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A Comparison of Three Vulnerability Models for the Onset of Substance Use in a High-Risk Sample*

CHRISTINE McCAULEY OHANNESSIAN, PH.D.[†] and VICTOR M. HESSELBROCK, PH.D.[†]
Department of Individual and Family Studies, 110 Alison Hall, University of Delaware, Newark, Delaware 19716

Abstract

Objective—The purpose of this prospective study was to compare the following three vulnerability models for early-onset substance use in a high-risk sample: the deviance proneness model, the negative affect regulation model, and a comprehensive model including both delinquency and negative affect.

Method—The sample included 249 15- to 19-year-old adolescents (57% children of alcoholics) and their fathers, all of whom were seen at follow-up 5 years later. At both times of measurement, participants completed a clinical psychiatric interview and a battery of self-report questionnaires assessing temperament, negative affect, delinquency, and substance use.

Results—Although all of the models fit the data well, the deviance proneness model was parsimonious and provided the best fit. Delinquency played a significant mediating role, whereas negative affect did not. Moreover, negative affect and delinquency were not significantly related to one another.

Conclusions—Results from this study suggest that the deviance proneness model may be a more useful theoretical framework than the negative affect regulation model or a comprehensive model when examining the onset of substance use, particularly in a high-risk sample.

Many studies have shown that children of alcoholics (COAs) are more likely to use alcohol and drugs and to experience alcohol and drug problems than are children of nonalcoholic parents (herein referred to as non-COAs; Chassin et al., 2004; Ohanessian et al., 2005; Russell et al., 1990). These differences in substance use are apparent quite early. Research has shown that COAs have an earlier onset of substance use than non-COAs (Chassin et al., 2002; Dawson, 2000). In addition, during early adolescence, COAs are significantly more likely to use alcohol, use illicit drugs, drink more heavily, and experience symptoms of substance dependence than non-COAs (Chassin et al., 1993; Hussong et al., 1998). Moreover, during adolescence, COAs have been observed to have a more accelerated trajectory of heavy alcohol use (Hussong et al., 1998) and to meet the criteria for substance dependence (Chassin et al., 2004) more often than non-COAs.

Deviance proneness model

Current theoretical models and research indicate that the relationship between parental alcoholism and COA substance use may be mediated by the offspring's temperament

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[†]Correspondence may be sent to Christine McCauley Ohanessian at the above address or via email at: E-mail: ohaness@udel.edu. Victor M. Hesselbrock is with the Department of Psychiatry, University of Connecticut School of Medicine, Farmington, CT..

characteristics. In addition, the deviance proneness model of vulnerability (Sher, 1991) suggests that delinquency may play an additional mediating role.

A wealth of research supports the deviance proneness model of vulnerability for COAs. Research has shown that COAs have higher levels of disinhibition and impulsivity and lower levels of agreeableness than non-COAs (Chassin et al., 2004; Loukas et al., 2000; Martin and Sher, 1994). These temperament characteristics, in turn, have been found to consistently predict delinquent behavior (Caspi and Silva, 1995; Desrichard and Denarie, 2005; Loukas et al., 2003). They have also been shown to be linked to the onset and frequency of substance use, heavier consumption (Chassin et al., 2002, 2004; Desrichard and Denarie, 2005), and substance abuse (Finn et al., 2000; Moeller et al., 2002; Simons et al., 2005). Similarly, extraversion has been shown to be related to substance-use onset, alcohol consumption, and alcohol problems (Flory et al., 2002; Wennberg, 2002). In a review of the literature, Sher et al. (2000, 2005) note that, in regard to temperament, traits related to impulsivity and behavioral disinhibition are most strongly and consistently related to substance use and to the development of substance-abuse problems.

Many studies have also indicated that delinquency plays a key role in the development of substance-use disorders. Research has suggested that delinquent behavior and substance use typically co-occur during adolescence (Loeber et al., 1999), with delinquent behavior during childhood and early adolescence preceding substance use and later problems (Fergusson et al., 2005; Mason and Windle, 2002; Sher et al., 2005). Temperament characteristics in early childhood also have been found to predict delinquent behavior and substance problems much later in development (Caspi and Silva, 1995; Caspi et al., 1996). Thus, a substantial amount of research supports the deviance proneness model vulnerability model for the development of alcohol and drug problems in COAs. However, other research indicates that the negative affect regulation model may be a more useful model for explaining substance use in COAs. We now turn to a discussion of this model.

Negative affect regulation model

As discussed previously, prior research has shown that temperament may mediate the relationship between parental alcoholism and offspring (COA) substance use. According to the negative affect regulation model, negative affect may further mediate this relationship. The primary premise of the negative affect regulation model is that alcohol and drug problems occur because people drink to reduce negative affect (Schuckit et al., 2006; Sher, 1991). It also should be noted that individuals who have certain temperament characteristics (e.g., high levels of neuroticism) are more likely to experience high levels of negative affect. Accordingly, these individuals have an elevated risk of using substances as a means to decrease their negative affect. In addition, experiencing a stressful environment (e.g., living with an alcoholic parent) also has been linked to higher levels of negative affect (Sher, 1991).

A fair amount of research supports the negative affect substance-abuse vulnerability model. COAs have been found to be more likely than non-COAs to possess temperament characteristics (e.g., neuroticism, emotionality) that are associated with negative affect (Chassin et al., 1993; Loukas et al., 2000). Not surprisingly, research has also shown that COAs are more likely to experience higher levels of negative affect than non-COAs (Chassin and Riller, 2001; Chassin et al., 1993; Shoal and Giancola, 2001). In turn, high levels of negative affect consistently have been found to be associated with substance use during adolescence (Chassin et al., 1993, 1996; Desrichard and Denarie, 2005; Shoal and Giancola, 2001). However, it is still unclear whether negative affect is a salient predictor of substance use over time.

A comprehensive model

The vast majority of studies in the literature have examined models of vulnerability to substance-abuse problems in isolation. For the most part, studies that have tested the deviance proneness model have not taken negative affect into account. Similarly, studies that have used a negative affect regulation framework have not included delinquency. The neglect to include both delinquency and negative affect in investigations examining adolescent substance use is problematic because recent research has indicated that there is substantial covariation between delinquency and negative affect (Chassin and Ritter, 2001). Therefore, it is unclear whether delinquency uniquely predicts adolescence substance use, once negative affect is considered, and vice versa.

The present study sought to address this limitation by comprehensively examining the deviance proneness and negative affect regulation models. Specifically, the potential mediating roles that delinquency and negative affect may play in the relationship between paternal alcoholism and the onset of COA substance use were tested both separately and together. Importantly, structural equation modeling (SEM) was used so that the potential effects that temperament, delinquency, and negative affect may have on substance use could be examined *simultaneously*. Furthermore, the saliency of these models was tested in a high-risk, predominately COA sample—individuals who already have a heightened vulnerability to early-onset substance use. Finally, gender differences were assessed because many of the variables examined in the present study have been found to differ by gender. More specifically, delinquency and substance-use problems have been shown to be more likely to occur in males (Fergusson et al., 2005; Kuperman et al., 1999), whereas negative affect and depression have been found to be more common in females (Ohannessian et al., 2005).

In summation, the primary purpose of the present investigation was to comparatively examine the following vulnerability models to COA substance use: (1) a deviance proneness model, focusing on temperament and delinquency; (2) a negative affect regulation model, focusing on temperament and negative affect; and (3) a comprehensive model, focusing on temperament, delinquency, and negative affect.

Method

All of the participants were involved in a larger, longitudinal study (The RISK project; Houston et al., 2005; Ohannessian and Hesselbrock, 2007) that was designed to follow offspring of alcohol and drug-dependent fathers over time as the offspring progress from adolescence into adulthood. The RISK project began in 1993 and is currently ongoing. The present investigation is based on Time 1 data (collected between 1993 and 1998) and Time 2 data (collected between 1998 and 2003).

Participants

At Time 1, data were collected from 249 15- to 19-year-old adolescents (60% girls) and their biological fathers. These individuals were followed up 5 years later (Time 2). The mean (SD) age of the adolescents at Time 1 was 16.70 (1.36). Most of the adolescents were white (62%) or black (25%), and all were from working-class families from an inner city in Connecticut. Approximately one half of the fathers (53%) had a high school diploma. The mean reported household gross income was 4.69 (2.42) on a scale ranging from 1 = \$0-\$9,999/year to 9 = \$150,000/year or more. This income level translates to about \$40,000/year.

Measures

Paternal substance dependence—The Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA) was administered to fathers and their offspring to obtain lifetime diagnoses of alcohol dependence. The SSAGA is a clinical, diagnostic psychiatric interview that measures 17 Axis I psychiatric diagnoses and antisocial personality disorders. Previous studies have demonstrated that the SSAGA is both a reliable and valid psychiatric diagnostic instrument (Bucholz et al., 1994; Hesselbrock et al., 1999). Based on the diagnoses obtained from the SSAGA, fathers were classified as having a history of alcohol dependence (57%) or no history of alcohol dependence (43%).

Temperament and personality—The NEO Five Factor Inventory—Form S (Costa and McCrae, 1992) was used to assess adolescent agreeableness, extraversion, and neuroticism. Each of the NEO scales includes 12 items. A representative item from the NEO is “I really enjoy talking to people” (extraversion). The response scale ranges from 1 = strongly disagree to 5 = strongly agree. Higher scores reflect higher levels of the temperament characteristics that the scale measures. Discriminant and convergent validity of the NEO scales has been demonstrated in previous studies (McCrae and Costa, 1992; Scandell, 2000). The NEO scales have also been shown to have high levels of internal consistency (Costa and McCrae, 1992; Loukas et al., 2000).

The Sensation Seeking Scale (SSS-V5; Zuckerman, 1984) was used to measure adolescent boredom susceptibility and disinhibition. The boredom susceptibility scale measures aversion to repetitive or dull experiences and the disinhibition scale measures the need to reduce inhibition (Roberti et al., 2004). Both scales include items that are summed to reflect a scale score. When completing the SSS-V5, individuals are asked to choose one of two options according to which one best describes them. For example, a representative item from the boredom susceptibility scale is “There are some movies I enjoy seeing a second or even a third time” or “I can’t stand watching a movie that I’ve seen before.” Both scales have been shown to be reliable and valid indicators of sensation-seeking behavior (Roberti et al., 2004; Zuckerman et al., 1980).

Negative affect—The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) was used to assess negative affect in the adolescents. When completing the PANAS, respondents are presented with a list of adjectives and are asked to what extent they “usually feel this way in general” on a scale ranging from 1 = very slightly or not at all to 5 = extremely. The negative affect subscale of the PANAS consists of the following adjectives: afraid, scared, nervous, jittery, irritable, hostile, guilty, ashamed, upset, and distressed. The PANAS scales have been shown to possess good construct and discriminant validity and reliability (Watson and Clark, 1991; Watson et al., 1988). In the present study, the Cronbach α coefficient for the negative affect subscale was .83.

Delinquency—A symptom count of the conduct-disorder items from the SSAGA was used to assess adolescent delinquency. Twenty items were summed to create a total delinquency scale score. Representative items from this scale include “Have you ever stolen anything, like money from someone’s purse or did you shoplift something from a store?” and “Have you ever been suspended or expelled from school?” The Cronbach α coefficient for this scale was .74.

Offspring substance use—All participating youth were asked how old they were when they first used tobacco, began drinking regularly, and first used marijuana (these variables were obtained from the SSAGA). The distributions for these variables were quite skewed. Therefore, participants were classified into the categories that follow. For tobacco-use onset and marijuana-use onset, the categories were 0 = never used, 1 = 19-22 years of age, 2 = 17-18

years of age, 3 = 15-16 years of age, 4 = 13-14 years of age, 5 = 11-12 years of age, and 6 = 10 years of age or younger. The categories for regular drinking differed because there were relatively few individuals who reported regular drinking before the age of 13. Therefore, for regular-drinking onset, the categories were 0 = have not begun to drink regularly, 1 = 19-22 years of age, 2 = 17-18 years of age, 3 = 15-16 years of age, and 4 = 14 years of age or younger.

Procedures

Subjects were recruited through their parents' response to newspaper advertisements or presentations at alcohol/drug treatment programs and support groups. Adolescents were also recruited directly through the community (e.g., YMCA/YWCA, presentations at high schools, information provided by guidance counselors, police athletic leagues). Individuals interested in the study were invited to call a research assistant for further information and screening. If they were still interested after the initial phone call, they were asked to visit the university to provide informed consent and to complete an extensive standardized neuropsychological test battery as part of their initial evaluation. Individuals who were unable to meet the basic reading requirements were excluded. Those who were not excluded were administered the SSAGA psychiatric interview. The adolescents also completed a series of self-report questionnaires.

All of the adolescents agreed to be contacted for a follow-up interview and additional testing 5 years after the initial testing. At Time 2, the youth were administered the SSAGA again. For their participation, adolescents and their fathers each were paid \$100 at Time 1. The youth also received \$150 at the Time 2 follow-up. Fathers were not reassessed at Time 2. The attrition rate between Time 1 and Time 2 was 15%. Youth who did not participate at Time 2 did not significantly differ from those who did participate at Time 2 on any of the demographic variables (gender, age, and ethnicity) or the substance-use variables (the temperament variables and negative affect were not assessed at Time 2).

Results

In the current study, temperament, negative affect, and delinquency were assessed at Time 1 and substance use was assessed at Time 2. Table 1 shows the correlations, means, and standard deviations between the variables examined. As shown in Table 1, paternal alcohol dependence was negatively associated with agreeableness and positively associated with disinhibition and boredom susceptibility. In addition, paternal alcohol dependence was related to (lower) onset of marijuana use. As shown, the majority of the correlations between the temperament, personality, delinquency, negative affect, and the measures of substance use were significant (see Table 1).

SEM was used to test the deviance proneness model, the negative affect regulation model, and a comprehensive model. Specifically, SEM was used to examine whether temperament, delinquency, and/or negative affect mediate the relationship between paternal substance dependence and adolescent substance-use age at onset. Three series of models were conducted. The first series examined the potential mediating roles of temperament and delinquency, whereas the second tested the potential mediating roles of temperament and negative affect. The third series examined a comprehensive model that included temperament, delinquency, and negative affect. The third series of models included only the significant paths and constructs from the previously run models.

For each series, three models were run. The first model was a basic unaltered saturated model. All direct and indirect paths were simultaneously included in this model and subsequent models. The second model allowed for errors with modification indices greater than 4.0 to be correlated (based on Model 1). The final model was the same as the second model, except that

all nonsignificant paths (from Model 2) also were set to 0. The final models in each series fit the data the best. These models are reported below and are shown in Figures 1-3.

A test of the deviance proneness model: The temperament-delinquency model

The temperament-delinquency model fit the data extremely well ($\chi^2 = 16.56$, 23 df, $p = .83$; normed fit index [NFI] = .96; comparative fit index [CFI] = 1.00; root mean square error of approximation [RMSEA] = .00). This model accounted for 21% of the variance for regular-drinking onset, 25% of the variance for marijuana-use onset, and 11% of the variance for tobacco-use onset.

As shown in Figure 1, paternal alcohol dependence significantly predicted marijuana-use onset only ($\beta = .16$, $p < .05$). In contrast, many significant indirect paths between paternal alcohol dependence and the substance-use age-at-onset variables were observed. Temperament characteristics (especially disinhibition) were involved in many of the indirect paths. Specifically, paternal alcohol dependence was significantly related to lower levels of agreeableness ($\beta = -.15$, $p < .05$) and higher levels of disinhibition ($\beta = .14$, $p < .05$) and boredom susceptibility ($\beta = .17$, $p < .05$). In turn, agreeableness was significantly related to later tobacco-use onset ($\beta = -.14$, $p < .05$). In contrast, disinhibition was significantly associated with an earlier age at onset for regular drinking, marijuana use, and tobacco use ($\beta = .40$, $p < .001$; $\beta = .29$, $p < .001$; $\beta = .23$, $p < .01$, respectively).

Importantly, delinquency was a significant mediator in this model; specifically, (lower) levels of agreeableness ($\beta = -.27$, $p < .001$) and higher levels of disinhibition ($\beta = .23$, $p < .001$) and boredom susceptibility ($\beta = .17$, $p < .01$) significantly predicted delinquency. Delinquency, in turn, significantly predicted earlier age of first marijuana use ($\beta = .26$, $p < .001$).

Sobel tests confirmed that delinquency significantly mediated the relationships between agreeableness and the onset of marijuana use (critical ratio [c.r.] = -2.96 , $p < .01$), disinhibition and the onset of marijuana use (c.r. = 2.64 , $p < .01$), and boredom susceptibility and the onset of marijuana use (c.r. = 2.20 , $p < .05$).

A test of the negative affect regulation model: The temperament—negative affect model

The temperament—negative affect mediating model also fit the data extremely well ($\chi^2 = 22.18$, 26 df, $p = .68$; NFI = .94; CFI = 1.00; RMSEA = .00). This model accounted for 20% of the variance for regular-drinking onset, 19% of the variance for marijuana-use onset, and 12% of the variance for tobacco-use onset.

Similar to the previous model, paternal alcohol dependence had a significant direct effect on marijuana-use onset ($\beta = .16$, $p < .05$). Again, temperament characteristics also were involved in many of the indirect paths; specifically, paternal alcohol dependence significantly predicted lower levels of agreeableness ($\beta = -.15$, $p < .05$) and higher levels of disinhibition ($\beta = .14$, $p < .05$) and boredom susceptibility ($\beta = .17$, $p < .05$) (see Figure 2).

Similar to the temperament-delinquency model, agreeableness was significantly associated with tobacco-use onset ($\beta = -.16$, $p < .05$) and disinhibition was significantly associated with the onset of regular drinking, marijuana use, and tobacco use ($\beta = .43$, $p < .001$; $\beta = .35$, $p < .001$; and $\beta = .24$, $p < .001$, respectively). However, it is important to note that negative affect was not a significant mediator in this model, primarily because it was not significantly related to any of the adolescent substance-use age-at-onset variables.

A comprehensive model

The comprehensive model including temperament, negative affect, and delinquency also fit the data quite well ($\chi^2 = 19.59$, 25 df, $p = .77$; NFI = .95; CFI = 1.00; RMSEA = .00). The comprehensive model accounted for 19% of the variance for regular-drinking onset, 24% of the variance for marijuana-use onset, and 10% of the variance for tobacco-use onset. The paths between paternal alcohol dependence and temperament, negative affect, and delinquency were nearly identical to those in the two models discussed previously (see Figure 3).

As found in the previous models, delinquency was a significant mediating variable, whereas negative affect was not. Specifically, paternal alcohol dependence significantly predicted (lower) levels of agreeableness ($\beta = -.15$, $p < .05$) and higher levels of disinhibition ($\beta = .14$, $p < .05$) and boredom susceptibility ($\beta = .17$, $p < .05$). These variables, in turn, significantly predicted delinquency ($\beta = -.32$, $p < .001$; $\beta = .21$, $p < .01$; and $\beta = .16$, $p < .05$, respectively), which significantly predicted lower age of first marijuana use ($\beta = .27$, $p < .001$). Again, Sobel tests confirmed that delinquency significantly mediated the relationships between agreeableness and the onset of marijuana use (c.r. = -3.29, $p < .001$), disinhibition and the onset of marijuana use (c.r. = 2.60, $p < .01$), and boredom susceptibility and the onset of marijuana use (c.r. = 2.16, $p < .05$).

As was found in the temperament—negative affect model, negative affect was not a significant mediating variable because agreeableness, extraversion, disinhibition, and boredom susceptibility did not significantly predict negative affect *and* negative affect did not significantly predict any of the substance-use age-at-onset variables (see Figure 3). The most striking finding to emerge in the comprehensive model was that negative affect and delinquency were not significantly related to one another.

A comparison of the models

Taken together, all of the models fit the data quite well. However, an examination of the direct and indirect paths revealed that negative affect contributed little to the models. Moreover, the model including only delinquency (without negative affect) fit the data slightly better overall than the negative affect model or the comprehensive model. In addition, it accounted for a greater percentage of variance when predicting age at onset for regular drinking and marijuana use.

Gender differences

Multiple groups structural models were run for each of the three final models to examine gender differences. In these models, all of the paths were constrained to be equal, across gender. The fit of these models and the pattern of relations observed were nearly identical to the original unconstrained models (deviance proneness model: $\chi^2 = 57.86$, 68 df, $p = .85$; NFI = .87; CFI = 1.00; RMSEA = .00; negative affect model: $\chi^2 = 57.64$, 71 df, $p = .87$; NFI = .87; CFI = 1.00; RMSEA = .00; comprehensive model: $\chi^2 = 52.17$, 70 df, $p = .77$; NFI = .94; CFI = 1.00; RMSEA = .00). Chi-square difference tests indicated that none of these models significantly differed from the original unconstrained models ($\chi^2 = 7.13$, 11 df, $p = \text{ns}$; $\chi^2 = 5.16$, 9 df, $p = \text{ns}$; and $\chi^2 = 7.98$, 13 df, $p = \text{ns}$, respectively).

Discussion

The primary aim of this study was to comparatively examine three substance-use vulnerability models: (1) the deviance proneness model, (2) the negative affect regulation model, and (3) a comprehensive model that included components of both models. In each model, it was hypothesized that paternal alcoholism would predict the temperament and personality characteristics, which, in turn, would predict delinquency (for the deviance proneness model)

and negative affect (for the negative affect regulation model). These variables subsequently were hypothesized to predict the onset of adolescent substance use.

Consistent with prior research examining adolescents and young adults (Chassin et al., 2004; Loukas et al., 2000; Martin and Sher, 1994; Ohannessian and Hesselbrock, 1995), adolescent COAs were found to have lower levels of agreeableness and higher levels of disinhibition and boredom susceptibility than non-COAs. In addition, lower levels of agreeableness and higher levels of disinhibition were related to earlier substance use. These results are in agreement with previous research (Chassin et al., 2004; LoCastro et al., 2000; Loukas et al., 2000; Sher et al., 2005).

The consistent role that disinhibition played was particularly striking. This finding is in line with other studies that have found disinhibition to play a key role in the development of substance-abuse problems, especially among COAs (Loukas et al. 2003; Sher et al. 2000).

In contrast, neuroticism did not play an important role in this study. It should be noted, however, that neuroticism typically has been found to be related to substance use in samples of older adults but not in samples of younger individuals, such as those assessed in the present study (Cloninger et al., 1995; LoCostra et al., 2000).

Similar to neuroticism, extraversion played no role in the present study. Although some studies have shown a link between extraversion and the development of substance-abuse problems (Flory et al., 2002; Wennberg, 2002), others have not (LoCastro et al., 2000). Again, differences in sample characteristics and methodology may account for the differing results. It also should be noted that in the present study, the direct links between extraversion and substance use were not assessed. The effect of extraversion was assessed via delinquency and negative affect. It may be that extraversion has more of a direct effect on substance use. Future research should consider this possibility.

Taken together, the results of this study indicate that the deviance proneness model may be a more useful heuristic framework than the negative affect regulation model—or even a comprehensive model—when examining predictors of substance use in COAs. In the present study, paternal alcoholism significantly predicted temperament (agreeableness, disinhibition, boredom susceptibility), which, in turn, significantly predicted delinquency. Delinquency, in turn, significantly predicted earlier age of first marijuana use.

In contrast, negative affect added virtually no explanatory value. Negative affect was not related to paternal alcoholism or to any of the substance-use variables. Importantly, in the comprehensive model, negative affect was also not related to delinquency, a finding that conflicts with the hypothesis that these two constructs are inherently related to one another. Finally, the comprehensive model, which included aspects of the deviance proneness model and the negative affect regulation model, did not add anything above and beyond the deviance proneness model and was less parsimonious.

It should be noted that in the present study, all of the substance-use measures reflected the age at onset of substance use. It may be that negative affect is a more salient predictor of later substance use or substance-abuse problems. Although negative affect regulation has been linked to adolescent substance use (Chassin et al., 1993,1996;Desrichard and Denarie, 2005;Shoal and Giancola, 2001), negative affect regulation models have been more typically used to explain later-stage substance abuse or dependence (Swaim et al., 1989). Perhaps the deviance proneness model is a more useful model for predicting the onset of substance use and the early development of problems, whereas the negative affect regulation model is a more useful model for predicting later alcohol and drug problems.

Consistent with this hypothesis, it should be noted that we have found some components of negative affect (e.g., hostility) to be related to substance-abuse indicators in the RISK data set at Time 2 (Ohannessian and Hesselbrock, in press). We should be able to explore these relationships longitudinally in the near future, as we are currently in the process of collecting Time 3 data from the RISK sample. The participants are now in their mid to late 20s. Time 3 data will allow us to examine the roles that delinquency and negative affect play in the development of alcohol and drug problems well into adulthood.

In conclusion, results from this study suggest that prevention programs aimed at delaying substance use in adolescents at risk for the development of substance-abuse problems should focus on reducing delinquent behavior and other factors (e.g., temperament, self-regulation) that may relate to deviance proneness. Contextual factors that have been linked to delinquency also should be targeted. For instance, peers have been shown to play a strong role in delinquency during adolescence (Loeber and Farrington, 2000; Piquero et al., 2005). Therefore, prevention programs might teach adolescents appropriate methods to resist the influence of delinquent peers. It should be noted that the present study focused only on a relatively small piece of the deviance proneness model. Future research is needed to examine other components of the deviance proneness model and the manner in which they interact to yield a more complete picture of the risk factors involved in the onset of substance use during adolescence.

Although the present study extends the current literature by employing a comprehensive examination of different vulnerability models, limitations should be noted. One limitation relates to the assessment of negative affect. In the present study, a general measure of negative affect was used. That is, different aspects of negative affect were not assessed (e.g., anger, fear, depressed mood). Some research has indicated that certain aspects of negative affect may relate more strongly to substance use than others (Swendsen et al., 2000). Perhaps negative affect would have been a more salient mediator in the present study if distinct components were assessed.

Another measurement limitation relates to fathers' substance dependence. In the present study, lifetime diagnoses of alcohol dependence were used. Therefore, it should be kept in mind that the fathers may or may not have been active alcoholics at the time of the study. Alcohol dependence is often a chronic and fluctuating illness, and defining a variable that captures this phenomenon accurately is difficult. It also should be noted that the youth substance-use measures related to the age at onset of use. Therefore, it is possible that substance-use onset could have occurred before Time 1 for some of the youth. Longitudinal studies, beginning earlier in development (e.g., middle childhood), need to be conducted to better address the temporal relations between the constructs assessed in the current study.

The present study was also limited by the overarching design of the research project. The RISK sample is a high-risk sample. Because fathers with substance dependence were targeted, the participants are likely to have an increased risk of other psychological problems (e.g., depression, anti-social personality disorder). Therefore, generalizability of the results should be made with caution. In addition, it should be noted that, in the RISK project, data were collected only from fathers and their children. As a result, possible distinctions between paternal and maternal alcoholism and their relationships to the variables assessed in the study could not be assessed. Finally, although gender differences were examined in the present study, the sample was relatively small. The absence of observed gender differences in this study may have been the result of insufficient statistical power needed to detect significant differences.

Nevertheless, the present study extends the extant literature in a number of respects. Importantly, parental alcoholism (a major risk factor for substance-abuse problems) was incorporated into the deviance proneness and negative affect regulation models. In addition,

in contrast to the majority of studies examining substance use, alcohol *and* drug use both were assessed. Most importantly, however, structural equation modeling was used to compare the deviance proneness model, the negative affect model, and a comprehensive model. This approach allowed for the *simultaneous* examination of the roles that temperament, delinquency, and negative affect play in the onset of substance use.

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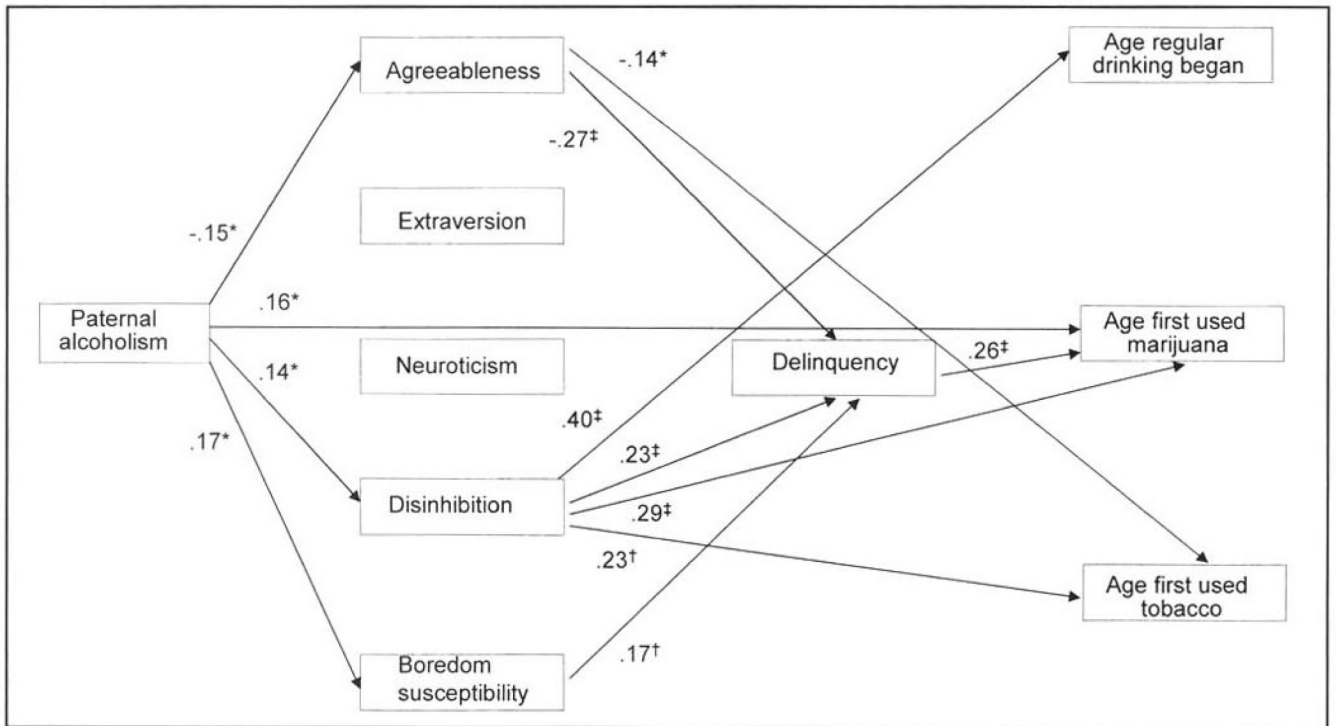


Figure 1. A test of the deviance proneness model. Standardized regression coefficients are presented. For ease of interpretation, only significant paths are displayed.
 $*p < .05$; $^\ddagger p < .01$; $^\ddagger\ddagger p < .001$.

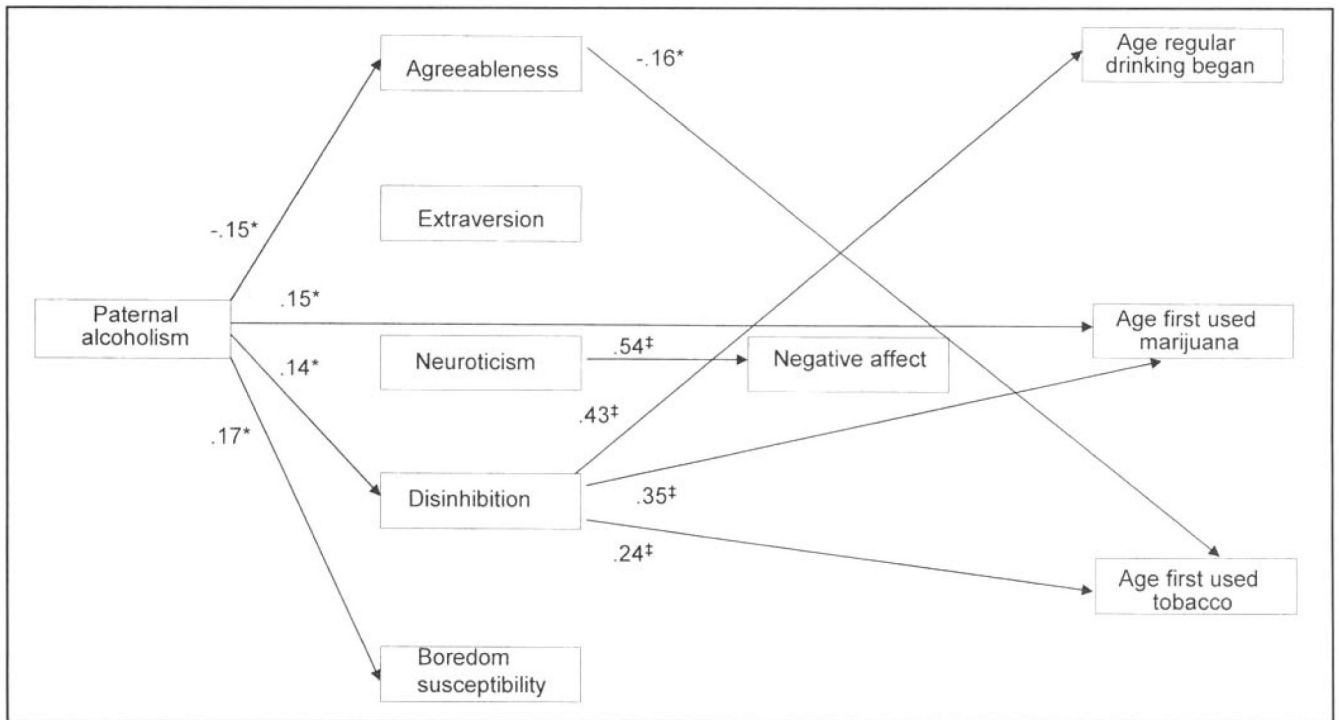


Figure 2.
 A test of the negative affect regulation model. Standardized regression coefficients are presented. For ease of interpretation, only significant paths are displayed.
 $*p < .05$; $‡p < .001$.

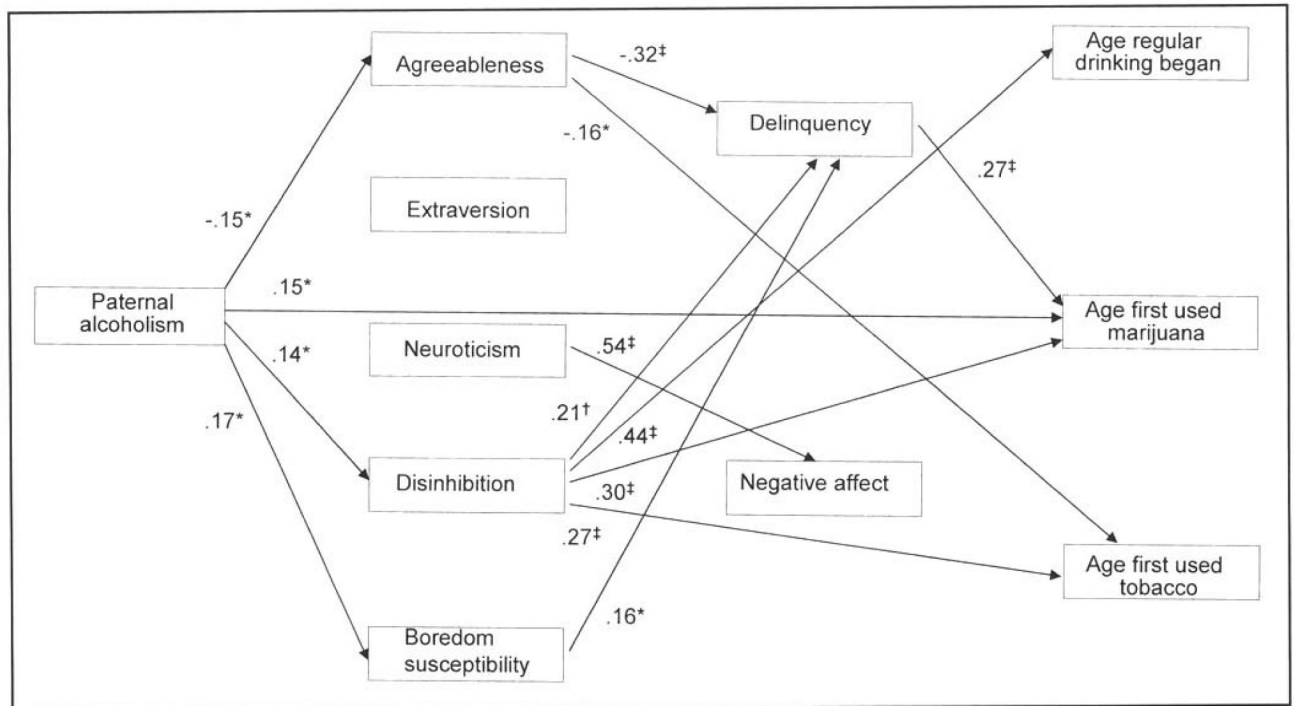


Figure 3.

A test of a comprehensive model. Standardized regression coefficients are presented. For ease of interpretation, only significant paths are displayed.

* $p < .05$; $^\ddagger p < .01$; $^\ddagger\ddagger p < .001$.

Table 1
Means, standard deviations, and correlations among study variables

Measure	1	2	3	4	5	6	7	8	9	10	11
1. Paternal alcohol dependence											
2. Agreeableness	-.15*										
3. Extraversion	-.05	.27 [†]									
4. Neuroticism	-.03	-.27 [†]	-.23 [†]								
5. Disinhibition	.14*	-.27 [†]	.15*	.09							
6. Boredom susceptibility	.17*	-.30 [†]	.05	-.01	.33 [†]						
7. Delinquency	.10	-.40 [†]	-.14*	.12	.33 [†]	.31 [†]					
8. Negative affect	.08	-.21 [†]	-.15*	.55 [†]	.14*	.09	.17*				
9. Tobacco age at onset	.09	-.23 [†]	.05	.10	.31 [†]	.14*	.22 [†]	.18 [†]			
10. Regular drinking age at onset	.12	-.16*	.02	.01	.44 [†]	.18 [†]	.25 [†]	.08	.39 [†]		
11. Marijuana age at onset	.22 [†]	-.23 [†]	-.01	.15*	.41 [†]	.21 [†]	.39 [†]	.17*	.49 [†]	.45 [†]	
Mean	0.87	29.15	29.21	21.57	4.67	3.43	19.62	21.74	2.83	1.68	2.23
SD	0.85	6.46	6.04	6.94	2.56	2.00	8.65	6.41	1.73	1.33	1.52

* $P < .05$ [†] $P < .01$ # $P < .001$.