recent drug use (THC, cocaine, benzodiazepines, opiates, and amphetamines; Panel/Dip Drugs of Abuse Testing Device, Redwood Biotech, Santa Rosa, CA).

Either self-reported use of a substance other than caffeine or a positive urine/breath test at any study visit was considered sufficient for classification as a Substance User. No youth reported any substance use or tested positive for alcohol or other drugs prior to age 12. Among those who reported substance use between ages 12 and 15, youth reporting at least 20 uses of alcohol or other drugs (based on TLFB data summed across all study visits after age 12) were coded as Heavy Users. This cut-off was chosen to differentiate significant drug involvement from more experimental involvement, and this classification is consistent with previous studies of adolescent substance use patterns (e.g., Green, Doherty, Stuart, & Ensminger, 2010; Green & Ensminger, 2006). Experimenters were defined as < 20 uses, and Non-Users had to report no substance use and screen negative for substances at all study visits.

2.3.2. Sensation seeking—At the age 12 wave, youth self-reported their sensation seeking using the Sensation Seeking Scale for Children (SSS-C; Russo et al., 1993). Responses were summed across 26 items to produce a total sensation seeking score that can range from 0 to 26, with higher total scores reflecting relatively more sensation seeking.

2.3.3. Exposure to stressors—Similar to the substance use data, information about exposure to stressors was collected at each wave of data collection after age 12 using the Stressful Life Events Schedule (SLES; Williamson et al., 2003), a standardized semi-structured interview used to gather descriptions of stressors. The SLES interview assesses exposure to 80 different types of stressors, ranging from typical experiences such as getting a bad grade in school or breaking up with a romantic partner, to more serious and traumatic events such as the death of an immediate family member or being the victim of a crime. Youth were interviewed about the occurrence of these events during the preceding 6 months at each biannual study visit. Following these interviews, the severity of each stressor was rated by trained research staff using a standardized procedure. This procedure includes the

interviewer meeting with 3 additional team members trained in rating SLES events. Each of these team members rates the severity of each event reported by the participant and the group discusses any discrepancies in ratings and arrives at a final consensus rating. In a previous study using the SLES, we found that the initial ratings of team members have substantial agreement with the final rating for stressor severity (average K = 0.65) across all event categories. In addition, these levels of agreement are maintained over at least a one-year period of consistent ratings (James et al., 2013). Severity ratings range from 1 (minimally stressful) to 4 (extremely stressful). Then, the cumulative severity of stressor exposure is calculated by squaring and summing the objective severity ratings, so that more severe ratings are more heavily weighted (Williamson et al., 2003). In the current study, the cumulative severity of stressor exposure obtained from SLES interviews covering approximately 2.5 years between age 12 and age 15 were summed to provide a measure of exposure to stress during early adolescence.

2.4. Data analysis

Demographic information was examined using chi-square tests or one-way ANOVA followed by LSD *t*-test, as appropriate. Substance Users vs. Non-Users were compared on sensation seeking at age 12 and exposure to stressors between age 12 and age 15 using a one-way ANOVA. Similar analyses were conducted comparing Non-Users, Experimenters, and Heavy Users. To examine whether the variables of interest could predict the number of substance uses reported by age 15, a negative binomial regression model with sensation seeking at age 12 and exposure to stressors from age 12 to age 15 as predictors, demographic information (sex, ethnicity, family SES) as covariates, and total number of alcohol and other drug uses reported by age 15 as the dependent variable was tested.

3. Results

3.1. Demographic information

Nearly half of youth in the larger study (n = 168) were excluded from the current analyses for being too young (i.e., having not yet reached age 15), and 44 additional youth were excluded for being FH −. Within the sample of 174 who met inclusion criteria for this study, 53 youth were missing data from at least one visit. Because the data appeared to be missing at random (e.g., a family would miss a study visit but return to complete later visits) and youth with missing data did not differ in sex ratios, ethnic breakdown, or age 12 sensation-seeking from youth with no missing data, hot deck imputation (Myers, 2011) was used to fill in the missing values. Hot deck imputation is an imputation technique in which a single value is imputed for a missing observation. This value is determined based on cases from a donor pool that are similar to the case with missing data on specified factors. For this study, the specified factors that identified donor cases were sex, ethnicity, and family SES. This technique replaced missing data for 46 cases, providing a final sample of 167 youth.

The three groups of interest in this study (Non-Users, Experimenters, Heavy Users) did not differ in sex ratios, age, or ethnic makeup. Heavy Users began using substances at an earlier age (14.2 vs. 15.1 years). As expected, Heavy Users also reported a greater lifetime number of substance uses than did youth in the Experimenter group (145 vs. 5 uses). Relative to the

Experimenter group, a higher proportion of Heavy Users had used marijuana, X^2 (1, N = 69)= 15.19, p <0.001, and other illicit drugs, X^2 (1, N = 69) = 8.76, p <0.01. The category of other illicit drugs included mostly (50% of cases) inhalants, as well as hallucinogens, benzodiazepines, stimulants, and unknown substances. Polysubstance use was common in the sample as a whole (reported by 54% of Substance Users), and particularly among the Heavy Users (reported by 69% of this subgroup). The median number of uses for youth who used only a single class of substance was 4.5 uses. For polysubstance users, that figure was 33 uses. Refer to Table 1 for more details about the demographic and substance use characteristics of the sample.

3.2. Substance Users vs. Non-Users

Substance Users, compared to Non-Users, reported greater sensation seeking at age 12 (M = 14.7, SD = 4.9 vs. M= 10.7, SD = 5.4, F(1, 165) = 24.28, p <0.001), and greater exposure to stress from age 12 to age 15 (M = 65.3, SD = 42.1 vs. M=46.1, SD = 44.0, F(1, 165) = 7.99, p <0.01). The mean score for 12 year olds in a standardization study of the Sensation Seeking Scale for Children was 13.3 (Russo et al., 1993). So, sensation seeking scores in the present study were somewhat lower than average for Non-Users but somewhat higher than average for Substance Users. This suggests that the respective groups in this study have levels of sensation seeking that are within the expected range for their age, but that the groups fall on different ends of the spectrum of same-age peers. Similar normative data for the SLES is not available, but we have previously found that FH + youth report greater exposure to childhood stressors than do FH − youth (Charles et al., 2015a). This appears to continue into adolescence, as a review of the SLES data for the FH − youth in the larger study who have data available for ages 12 to 15 (n = 43) indicates that FH − youth report less exposure to stressors (M = 35.6, SD = 27.2) than do the FH + youth in the current study (M =54.1, SD = 44.1). Importantly, all three groups of FH + youth (Non-Users, Experimenters, Heavy Users) reported greater exposure to stressors from age 12 to age 15 than do the FH − youth in the larger study. Specifically, Non-Users in the current study report exposure to stress that is about 30% higher (M = 46.1, SD = 44.0) than the comparison group of FH − youth, and the Experimenters (M = 56.6, SD = 35.7) and Heavy Users (M = 75.4, SD = 47.0) report still greater exposure to stressors. Additionally, the frequency of stressors per each biannual follow-up period was similar across groups ($M_{oversll}$ = 3.5, SD = 2.3, F(1, 165) = 0.39, ns). This frequency was higher than that reported by the comparison group of FH − youth (M = 2.8, SD = 1.7), but this difference only approached significance, F(1, 209) = 3.37, p = 0.07. Thus, youth in this study report levels of sensation seeking that are within the expected range for their age but their exposure to stressors appears elevated in comparison to a more general sample of youth.

The relative contributions of sensation seeking and exposure to stressors to amount of substance use by age 15 was tested first using a binary logistic regression with sex, ethnicity, and family SES in the first block, sensation seeking at age 12 and exposure to stressors from age 12 to age 15 in the second block, and substance use/non-use as the outcome. A test of the full model including the two main effects was statistically significant, indicating that sensation seeking at age 12 and exposure to stressors from age 12 to age 15 reliably distinguished Substance Users from Non-Users at age 15 (chi square = 34.86, p < 0.001 with

df = 7). Prediction success overall was 69.5% (80.6% for Non-Users and 53.6% for Substance Users). More information about this model is displayed in Table 2. Briefly, sensation seeking at age 12 significantly differentiated youth in the Substance User vs. Non-User group at age 15 beyond the contributions made by sex, ethnicity, family SES, and exposure to stressors from age 12 to age 15. In addition, the model indicates that when sensation seeking at age 12 is raised by one unit (one point on the SSS-C; range of scores was 0 to 23) the adolescent is 1.17 times more likely to be in the Substance User group at age 15 (17% increase in risk). Exposure to stressors from age 12 to age 15 was not significantly related to group membership ($p = 0.11$) beyond the contribution made by other variables in the model.

Because Substance Users in this sample were a heterogeneous group, with number of individual uses reported ranging from 1 to 567 (mode: 1 use; median: 6 uses), additional analyses were conducted to examine how the variables of interest related to cumulative amount of substance use reported by age 15.

3.3. Comparing amounts of substance use

The associations between sensation seeking at age 12, exposure to stressors between age 12 and age 15, and cumulative amount of substance use by age 15 were examined in several ways. First, bivariate correlations were performed between these variables. Sensation seeking at age 12 was positively associated with cumulative substance use at age 15 ($r = 0.29$, $p < 0.001$), as was exposure to stressors between age 12 and age 15 ($r = 0.19$, $p < 0.05$). To determine whether sensation seeking at age 12 and exposure to stressors between 12 and 15 significantly differed between the three groups (Non-Users, Experimenters, Heavy Users), a one-way ANOVA was conducted with use group as the factor. This analysis revealed that there were significant differences in sensation seeking at age 12, $F(2, 164) = 15.44$, $p < 0.001$, and exposure to stressors between age 12 and age 15, $F(2, 164) = 5.69$, $p < 0.01$, among the three groups. The values for each group are displayed in Table 3. Post hoc LSD tests indicated that all three groups significantly differed from one another on sensation seeking, that Heavy Users differed from Non-Users on exposure to stressors, and that the difference in exposure to stressors between Experimenters and Heavy Users approached significance ($p = 0.07$).

A negative binomial regression was used to test the ability of sensation seeking at age 12 and exposure to stressors between age 12 and age 15 to predict the count of substance uses by age 15. Three models were fitted: one that included only demographic variables, one that included demographic variables and sensation seeking at age 12, and one that included demographic variables, sensation seeking, and exposure to stressors from age 12 to age 15. The details of these models are presented in Table 4. Results from negative binomial models are sometimes expressed as incidence risk ratios. These are obtained by exponentiation of the regression coefficients (i.e., $\exp[\beta]$). The equation $100^{*}(\exp[\beta] - 1)$ can be used to determine the percentage change in relative risk for increased substance use for each unit increase in the predictor (i.e., an $\exp[\beta]$ of 1.50 means that $100^{*}(1.50 - 1) = 50$, or a 50% is the increase in the incidence risk ratio for the dependent variable for each unit increase in the predictor).

In Model I, it is shown that being an ethnicity other than Caucasian is associated with decreased incidence rates for substance uses by age 15. In addition, each unit increase in family SES on the FFISS was associated with a reduction in substance use incidence rates. When sensation seeking at age 12 was added to the model (Model II), the effects noted for demographic variables in Model I remained significant and sensation seeking was also significantly related to incident rates, with a one unit increase in sensation seeking at age 12 associated with a 25% increase in incident rates for substance use by age 15. When exposure to stressors was added to the model (Model III), the previous results were preserved and it was found that each one unit increase in exposure to stressors was associated with a 2% increase in incident rates for substance uses by age 15.

4. Discussion

This study examined the associations between preadolescent sensation seeking, exposure to stressors during early and mid-adolescence, and cumulative substance use by age 15 in a cohort of FH + majority Hispanic youth participating in a longitudinal study. The results demonstrate that preadolescent sensation seeking differentiates youth who do not engage in substance use by age 15 from those who do. This variable predicted membership in the Substance User vs. Non-User group better than chance, and beyond the contribution of covariates.

Similar results were found when youth who developed heavy substance use by age 15 (i.e., using on > 20 occasions) were compared to experimental users (i.e., < 20 uses) and those who did not use substances at all. Preadolescent sensation seeking differentiated both experimental and heavier users from youth who did not use any substances. In addition, both sensation seeking during preadolescence and exposure to stressors during early and mid-adolescence were associated with the number of substance uses reported by age 15. Taken together, these results indicate that greater preadolescent sensation seeking increases the likelihood of any substance use by age 15, and that greater sensation seeking and greater exposure to stressors from preadolescence to mid-adolescence are both associated with having a higher number of uses by age 15.

The results of this study are consistent with previous research on the association between sensation seeking and substance use. In cross-sectional research, heavier substance users and individuals with substance use disorders show greater sensation seeking than do individuals who do not misuse substances. Studies focusing specifically on sensation seeking and substance use during adolescence have found that sensation seeking can predict alcohol and marijuana use patterns longitudinally (Crawford et al., 2003; Fischer & Smith, 2008; Gerra et al., 2004; La Grange et al., 1995; Pedersen et al., 2012). Importantly, the current study builds on this previous literature by assessing use of illicit drugs in addition to marijuana. Additionally, this study examines the number of uses of all substances combined as the outcome variable, rather than attempting to predict the use of each substance individually. The rationale for this decision arose from the observations made in the study, such as the finding that the majority of heavier-using youth reported using more than one type of substance. This suggests fairly indiscriminate use patterns that would be best understood by grouping use data across substance classes. Additionally, our grouping of all substances used

into a single variable is theoretically consistent with the common liability model of addiction, which asserts that a considerable amount of the variance in risk for developing a substance use disorder is attributable to factors that are common across many different substance use disorders (Vanyukov et al., 2003). Sensation seeking appears to be one such factor, and our decision to group the use of all substances together allows us to look at risk for engaging in a substance use by age 15 in more general terms than if we had restricted our analyses to specific substances.

Another way in which the current study contributes to the literature on adolescent substance use is through the simultaneous examination of sensation seeking and exposure to stressors. Although there is considerable research relating both sensation seeking and exposure to stressors to substance use, we are not aware of any studies comparing these two factors in the same model. Previous cross-sectional research on exposure to stressors has found that substance-using adolescents and young adults report higher levels of both severe stressors, such as experiencing or witnessing violence (Vermeiren et al., 2003) and being abused (Anda et al., 2002), as well as less severe stressors, such as problems at school (Charles et al., 2015), at work (Wiesner, Windle, & Freeman, 2005), and within their family (Pillow et al., 1998). The results of retrospective studies have found that adults who began using substances at an early age (Rothman, Edwards, Heeren, & Hingson, 2008), are binge drinkers (Pilowsky et al., 2009), drink heavily (Dube et al., 2002), or have substance use disorders (Anda et al., 2006) all report more childhood stressors than do adults with no history of substance use disorders. Less research has been done using prospective approaches, but there is evidence that exposure to stressors during adolescence predicts a greater increase in substance use among adolescent substance users (Hoffmann, Cerbone, & Su, 2000) and more symptoms of substance use disorders by mid- to late-adolescence (Windle, 2000). The results of this study are consistent with these findings indicating an association between exposure to stressors and substance use during adolescence. In addition, they provide new evidence that exposure to stressors contributes independently to adolescent substance use, especially heavier use.

This study provides new evidence of how sensation seeking and exposure to stressors contribute to the development of substance use patterns by mid-adolescence. However, it is not without limitations. The results reported here were from obtained from a convenience sample of mostly Hispanic, FH + youth in an ongoing longitudinal study. Therefore, our results may not be representative of all youth in this age range. However, it is important to note that our use of a predominately Hispanic sample can actually be viewed as a strength, as Hispanics are one of the fastest growing ethnic groups in the United States but are understudied in research on substance abuse (Alegria et al., 2006). In addition, most substance users in this sample have been using for a relatively short period of time. This means that there is limited follow-up data that can be used to determine any reciprocal effects between substance use and exposure to stressors or sensation seeking. It also means that some youth who are currently classified as Experimenters may go on to be Heavy Users after additional waves of data are collected, although it is important to note that our classification criterion is consistent with previous studies of adolescent substance use patterns (e.g., Green et al., 2010; Green & Ensminger, 2006). A third limitation is that sensation seeking, exposure to stressors and most of the substance use data were self-

reported by the youth. Many of the questions required recall of information from several months in the past, such as information about recent stressors and their substance use since the previous study visit. Thus, our results may have been subject to recall biases as well as under- or over-reporting. However, it is important to note that nearly all data about substance use were self-reported rather than detected by urine drug screens; urine tests identified use by participants who had not disclosed use in very few cases (i.e., < 5% of the sample). A fourth limitation is that this study did not include measurements of current peer substance use, which is a recognized risk factor for youth substance use (e.g., Simons-Morton & Chen, 2006), nor did it include potentially relevant youth traits, such as coping skills (e.g., Wills, Sandy, Yaeger, Cleary, & Shinar, 2001), that might moderate the effects of exposure to stressors on substance use. Finally, the sample for this study is entirely FH +, so it is not clear whether the effects of sensation-seeking and exposure to stressors reported in this study are uniquely important for this subgroup of youth, or more generally applicable. Future research with this sample and others will be able to test this idea.

Despite these limitations, this study has a number of strengths. One strength is the fairly large sample that was followed longitudinally through an important developmental period. Because of this, we are able to examine how preadolescent traits and subsequent exposure to stressors relate to substance use in mid-adolescence among a well-characterized, high-risk group of adolescents. Another strength is the detailed assessment of exposure to stressors conducted every six months from age 12 to age 15. This allows us to collect more nuanced data about exposure to stressors during this important life period, and also to determine the association of not only major stressors, such as trauma, but also more moderate stressors, such as academic problems, with substance use patterns by age 15. Future research with this cohort will track developmental trajectories for substance use, exposure to stressors, and sensation seeking during mid- to late-adolescence. Additionally, future research will test motivations for substance use to determine if factors such as increased exposure to stressors are directly related to substance use (i.e., using to cope with stress), or whether another mechanism is driving the association between the risk factors presented here and the adolescents' level of substance use (e.g., youth who are more impulsive in general have higher levels of all traits and behaviors assessed in this study).

As a whole, the results of this study indicate that youth with greater sensation seeking tendencies are at risk for becoming both experimental and heavier substance users by age 15, and that greater exposure to stressors during early to mid-adolescence is also associated with becoming a heavier user. This information can be valuable for researchers and clinicians attempting to develop prevention and early intervention programs for high-risk youth. The data presented here suggest that youth could be screened at age 12 and those with higher sensation seeking might be more closely monitored and/or receive additional services. Youth who screen high for sensation seeking and appear to be exposed to high levels of environmental stress would be especially appropriate for targeted interventions. In addition, programs that more broadly seek to reduce stressors affecting the families of high-risk youth, and those that increase coping skills among the youth, may also be effective in reducing their substance use. Future research that tests these possibilities could be very useful for the field.

Acknowledgments

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Table 1

Demographic information.

	Heavy users (n = 32) (A)	Experimenters (n = 37) (B)	Non-Users (n = 98) (C)	Significant difference?
Sex	n (%)	n (%)	n (%)	
Girls	17 (53)	19 (51)	53 (54)	–
Boys	15 (47)	18 (49)	45 (46)	
Ethnicity				
Caucasian	6 (19)	3 (8)	12 (12)	
Hispanic	24 (75)	28 (76)	66 (67)	–
African-American	2 (6)	3 (8)	18 (18)	
Other	0 (0)	3 (8)	2 (2)	
Substances used[a]				
Alcohol	18 (64)	27 (68)	0 (0)	–
Tobacco	13 (41)	7 (19)	0 (0)	–
Marijuan	32 (100)	23 (62)	0 (0)	A > B
Other[b]	18 (56)	8 (22)	0 (0)	–
More than one	22 (69) (transposed column A and B data)	15 (41)	0 (0)	A > B
	M (SD)	M (SD)	M (SD)	
Age at wave 1 (years)	12.7 (0.1)	12.8 (0.2)	12.7 (0.1)	–
Age at wave 2 (years)	15.4 (0.5)	15.6 (0.2)	15.6 (0.3)	A < B,C
Number of uses at wave 2	145.0 (159.3)	5.4 (5.1)	0 (0)	A > B,C

[a] Substance use comparisons are only between the Experimenter and Heavy User groups.

[b] Other substances used include inhalants, stimulants, hallucinogens, benzodiazepines, and unknown substances.

Table 2

Odds ratios for demographic characteristics, sensation seeking, and exposure to stressors as predictors of membership in the Substance User vs. Non-User group at age 15.

	Parameter estimates	
	OR	**95% CI**
Sex (male)	1.25	(0.59–2.63)
Ethnicity		
Hispanic: Caucasian	0.38	(0.04–3.97)
African-American: Caucasian	0.31	(0.04–2.59)
Other: Caucasian	0.12	(0.01–1.26)
SES	0.98	(0.95–1.02)
Sensation seeking	1.17[*]	(1.09–1.26)
Cumulative severity of stressors	1.01	(1.00–1.02)

Note. OR = odds ratio; 95% CI =95% Confidence Interval for the OR; Sensation seeking = Sensation Seeking Scale for Children Total Score at age 12; Cumulative severity of stressors = Stressful Life Events Schedule cumulative objective severity of stressors from age 12 to age 15.

[*]
$p < 0.05$.

Table 3

Sensation seeking and exposure to stressors in Heavy Users, Experimenters, and Non-Users.

	Heavy Users (n = 32) (A)	Experimenters (n = 37) (B)	Non-Users (n = 98) (C)	Significant difference?
	M (SD)	M (SD)	M (SD)	
Sensation seeking	16.3 (5.3)	13.4 (4.1)	10.7 (5.4)	A > B > C
Cumulative severity of stressors	75.4 (47.0)	56.6 (35.7)	46.1 (44.0)	A > C

Note. Sensation seeking = Sensation Seeking Scale for Children Total Score at age 12; Cumulative severity of stressors = Stressful Life Events Schedule cumulative severity from age 12 to age 15.

Table 4

Results of regression models examining the ability of sensation seeking and exposure to stressors to predict count of substance uses by age 15.

	Model I		Model II		Model III	
	exp[β]	95% CI	exp[β]	95% CI	exp[β]	95% CI
Sex						
Female (RC)	–		–		–	
Male	1.14	0.93–1.76	0.77	0.55–1.09	0.98	0.70–1.39
Ethnicity						
Caucasian (RC)	–				–	
Hispanic	0.46 **	0.27–0.77	0.16 **	0.09–0.30	0.33 *	0.18–0.62
African-American	0.18 **	0.10–0.35	0.26 **	0.13–0.52	0.34 *	0.17–0.69
Other	0.02 *	0.01–0.06	0.01 **	0.00–0.05	0.04 **	0.01–0.14
SES	0.93 **	0.91–0.94	0.91 **	0.89–0.92	0.92 **	0.91–0.94
Sensation seeking			1.25 **	1.20–1.30	1.24 **	1.19–1.28
Stress					1.02 **	1.01–1.02
Likelihood ratio	109.85 **		241.87 **		290.07 **	
X^2 Degrees of freedom	5		6		7	

Note. RC = reference category; SES = score on Hollingshead's Four Factor Index of Social Status; sensation seeking = Sensation Seeking Scale for Children Total Score at age 12; stress = Stressful Life Events Schedule cumulative severity from age 12 to age 15.

*
p <0.01.

**
p <0.001.