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## **Sensation Seeking and Substance Use: A Cross-Lagged Panel Design**

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**ABSTRACT** - Sensation seeking has received considerable attention as a predictor of drug and alcohol use. However, many studies of the sensation seeking-substance use relation have used cross-sectional designs and are unable to make definitive claims about the causal direction of the relation. This study addresses this issue in a longitudinal, cross-lagged panel design. Participants were assessed for the level of sensation seeking and substance use in 9<sup>th</sup>/10<sup>th</sup> grade and at ages 19-21. The results indicated that sensation seeking and substance use appear to mutually influence each other. This opens up new areas for research in the personality-substance use literature.

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Adolescents who abuse alcohol and drugs are more likely than non-substance abusing peers to quit school, engage in delinquent behavior, and have trouble in their home environment (Hawkins, Catalano, & Miller, 1992). Thus, it is not surprising that researchers, politicians and parents are clamoring for prevention and intervention programs for substance use as well as an explanation for the development of substance abuse problems.

Substance use among adolescents has been studied from a variety of perspectives, and many models have been proposed to explain the causal pathways of drug and alcohol use. One of the most frequently used constructs has been personality. Personality has received much attention in the literature as an explanatory factor for substance use, with researchers identifying relations between substance use and a number of different personality traits, including neuroticism (Sher & Trull, 1994), extraversion (Trull & Sher, 1994), conscientiousness/ constraint (Cook, Young, Taylor, & Bedford, 1998), and openness to experience (Trull & Sher, 1994). In particular, the trait of sensation seeking (alternatively labeled novelty seeking) has garnered a substantial amount of attention and support in the literature (Cloninger, Sigvardsson, & Bohman, 1988; Galen, Henderson, & Whitman, 1997; Wills, DuHamel, & Vaccaro, 1995; Wills, Windle, & Cleary, 1998). Sensation seeking, as defined by Zuckerman (Zuckerman, 1994; Zuckerman, & Kuhlman, 2000), is the seeking of novel and intense experiences and the willingness to take risks for the sake of such experiences. Many researchers have hypothesized that the need for excitement, inherent in sensation seekers, leads these individuals to experiment with drugs and alcohol (Andrew & Cronin, 1996). Furthermore, a meta-analysis by Derzon (2000) showed that sensation seeking may be the most potent predictor of substance use.

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Researchers examining the relations between personality and substance use have traditionally explored these in terms of personality as the predictor (e.g., Galen et al., 1997). This seems understandable given that research has demonstrated that personality starts early in life and thus would predate the onset of substance use (Caspi & Silva, 1995). However, because much of this research has been cross-sectional, it is not possible to adequately determine if personality only operates as a predictor of substance use or if personality changes may also result from substance abuse. Some researchers propose that substance use predicts, and potentially alters, personality rather than vice versa (Sher & Trull, 1994). Researchers who espouse this belief suggest that the psychosocial and biological consequences of substance use affect personality changes.

During the 1970's, Kammeier, Loper and Hoffmann (Kammeier, Hoffmann, & Loper, 1973; Loper, Kammeier, & Hoffmann, 1973; Hoffmann, Loper, & Kammeier, 1974) published a series of longitudinal studies that addressed personality traits of hospitalized alcoholics. These studies compared MMPI profiles of alcoholics in an in-patient rehabilitation unit with their MMPI profiles from their freshmen year of college. The authors also compared the alcoholic sample with a sample of non-alcoholics. Significant differences between the pre-alcoholic group and the control group as freshmen suggested that the pre-alcoholics were more gregarious, and impulsive and less conforming than their peers (Loper et al., 1973). Approximately 10 years later, after the pre-alcoholics were admitted to the hospital, their personality profiles indicated significant changes in the following areas: increased scores on Social Maladjustment, Depression, Feminine Interests, Poor Morale, and Family Problems; decreased scores on Religious Fundamentalism. The authors suggest that these changes reflect an overall change in personality toward a more depressive, anxious and fearful interpersonal style (Hoffmann et al., 1974).

These studies present some interesting results that suggest that alcoholics can be differentiated from their non-alcohol abusing peers on the basis of MMPI scores both before and after the onset of the alcoholism, with prolonged alcohol use/abuse leading to changes in personality. However, it can also be argued that these studies are not really studies of personality and substance use. The MMPI is a measure of psychopathology and symptoms of abnormal functioning. The traits that the authors note as differentiating the two samples (e.g. depression, family problems, religious attitudes and social maladjustment) are not specific indicators of personality changes. Although these symptoms may be indicative of underlying changes in personality, it seems that research that more specifically addresses the bidirectional relation between personality and substance use is needed.

Thus, to date, no research has addressed the relation between substance use and personality among adolescents in a longitudinal, cross-lagged analysis. Other researchers have used a similar model to address the relation between substance use and other variables, such as adolescent delinquency (Mason & Windle, 2002) and emotional distress (Orlando, Ellickson & Jinnett, 2001). In their examination of the reciprocal relations between substance use and delinquency, Mason and Windle (2002) gathered data from a large sample of high school juniors and seniors over a two-year period. The authors collected data at four time points during this two-year period, in order to examine changing patterns in delinquency and substance use. The findings indicated that substance use and delinquency had a reciprocal relation, providing some support for the hypothesis that substance use both impacts future behavior and is in turn affected by previous behaviors.

Delinquency, though, is a different type of variable than personality. Some might say that behaviors are more easily influenced and changed by other behaviors, which would

explain why delinquency and substance use would have a mutual influence on each other. Personality, on the other hand, is generally considered more stable and less likely to be affected by substance use. However, there is some research to support substance use's association with personality change.

Orlando et al. (2001) examined the reciprocal relation between tobacco use and emotional distress. Although the authors did not have personality data, emotional distress is likely highly correlated with the personality trait of negative emotionality. Orlando and colleagues included approximately 3,000 young adults in a longitudinal study extending from 10<sup>th</sup> grade and 12<sup>th</sup> grade to age 23. The authors found a significant cross-lagged pattern for only one of the models. The authors found significant relations between emotional distress in 10<sup>th</sup> grade and smoking in 12<sup>th</sup> grade and between smoking in 12<sup>th</sup> grade and emotional distress at age 23. They did not find a significant pattern between smoking in 10<sup>th</sup> grade, distress in 12<sup>th</sup>, and smoking at age 23. Thus, the results of this study suggest that individuals with a propensity for experiencing high levels of emotional distress are more likely to engage in smoking behavior, which then leads to increased emotional distress.

The results of the Orlando et al. (2001) and the Mason and Windle (2002) studies provide some initial support for the model in the current study. Substance use and other factors, namely delinquency and emotional distress, can exert a mutual influence on each other. Thus, it is possible that substance use and personality operate in a similar fashion. The current study directly examines this issue. Using a longitudinal, cross-lagged panel design, this study tests whether personality or substance use in 9<sup>th</sup>/10<sup>th</sup> grade serves as a stronger predictor for the other at ages 19-21. This study is the first, to our knowledge, to examine these relations in a longitudinal, cross-lagged panel design (Cook & Campbell, 1979). This design is superior to cross-sectional samples (Finn, Sharkansky, Brandt, & Turcotte, 2000), which do not allow for a temporal conclusion of the relations between personality and substance use.

We have decided to examine this model with sensation seeking as opposed to other personality variables for a number of reasons. First, sensation seeking has been well validated as a predictor of substance use. As a recent meta-analysis by Derzon (2000) indicated, sensation seeking is the single most important personality predictor of substance use. Providing further support, Cloninger, et al. (1988) showed that novelty seeking at age eleven predicted alcohol use at age 27. Second, this measure of personality is reliable at a relatively young age (Potts, Martinez, & Dedmon, 1995), whereas other personality traits have not been well-studied and validated during childhood and adolescence. Third, findings from the research on extraversion as a predictor of substance use are mixed (Cloninger, et al., 1988; Cook et al., 1998; Sher & Trull, 1994). Sher and Trull have suggested that the inconsistencies with extraversion may be attributed to the fact that some measures of this trait are actually tapping into sensation seeking. This could suggest that studies of extraversion are actually indirect tests of sensation seeking. Thus, sensation seeking seems to be the most appropriate personality trait for this study given its consistent strength as a predictor of substance use and its apparent stability over the lifespan.

We have chosen to examine this model with individuals in early adolescence and early adulthood. Specifically, we examine the data at time one with a sample of 9<sup>th</sup> and 10<sup>th</sup> grade students and again at time two when the students are 19-21 years of age. These ages were chosen because they represent the beginning of the period of risk for adolescent substance use and the end of the risk period, when most young adults have begun to stabilize in their substance use (Johnson, Gruenwald, Treno, & Taff, 1998).

We hypothesize that substance use and sensation seeking will have a mutual influence

on each other, but that the association between sensation seeking at 9<sup>th</sup>/10<sup>th</sup> grade and substance use at ages 19-21 will be stronger than the association between substance use at 9<sup>th</sup>/10<sup>th</sup> grade and sensation seeking at ages 19-21.

## Method

### Participants

The initial data collection for this study came from a sample of 2,071 children enrolled in the 6<sup>th</sup> grade in the Lexington, Kentucky school system during the 1987-1988 school year. This sample represents 93% of all the 6<sup>th</sup> graders in the school system. These students were initially recruited to participate in an evaluation of the effectiveness of Project DARE. For a detailed description of the initial recruitment procedures, refer to Clayton, Catarello and Johnstone (1996). Although testing DARE's effectiveness was the major thrust of the study, it was also designed to explore etiological pathways of drug use, and thus data were collected every year from 6<sup>th</sup> grade to 10<sup>th</sup> grade. The fact that this DARE intervention was found to have no effects on any program targets either five (Clayton et al., 1996) or 10 (Lynam et al, 2001) years later, suggests that this is an appropriate community sample for such a longitudinal investigation because the results are not contaminated by any intervention effects.

Of the original 2,071 participants, 1,429 students completed questionnaires on at least three occasions, and it was these students that were targeted for a follow-up at ages 19-21. The two groups were compared to see if there were differences between the 642 participants who dropped out and the 1,429 who completed the study. There were no differences between the groups on race ( $\chi^2(2) = 2.56$ ) and gender ( $\chi^2(1) = 2.13$ ), but the drop-outs were somewhat older ( $\chi^2(7) = 75, p < .001$ ). There were also differences in substance use between those who dropped out and those who completed the study. Drop-outs used more cigarettes at 6<sup>th</sup> grade ( $t(1892) = 4.96, p < .001$ ), 7<sup>th</sup> grade ( $t(1674) = 7.92, p < .001$ ), and 8<sup>th</sup> grade ( $t(1607) = 8.23, p < .001$ ). Drop-outs also reported more use of alcohol at 6<sup>th</sup> grade ( $t(1906) = 3.0, p < .01$ ), 7<sup>th</sup> grade ( $t(1674) = 3.2, p < .01$ ), and 8<sup>th</sup> grade ( $t(1602) = 7.6, p < .01$ ). Finally, drop-outs reported more use of marijuana at 6<sup>th</sup> grade ( $t(1900) = 2.46, p < .05$ ), 7<sup>th</sup> grade ( $t(1674) = 4.5, p < .001$ ), and 8<sup>th</sup> grade ( $t(1607) = 9.3, p < .001, r = .23$ ). Using the above variables to predict missing status (present versus absent) in a simultaneous multiple regression with a pairwise correlation matrix we found that missing status accounted for a small but significant proportion of the variation in the study variables ( $R^2 = 0.09; F(10, 1471) = 14.42, p < .001$ ).

A total of 1,002 individuals of the 1,429 eligible to participate in the study completed a mailed questionnaire in the young-adult follow-up. The sample of 1002 students consisted of 431 (43%) males and 571 (57%) females. The average age of the participants was 20.1 ( $SD = .78$ ). The racial composition of the sample was as follows: 748 (75.1%) Caucasian, 204 (20.4%) African American, and 44 (.4%) other. Further attrition analyses were undertaken to determine whether the 1,002 participants differed from the 427 who did not complete the mailed survey. Analyses revealed that there were no differences between the groups on race ( $\chi^2(2) = 1.92, p > .05$ ). However, females were more likely than males to participate ( $\chi^2(1) = 69, p < .001, r = .22$ ) and participants were younger ( $\chi^2(1) = 10.7, p < .001, r = .09$ ). There were also differences in substance use between those who dropped out and those who completed the study. Drop-outs used more cigarettes at 6<sup>th</sup> grade ( $t(1352) = 2.39, p < .005, r = .06$ ), 7<sup>th</sup> grade ( $t(1357) = 2.25, p < .05, r = .06$ ), 9<sup>th</sup> grade ( $t(1318) = 2.83, p < .01, r = .08$ ) and 10<sup>th</sup> grade ( $t(1122) = 2.45, p < .05, r = .07$ ). Drop-outs also reported more use of alcohol at 7<sup>th</sup> grade ( $t(1357) = 3.25, p < .01, r = .09$ ), 8<sup>th</sup> grade ( $t(1350) = 3.53, p < .001, r = .10$ ), 9<sup>th</sup> grade ( $t(1314) = 3.95, p < .001, r = .11$ ) and 10<sup>th</sup> grade ( $t(11210) = 2.33, p < .05, r = .07$ ). Finally, drop-outs reported more use

of marijuana at 9<sup>th</sup> grade ( $t(1315) = 4.60, p < .001, r = .13$ ), and 10<sup>th</sup> grade ( $t(1123) = 3.81, p < .001, r = .11$ ). Again, using the above variables to predict missing status (present versus absent) in a simultaneous multiple regression with a pairwise correlation matrix we found that missing status accounted for a small but significant proportion of the variation in the study variables ( $R^2 = 0.07; F(12, 1002) = 6.24, p < .001$ ). In general, rates for attrition in this sample are similar to those of other longitudinal studies (e.g. Newcomb & Bentler, 1988) and the small relations between missing status and other variables suggest that attrition does not invalidate our results.

Four hundred eighty-one of the 1002 participants were randomly recruited to participate in an intensive laboratory assessment during which time the participants completed a variety of measures. Of these 481 participants, 241 (50.1%) were males and 240 (49.9%) were females. The racial composition of this laboratory sample was similar to that of the larger sample: 381 (79.2%) Caucasians, 76 (15.8%) African Americans, and 24 (5%) other. For this study, data were analyzed for the 481 individuals from the 9<sup>th</sup>/10<sup>th</sup> grade and 19/21 year-old data collections.

### Measures

The measures for the 9<sup>th</sup>/10<sup>th</sup> grade sample were taken from a school questionnaire completed each year, from 6<sup>th</sup> through 10<sup>th</sup> grade. A similar questionnaire was used for the 19/21 year-old data. The school questionnaire addressed issues of demographics, school achievement, relationships with peers and family, self-esteem, peer pressure, sensation seeking, attitudes toward substance use, and substance use. Only measures relevant to this study are described.

**Sensation seeking.** Sensation seeking was measured in 9<sup>th</sup>/10<sup>th</sup> grade using 24 items that were based on the 40-item Sensation Seeking Scale developed by Zuckerman (1994). The items were adapted from the original forced choice format to one in which participants indicated their agreement with each item on a scale of one to five, one indicating strong disagreement and five indicating strong agreement. The original school questionnaire contained 26 items, but two items addressing substance use were dropped from our analyses, so as not to create a spurious relation to the outcome variable based on these items. To examine the comparability of this adapted scale with the original, we administered both scales to a group of 85 young adults. The correlation between the two scales was the highest correlation obtainable, given the reliabilities of the two scales ( $r = .85$ ), indicating equivalence between the two scales. The internal consistency of the 9<sup>th</sup>/10<sup>th</sup> grade measure was acceptable ( $\alpha = .71$ ).

The 19-21 year-old sample completed Zuckerman's Sensation Seeking Scale (1994) in its entirety. The 40-item questionnaire yields a total score and four subscale scores. The reliability and validity of these scales have been well established (Zuckerman, 1994). However, like in 9<sup>th</sup>/10<sup>th</sup> grade, the drug and alcohol items were removed before conducting the analyses. The internal consistency of the SS scale was good ( $\alpha = .83$ ).

**Substance use.** At all ages, participants were asked nineteen questions regarding their use of alcohol, tobacco, marijuana, and other illegal drugs. In this study we focus specifically on the questions regarding the three forenamed substances. Participants indicated from a selection of seven response choices, ranging from 0 times to 40 or more times, how many times they had used each substance. For each substance, students were asked how many times they had used the substance in their lifetime, in the past year and in the past month.

Although validity information for the substance use measures is not available, similar self-report measures have been widely used in previous research. Additionally, individuals in the study were assured at each phase of the data collection that their individual

responses would remain confidential and anonymous. Hill, Dill and Davenport (1988) assert that these are simple ways for a researcher to increase the honest responding of those being measured. Thus, it is reasonable to believe that participants in this study provided truthful responses on the questionnaires.

In addition, analyses of the data on drug and alcohol use across data assessments revealed that students consistently responded (i.e. no student indicated that he/she had used drugs or alcohol at a younger age, but not at an older age). Furthermore, there is a general trend in the data to indicate an overall increase in substance use as the students moved from 6<sup>th</sup> to 10<sup>th</sup> grade and to age 19/21 years, which is consistent with literature on adolescent drug use (Nagel, McDougall, & Granby, 1996).

## Results

Analyses for the cross-lagged panel comparisons involve three types of tests: test-retest correlations, synchronous correlations, and cross-lagged regression equations. Test-retest correlations involve a correlation of the variable at time one and time two. Synchronous correlations are a correlation of the two variables as measured at each time point. Finally, cross-lagged regression equations involve the regression of the time two variable (i.e. substance use at age 19/21) on the time one variable (sensation seeking at 9/10<sup>th</sup> grade), controlling for the effect of the time two variable at time one (substance use at 9/10<sup>th</sup> grade). Analyses were run separately for each of the substances (alcohol, tobacco and marijuana), but results were similar for each substance and thus the results of total substance use are reported instead of results for the separate substances. The results of these analyses are described below.

Test-retest correlations were significant for sensation seeking ( $r = .578; p < .01$ ) and substance use ( $r = .443; p < .01$ ). Synchronous correlations were also significant for sensation seeking and substance use at 9<sup>th</sup>/10<sup>th</sup> grade ( $r = .370; p < .01$ ), and at 19/21 years ( $r = .534; p < .01$ ). Finally, cross-lagged regression equations yielded significant findings for substance use at 19/21 regressed on sensation seeking at 9<sup>th</sup>/10<sup>th</sup> grade ( $\beta = .212; p < .01, R^2 = .039$ ), controlling for substance use in 9<sup>th</sup>/10<sup>th</sup> grade. Findings were also significant for sensation seeking at 19/21 regressed on substance use at 9<sup>th</sup>/10<sup>th</sup> grade ( $\beta = .103; p < .05, R^2 = .009$ ), controlling for sensation seeking at 9<sup>th</sup>/10<sup>th</sup> grade. Thus, findings for both regression equations were significant, suggesting that substance use and sensation seeking have a reciprocal influence on each other.

## Discussion

Based on the results of this study, it seems that sensation seeking and substance use exert a reciprocal influence on each other. This finding is both intriguing and perhaps even controversial. To date, although a few researchers have suggested that substance use affects changes in personality (Finn et al., 2000; Sher & Trull, 1994; Trull & Sher, 1994), most researchers have focused on how personality influences substance use.

However, the majority of studies on substance use have used cross-sectional designs. The weakness of the cross-sectional design is that it is not possible to determine which variable is truly the predictor and which is the outcome. Thus, for decades, the substance use research community has generally assumed that personality precedes substance use. This study documents that we can no longer automatically make this assumption. Sensation seeking, which is a very reliable predictor of substance use, showed a reciprocal relation with substance use in this study.

The findings in this study suggest that higher levels of sensation seeking at 9<sup>th</sup>/10<sup>th</sup> grade are associated with higher levels of substance use at 19/21 years. However, earlier substance use also seems to reciprocally influence later personality development, with

increased levels of substance use at 9<sup>th</sup>/10<sup>th</sup> grade being associated with higher levels of sensation seeking at 19/21 years. This finding is counter to what many researchers have proposed and hypothesized.

These results suggest that there is something about substance use that is associated with later personality changes/developments. Substance use itself could be causing these changes or possibly there is a third variable that could explain this association. As we consider these possible explanations, we begin first with the processes that might be involved in substance use leading to changes in personality.

How might personality be altered by substance use? It is possible that there could be biological changes caused by substance use that lead to personality changes. It is well documented that alcohol and drugs affect brain functioning, both in the short term and in the long term (e.g., Oscar-Berman, 1994). Furthermore, research has clearly shown that changes in the brain can lead to personality changes, as in cases of traumatic brain injury (e.g., Max, Robertson, & Lansing, 2001). Thus, it is possible that substance use could change the functioning of the brain in such a way that it leads to changes in personality.

Aside from biological changes, sensation seeking could be affected by substance use because of the disinhibiting effects of alcohol and drugs. When individuals who are not normally high sensation seekers engage in substance use, they become less inhibited and thus more likely to engage in risky behavior. These individuals may then learn that they enjoy risky behavior, which would lead them to engage in more risk taking activities and score higher on sensation seeking in later life. Another possible way that substance use may affect sensation seeking is through friendships. Typically, individuals who engage in substance use are likely to engage in other risky activities (Zuckerman, 1994). Thus, when a teenager begins associating with substance using peers, the adolescent also will be exposed to other risky activities within the peer group. Through this exposure, the adolescent may learn to enjoy these types of activities or may develop a need for high sensation seeking to gain approval from the peer group. In either case, it appears that individuals may develop an appetite for high-risk behaviors because of an involvement with alcohol and drugs.

Certainly it is possible that earlier substance use affects later personality development through a number of potential mechanisms. However, it is further possible that the relation between these variables is not at all causal, but the result of a third variable that has impacted both substance use and personality. There are any number of potential third variables that might explain the relation between earlier substance use and later personality changes. Potential third variables for the substance use-personality relation could include a genetic predisposition, an individual's peer group, the family environment, or the occurrence of high stress or trauma.

Thus, there are a number of possible explanations for the reciprocal relation between substance use and personality identified in the current study. Although this study does not identify the mechanism of this relation, the findings do highlight an often overlooked factor in the substance abuse literature. Earlier studies on personality and substance use have generally assumed that personality precedes, predicts and perhaps even causes substance use. However, due to the longitudinal design of this study, it appears that the relation between personality and substance use is reciprocal. This opens a new area for research on predictors and consequences of personality and substance use, and the mechanisms that account for the reciprocal relation between these factors.

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