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published in

Psychology of Addictive Behaviors
2001

DOI (link to publisher)

[10.1037/0893-164X.15.3.227](https://doi.org/10.1037/0893-164X.15.3.227)

document version

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

citation for published version (APA)

White, H. R., Xie, M., Thompson, W., Loeber, R., & Stouthamer-Loeber, M. (2001). Psychopathology as a predictor of adolescent drug use trajectories. *Psychology of Addictive Behaviors*, 15(3), 227-236.
<https://doi.org/10.1037/0893-164X.15.3.227>

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Psychopathology as a Predictor of Adolescent Drug Use Trajectories

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The authors examined early psychopathology as a predictor of trajectories of drug use from ages 13–18 years. Six years of annual data were analyzed for 506 boys using a mixed effects polynomial growth curve model. They tested whether distinct measures of psychopathology and behavioral problems (i.e., attention-deficit/hyperactivity disorder, oppositional defiant disorder, conduct disorder, depression, and violence) assessed in early adolescence could prospectively predict level and change in alcohol and marijuana use. Higher levels of all of the types of psychopathology predicted higher levels of alcohol use, and higher levels of attention-deficit/hyperactivity disorder, conduct disorder, and violence predicted higher levels of marijuana use. Only conduct disorder predicted linear growth in alcohol use, and none of the measures predicted growth in marijuana use. The results suggest that drug use prevention programs should target youths with early symptoms of psychopathology.

Adolescent substance use is a serious problem in the United States. Although rates of drug use declined for most categories of drugs during the early 1990s, recent national surveys of high school seniors indicate that drug use increased from 1992 until 1997 and has leveled off since then (Johnston, O'Malley, & Bachman, 2000). For several decades researchers have been studying the predictors and correlates of adolescent substance use and have generated numerous explanatory theories (for a review and critique of these studies see Petraitis, Flay, & Miller, 1995). Although these theories have adequately explained initiation and experimental use, most have failed to specify the processes and mechanisms that account for the development of regular and problem substance use (Glantz, 1992; Petraitis et al., 1995; White, 1996).

There is growing recognition, however, that we must begin to pay greater attention to the predictors of developmental changes in

substance use (Cicchetti & Rogosch, 1999; Glantz, 1992; White, 1996). Most research indicates that social and environmental variables (e.g., friends' use, community norms) are more important as predictors of initiation of drug use but that psychological variables (e.g., negative affect, psychopathology) and biogenetic variables (e.g., neurochemical systems, family history of alcoholism) are more important in the transition to regular and frequent use (see Glantz; Pickens & Svikis, 1988; Stice, Barrera, & Chassin, 1998; Tarter & Edwards, 1987).

Psychopathology may be especially important for the transition to increased levels of substance use. Studies of adolescents (e.g., Labouvie, 1990; Weber, Graham, Hansen, Flay, & Johnson, 1989), as well as of adult alcoholics (e.g., Cloninger, Bohman, & Sigvardsson, 1981; Zucker, 1987) have identified several types of substance users based on age of onset, internalizing problems, externalizing problems, and personality traits. In these typologies there is usually one group of abusers or heavy users who display early symptoms of psychopathology. Furthermore, this is the group that generally shows the worst treatment outcomes (Myers, Brown, & Mott, 1995). Thus, psychopathology may be a significant predictor of substance abuse and dependence, especially early-onset, severe types of abuse. Yet it is also possible that substance use may lead to the development of psychopathology or enhance already existing disorders (for a review, see Austin, Macari, Sutker, & Lettieri, 1977) or that substance use and psychopathology may be predicted by the same set of underlying factors (e.g., parental alcoholism; Weinberg & Glantz, 1999). Loeber, Farrington, Stouthamer-Loeber, and Van Kammen (1998b) addressed the latter possibility. They found that the risk factors for substance use were largely different from the risk factors for psychopathology and behavioral problems (e.g., physical aggression and conduct problems) and that the least overlap was between the risk factors for attention-deficit/hyperactivity disorder (ADHD) and the risk factors for substance use.

Studies of both clinical populations and community samples have found that individuals with alcohol- or drug-related problems often have other mental health problems, such as a diagnosis of

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Preparation of this article was supported in part by grants from the National Institute on Drug Abuse (DA 41101 and DA/AA 03395), the National Institute of Mental Health (NIMH 50778), and the Office of Juvenile Justice and Delinquency Prevention (OJJDP 96-MU-FX-0012). Points of view or opinions in this article are those of the authors and do not necessarily represent the official position or policies of the Office of Juvenile Justice and Delinquency Prevention, the National Institute of Drug Abuse, or the National Institute of Mental Health.

An earlier version of this article was presented at the Life History Research Society meetings in Kauai, Hawaii, September 1999. We thank Marsha Bates for her comments on an earlier version of this article and Ping-Hsin Chen for her assistance with the data analysis and article preparation.

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antisocial personality syndrome (for a review see Weinberg & Glantz, 1999). For adolescent alcohol and drug abusers, conduct disorder (CD) appears to be the most common comorbid psychiatric diagnosis (Myers et al., 1995). Furthermore, CD appears to be a powerful prospective predictor of drug use and abuse among adolescents (Clark, Parker, & Lynch, 1999; E. J. Costello, Erkanli, Federman, & Angold, 1999; Loeber, Stouthamer-Loeber, & White, 1999; Weinberg & Glantz, 1999). In contrast, oppositional defiant disorder (ODD) has received little support as a predictor of substance use, although it often precedes CD (Weinberg & Glantz). E. J. Costello et al. found a significant effect of ODD on substance use but not when they controlled for CD (see also Greene et al., 1999). In addition, early aggressive and delinquent behavior has been linked to substance use and abuse in numerous studies (for a review see White, 1990, 1997).

Findings regarding ADHD as a predictor of substance use, abuse, or disorders are less clear (for a review, see Wilens, Biederman, & Spencer, 1996). In general, prospective studies have found that the effect of ADHD on substance use and abuse is mediated by CD (Clark et al., 1999; E. J. Costello et al., 1999; Loeber et al., 1999; Lynskey & Fergusson, 1995; Molina, Smith, & Pelham, 1999; Weinberg & Glantz, 1999). However, few studies have examined this relation with developmental changes in substance use as the criterion.

The data on the relation between substance use and internalizing problems are also inconsistent. Depression has been associated with substance abuse in numerous studies, although the direction of the relation remains questionable (Bukstein, Brent, & Kaminer, 1989; Clark et al., 1999; Weinberg & Glantz, 1999). Pandina, Johnson, and Labouvie (1992) argued that drugs are potent inducers of positive affect and reducers of negative affect. Therefore, individuals who are chronically deprived of positive reinforcement (i.e., individuals who are dominated by pervasive negative mood states) are most likely to find drug intoxication attractive and desirable. Pandina et al. found that negative affectivity was significantly associated with problem drug use among adolescent users. E. J. Costello et al. (1999) found that both depression and disruptive behavior disorders (primarily CD) were associated with a higher rate and earlier onset of substance use. In contrast, other researchers have failed to find that internalizing problems predict substance use when they have controlled for conduct problems (e.g., Brook, Whiteman, & Gordon, 1985; Clark et al.; Robins & Przybeck, 1985). In sum, the literature suggests that several forms of psychopathology and behavioral problems are likely to precede the development of substance use. However, the lack of consistency for each specific type of psychopathology (except behavioral problems) is noteworthy, and the relation between psychopathology and changes in substance use patterns has rarely been assessed.

Researchers have begun to realize the importance of studying individual development of problem drug use over time (Cicchetti & Rogosch, 1999). Therefore, there is a growing appreciation that greater attention needs to be directed toward individual growth curves and the description and explanation of differences in intra-individual change (White, Bates, & Labouvie, 1998; Willett, Singer, & Martin, 1998). Person-centered techniques that examine individual growth curves have gained popularity among developmental psychologists and drug researchers. It is also clear that a developmental model based on a single narrow window of onset

for later heavy substance use is inadequate. Empirical findings show that heavy substance use can emerge at different ages (from late childhood to adulthood; Loeber et al., 1999). Therefore, models of substance use have to account for the heterogeneity of developmental patterns.

It is the purpose of this article to examine whether measures of psychopathology and behavioral problems in early adolescence can predict individual trajectories of drug use from early to later adolescence using growth curve modeling. On the basis of the literature just reviewed, it is reasonable to assume that higher levels of psychopathology would predict early onset of substance use and higher initial levels of use, which are then maintained over time. In this study we addressed the unanswered question of whether these initial psychological problems would also predict greater growth in the behavior over time.

Method

Design and Sample

Data were collected as part of the Pittsburgh Youth Study, a prospective longitudinal study of the development of delinquency, substance use, and mental health problems (Loeber, Farrington, Stouthamer-Loeber, & Van Kammen, 1998a). In 1987–1988, random samples of first-, fourth-, and seventh-grade boys enrolled in Pittsburgh public schools were selected. Approximately 850 boys in each grade (85% of the target sample) were screened. Families were paid for their participation, and informed written consent was obtained from both the participants and their legal guardians. The 15% nonparticipation rate did not result in sample bias, at least in regard to achievement test results and racial distribution, which were the only two variables that could be compared from school records (Loeber et al., 1998a).

About 500 boys in each grade (the 250 most antisocial and another 250 randomly selected from the remaining 600) were selected for the first follow-up 6 months later. For the present analyses we used only the oldest cohort ($N = 506$), because levels of drug use were too low in the other cohorts. After the first follow-up the boys in the oldest cohort were subsequently followed up at 6-month intervals for four additional assessments and then at yearly intervals for another three assessments. Attrition has remained relatively low, and the completion rate has averaged 93.6% over nine data waves (range: 100%–86%) for the oldest cohort. The sample is 57.5% African American, with the remainder almost all White. In addition, 36.2% of the boys' families received public assistance or food stamps. (For greater detail on participant selection and sample characteristics, see Loeber et al., 1998a.)

In order to use a common 1-year period for our analyses, we combined the first and second 6-month assessments: the third and fourth and the fifth and sixth. Merging these three combined assessments with the next three yearly assessments gives us six waves of annual data from participants' average age 13.25 years to 18.5 years.¹ (For the purposes of this article, age is referred to in whole years, i.e., ages 13–18.)

Measures

The data on substance use and delinquency came from self-report questionnaires from the participants. Self-reports are generally accepted as

¹ During the 6-month assessments the questions asked about the frequency of drug use (number of times) in the last 6 months, and during the annual assessments the questions asked about use in the last year. Thus, adding the number of times for two consecutive 6-month periods provides a comparable number to that for the 1-year assessments.

reliable and valid indicators of delinquent behavior and drug use (Farrington, Loeber, Stouthamer-Loeber, Van Kammen, & Schmidt, 1996; Single, Kandel, & Johnson, 1975). (For greater detail on the advantages and disadvantages of self-report data, see Elliott, Huizinga, & Menard, 1989; Farrington et al.). Adolescent self-reports were supplemented by parent reports.

Drug use measures. Substance use was assessed with the 16-item Substance Use Scale adapted from the National Youth Survey (Elliott et al., 1989). Alcohol use was measured as the product of frequency $\times$ quantity. Frequency of alcohol use was the sum of the number of times participants had used beer, wine, and hard liquor during the past year. Typical quantity (i.e., number of drinks) per occasion was assessed separately for beer, wine, and hard liquor. We took the maximum value as our measure of alcohol quantity. We also measured frequency of use (number of times) participants had used marijuana during the past year. Other drugs were not included because of the low level of other drug use in this sample (see White, Loeber, Stouthamer-Loeber, & Farrington, 1999). Alcohol and marijuana use were logged and measured at ages 13, 14, 15, 16, 17, and 18. These measures were used to develop trajectories separately for each drug.²

Psychopathological characteristics. We selected five measures of psychopathology and behavioral problems that have been found to co-occur with substance use (Loeber et al., 1998b; Loeber et al., 1999; Weinberg & Glantz, 1999). These data were collected from the boys and their primary caretaker (usually a mother). At each assessment, the boys completed the Self-Report Delinquency Scale (SRD; Loeber et al., 1998a), which includes 40 items measuring status offenses, overt, and covert delinquency. The questions assess the number of times participants engaged in each behavior in the last 6 months. In addition, at each assessment the boys completed the 112-item Youth Self-Report (YSR; Achenbach & Edelbrock, 1987). This scale measures child behavior problems as well as social and academic competencies. Nine items were added to this scale to cover covert antisocial behaviors and to increase comparability with similar forms completed by parents.

At the first follow-up (second assessment), the caretaker completed the Revised Diagnostic Interview Schedule for Children, Parent Version (DISC-P; A. Costello, 1987), which was developed as a measure of child psychopathology to be administered by lay interviewers. The DISC-P covers most forms of child psychopathology contained in the *Diagnostic and Statistical Manual of Mental Disorders* (3rd ed., American Psychiatric Association, 1980; 3rd ed., rev. [DSM-III-R], 1987).

ADHD and ODD scores were assessed on the basis of the DISC-P at the second assessment. ADHD scores were based on 28 questions covering 14 behaviors ($\alpha = .84$). Answers ranged from "never" (0) through "sometimes" (1) to "often" (2) and were added together. The behaviors fall under the broad categories of restlessness or hyperactivity, attention deficit, and impulsivity. ODD scores were based on 13 questions that cover 9 oppositional defiant behaviors, such as losing one's temper, arguing, and blaming others ($\alpha = .78$). Scoring was the same as for ADHD.

CD score was the number of symptoms endorsed by items from the DISC-P (as reported by the primary caretaker at the second assessment) and the participant's YSR and SRD scores at the second assessment. Twenty-five questions from the DISC-P covered 13 conduct problems ranging from lying to status offenses to delinquent acts. In addition, 17 items from the SRD and 4 items from the YSR that refer to CD symptoms were included ($\alpha = .65$). (Note that no substance use items were included in this scale.)³

Depressed mood score was the number of symptoms from the Recent Mood and Feelings Questionnaire (E. J. Costello & Angold, 1988) completed by the participants at the first follow-up. The 13 questions cover the symptoms (during the previous 2 weeks) necessary for making a diagnosis of major depression according to DSM-III-R criteria ($\alpha = .84$; American Psychiatric Association, 1987).

Violent behavior score was the sum of the number of times in the last year that a participant strongarmed, attacked someone with a weapon or

with intent to seriously hurt or kill him or her, took part in gang fights, hurt or threatened to hurt someone to have sex with him or her, and forced sex or attempted to force a person into sex. This measure was based on participant self-report at the screening and first follow-up. Note that all of these violence items except gang fighting were also included as part of the CD score. We did not omit these items because we wanted our measure of CD symptoms to be comparable with those used in other studies (see Loeber et al., 1998a).

Analyses

We used a mixed effects model approach (Bryk & Raudenbush, 1992) and polynomial function to develop our trajectories of alcohol and marijuana use for each individual. The mixed effects model was specified in two levels. The Level 1 model used a polynomial function of order k to model the growth process of participant i over age 13–18 years:

$$Y_{ij} = b_{i0} + b_{i1}A_{ij} + b_{i2}A_{ij}^2 + \dots + b_{ik}A_{ij}^k + E_{ij}, \text{ for } j = 1, 2, \dots, 6 \quad (1)$$

where Y_{ij} = response at time t_j for participant i , $A_{ij} = (\text{Age}_i[j] - 13)/5$, and E_{ij} = error terms for the i th participant at time t_j .

The Level 2 model specified equations for the random coefficients b_{is} in Equation 1,

$$b_{is} = \beta_s + \gamma_s x_i + \pi_{is}, \text{ for } s = 0, 1, 2, \dots, k, \quad (2)$$

where $x_i = (F_i - \text{average } [F])/se(F)$ (x standardized the F_i value), and π s are normally distributed random errors. F_i is the measurement of one of the psychopathology variables described in the previous section for participant i at age 13.

The polynomial function in Equation 1 describes the trajectories of alcohol and marijuana use for each individual. The β coefficients in Equation 2 capture the average growth pattern for the entire sample, and the γ_s coefficient represent the effect of the psychopathology variable on the s th order term of the polynomial function of the average growth. The π s in Equation 2 were used to model the unique difference between each individual trajectory and the overall average growth curve. If the psychopathology variable does not affect the growth curve (i.e., $\gamma_0 = \gamma_1 = \gamma_2 = \dots = \gamma_s = 0$), then the Level 2 model in Equation 2 would reduce to the basic Level 2 model:

$$b_{is} = \beta_s + \pi_{is}. \quad (3)$$

We used S-Plus (MathSoft, 1999) to fix the models and perform statistical analyses. All participants were included in these analyses, and only a small percentage of participants had missing observations for alcohol or marijuana use at various waves. We treated these observations as missing at random, and they were handled in the usual way in maximum likelihood estimation (Little & Rubin, 1987).

For different k , Equations 1, 2, or 3 specify a series of mixed effects polynomial growth curve models. We needed to determine which polynomial function best described the growth curve of the entire sample, that is, to determine the highest order of the polynomial growth function. To do so, we studied a series of nested models of Equation 1. More specifically, we started from the linear growth curve model (i.e., set $k = 1$ in Equation 1) and tested whether the slope of the overall growth (β_1) was significant. If it was significant, then we proceeded to fit the quadratic growth curve model (i.e., set $k = 2$ in Equation 1) and tested whether the quadratic term of the overall growth was significant. We repeated this analysis procedure

² The annual prevalence of alcohol use ranged from 43% at age 14 to 70% at age 18. The annual prevalence of marijuana use ranged from 9% at age 14 to 33% at age 18.

³ At age 13, 9% of the participants met diagnostic criteria for ADHD, 27% for CD, and 24% for ODD.

to cubic (i.e., set $k = 3$ in Equation 1) and higher order polynomial regression models, until the first time we found the coefficient of the highest order term (β_k) was not significant. The polynomial growth function we used was the last model in which the coefficient of the highest order term β_k was significant.

To answer the question of whether each of the psychopathology variables described in the previous section affected the growth, we performed statistical analysis of hypothesis testing to determine whether $\gamma_0, \gamma_1, \gamma_2, \dots, \gamma_k$ were significantly different from zero. We used a Wald type chi-square test method (asymptotically equivalent to the likelihood ratio test) to test whether psychopathology variables had an overall effect on the growth model ($H_0: \gamma_0 = \gamma_1 = \gamma_2 = \dots = \gamma_k = 0$ vs. H_1 : at least one of γ s was not zero). If the overall effect was significant, we used the t ratio tests (Bryk & Raudenbush, 1992) to determine whether there was any effect on the intercept (γ_0), slope (γ_1), quadratic term (γ_2), cubic term (γ_3), and so on. Because the measures of psychopathology were derived from the screening and first follow-up assessment, few participants were missing data on any of the predictor variables.

Results

For both the alcohol and marijuana data sets, the linear, quadratic, and cubic growth curve models were significant, and the fourth-order models were not significant. These results suggest that the cubic polynomial growth curve should be used to model both alcohol and marijuana use in this study.

Figures 1A and 1B present the growth curves for alcohol use and marijuana use, respectively, for the total sample. Although the curves were cubic, both alcohol quantity and frequency and marijuana frequency increased from early to later adolescence. There was a steeper increase for alcohol than for marijuana.

Next we determined the effects of each predictor on the overall growth curve and on the intercept and linear, quadratic, and cubic trends according to the method described in the *Analyses* section. Table 1 shows the significance levels for the chi-square tests. For alcohol, all of the overall effects were significant. The results indicate that each type of psychopathology was significantly related to the level of alcohol use; that is, higher psychopathology scores were related to higher levels of alcohol use during adolescence. None of the linear effects was significant except for the negative effect of CD symptoms. This negative effect means that although participants higher in CD began adolescence with higher levels of alcohol use, alcohol use of participants who were lower compared to higher in CD symptoms actually grew faster. A negative but nonsignificant linear effect was noted for the other measures of psychopathology as well. There were no significant effects of any type of psychopathology on the quadratic or cubic shapes of the alcohol use trajectory.

These results are further amplified in Figure 2, in which the growth curves for participants in the highest quartile (dashed line),

Figure 1. Cubic growth curves for alcohol and marijuana.

Table 1
Psychopathology Predictors of Trajectories of Drug Use:
Significance Levels of Chi-Square Analyses

Predictor	Overall	Level	Slope (linear)	Shape 1 (quadratic)	Shape 2 (cubic)
Alcohol					
ADHD	.001	.000	.761 ^a	.349	.934 ^a
ODD	.044	.010	.350 ^a	.214	.416 ^a
CD	.000	.000	.018 ^a	.496	.206 ^a
DEP	.017	.006	.068 ^a	.908	.244 ^a
VIOL	.000	.000	.160 ^a	.739	.720 ^a
Marijuana					
ADHD	.012	.004	.085 ^a	.915	.236
ODD	.103	.051	.376 ^a	.160	.289
CD	.000	.000	.684 ^a	.665	.220
DEP	.877	.454	.969 ^a	.783	.45
VIOL	.000	.000	.265 ^a	.485	.316

Note. ADHD = attention-deficit/hyperactivity disorder; ODD = oppositional defiant disorder; CD = conduct disorder; DEP = depressed mood; VIOL = violent behavior.

^a Negative affect.

middle two quartiles (solid line) and lowest quartile (dotted line) are shown for each type of psychopathology. Except for ADHD scores, all of the panels in the figure show a similar pattern; that is, at the beginning of adolescence there were larger discrepancies between the high and low groups in terms of levels of alcohol use compared to the end of adolescence, in which the differences were less pronounced. For example, for depression all groups displayed similar levels of alcohol use at age 18, although the slope differences were not statistically significant.

For marijuana use, the overall effects of ADHD, CD, and violence scores were statistically significant, although the effect was for level and not growth; that is, higher levels of ADHD, CD, and violence predicted higher levels of marijuana use during adolescence but did not predict steeper or faster growth. On the other hand, there was no significant relation between depression or ODD scores and marijuana use (see Table 1). The findings are also illustrated in Figure 3, in which the trajectories for participants in the highest quartile (dashed line), middle two quartiles (solid line), and lowest quartile (dotted line) for each measure of psychopathology are shown. As with alcohol, the negative linear trend is noteworthy, although it was not significant in any of the models;

Figure 2. Alcohol use cubic growth curves for boys with high, medium, and low psychopathology scores. ADHD = attention-deficit/hyperactivity disorder; ODD = oppositional defiant disorder; CD = conduct disorder; DEP = depressed mood; VIOL = violent behavior.

Figure 3. Marijuana use cubic growth curves for boys with high, medium, and low psychopathology scores. ADHD = attention-deficit/hyperactivity disorder; ODD = oppositional defiant disorder; CD = conduct disorder; DEP = depressed mood; VIOL = violent behavior.

that is, participants with higher levels of psychopathology began adolescence with higher levels of marijuana use but grew at a slower pace than those lower in psychopathology. In addition, the quadratic and cubic trends were positive but not significant in any of the models.⁴

Conclusions

The findings presented here suggest that all of the measures of psychopathology we studied were predictive of level in either alcohol or marijuana use, or both. Higher levels of violence were related to higher levels of both alcohol and marijuana use. This finding complements other studies of this sample (Loeber et al., 1998a, 1998b; White et al., 1999), as well as research on other samples (White, 1997), which show that early aggressive behavior predicts adolescent alcohol and drug use. CD symptoms also predicted level of alcohol and marijuana use. This finding is consistent with previous research in which CD has been the most consistent disruptive behavior disorder associated with substance use and abuse (Clark et al., 1999; E. J. Costello et al., 1999) and

with studies showing that early delinquent behavior is related to later substance use (White, 1990, 1997).

ADHD symptoms predicted higher levels of alcohol use and marijuana use. These findings are in contrast to several other studies that have failed to find an association between ADHD and different measures of substance use (e.g., Biederman et al., 1997). Also, in a previous analysis of these data, Loeber et al. (1999) found that ADHD was not related to persistent substance use. Perhaps the difference occurred because Loeber et al.'s (1999) study used a stage measure of substance use (highest level achieved) and did not take into account intensity (i.e., frequency,

⁴ We also conducted similar analyses using diagnosis at age 13 as a predictor of growth curves of substance use. (Note that for depression and violence we dichotomized participants into the highest quartile versus the rest to create a dichotomous variable.) Only violence significantly ($p < .001$) predicted level of alcohol use, although ODD ($p = .06$) and CD ($p = .07$) were marginally significant. ODD ($p = .04$), CD ($p = .02$), and violence ($p < .001$) significantly predicted level of marijuana use. None of the variables predicted growth in alcohol or marijuana use.

quantity, or both) of use as this study did. Number of ODD symptoms was a significant predictor of level of alcohol use but not of marijuana use. These inconsistent findings for ODD parallel those found in the literature (Weinberg & Glantz, 1999).

Similarly, number of symptoms of depression was positively related to level of alcohol use but not marijuana use. Young males who were higher compared to lower in depression began adolescence more heavily involved in alcohol use. However, all participants, regardless of their level of depression, began adolescence at the same level of marijuana use. This difference between substances could result from the fact that by age 13 alcohol had been tried by a substantial proportion of boys; however, the age of onset for marijuana use begins later for most participants regardless of whether they are depressed. Furthermore, the fact that depression predicted higher levels of alcohol use in early adolescence is consistent with Loeber et al.'s (1999) findings. In that study, the authors found that different measures of psychopathology were related to persistent substance use at various stages of the life cycle. Internalizing problems was associated with persistent substance use in childhood but not during adolescence. Thus, internalizing problems may predict early onset of substance use, or at least alcohol use.

A limitation of the present study was that we looked at each measure of psychopathology in its own model, without controlling for other forms of psychopathology. We did this because of the high degree of overlap among the different measures and problems of multicollinearity (see Loeber et al., 1998b; Loeber et al., 1999). Greene et al. (1999, p. 353) found that numerous factors were significant predictors of substance use outcomes when they were considered in isolation. However, when they were considered simultaneously, the predictive utility of these constructs was greatly reduced, except for social impairment and CD.

Another possibility that we did not address in these analyses is that some aspects of a specific disorder may be particularly relevant to substance use, whereas other aspects may not be. For example, several studies have reported a significant relation between ADHD and tobacco use (e.g., Milberger, Biederman, Faraone, & Chen, 1997). However, Burke, Loeber, and Lahey (2000) determined that only one aspect of ADHD—namely, attention problems—was significantly associated with tobacco use, and the relation remained significant even after controlling for CD. In addition, we did not examine the simultaneous development of different types of substance use. Given that onset of different substances, such as alcohol, tobacco, and marijuana, often occurs in a relatively short period of time, future research should address this issue.

Our data clearly demonstrate that early symptoms of psychopathology and high levels of violent crime are strongly related to higher levels of alcohol and marijuana use in early adolescence. Given that the data on psychopathology were collected at the same time that intercept was measured, we cannot determine for sure whether alcohol and marijuana use did not cause these forms of psychopathology or enhance pre-existing psychopathology. Nevertheless, some of these behaviors by definition (e.g., ADHD and ODD symptoms) occurred developmentally before heavy involvement in either alcohol or marijuana use. Furthermore, we cannot be certain that the relation between substance use and psychopathology is not spurious—that is, rather than psychopathology predicting substance use, it is possible that some third factor (such as

parental alcoholism or genetic factors) predicted both. Therefore, greater attention has to be focused on the sequencing of these disorders as well as the common and independent risk factors. The findings of this study should be considered within these measurement limitations.

There are numerous pathways to substance abuse. Even within individuals there are likely to be multiple processes rather than a unitary cause for substance abuse and dependence (Cicchetti & Rogosch, 1999). Having only one risk factor may not be enough to create a problem; rather, the potential impact of any risk process may depend on its combination with other risk processes, and the multiple risk factors may act additively or synergistically (see also Bry, McKeon, & Pandina, 1982; Newcomb & Felix-Ortiz, 1992). As well, it may be the accumulation of risk factors over the life course that intensifies vulnerability for drug abuse (see Glantz, 1992). Furthermore, risk factors tend to co-occur, and some risk factors may increase the risk of developing other risk factors. Thus, there may be different types of substance abusers, whose onset and development of problems may depend on various combinations of internalizing and externalizing problems. In future research, we plan to examine different trajectories of substance use among different types of substance abusers based on the nature and extent of their comorbid psychopathologies.

Another limitation of this study was that we did not control for other factors that might influence both level and growth in substance use, such as parenting behaviors and modeling of substance use by parents and peers as well as pharmacological effects of drugs. Thus, future research needs to better understand the mediating processes between psychopathology and substance abuse (see also Cicchetti & Rogosch, 1999). Furthermore, we need to consider contextual factors and examine the interaction of psychopathology with environmental influences (see Sampson & Laub, 1993).

Finally, there were limitations due to the nature of the sample, which comprised only males, and thus we could not examine gender differences in predictors. We have just undertaken a study similar to the present one with a sample of girls, so we will be able to better address these issues in the future. Also, the present study was limited to one geographical area, the city of Pittsburgh, and therefore the results may not be generalizable to other samples. Finally, these participants were relatively young to be diagnosed with substance use disorders. As these participants age, we will be able to determine which ones develop serious alcohol and drug dependence. It will then be possible to shed more light on the ways that early psychopathology predicts the development and course of substance use.

Despite these limitations, this study had several strengths. It used prospective longitudinal data collected from boys and their parents on multiple occasions. The original sample had a high cooperation rate, and attrition has remained low. The Pittsburgh Youth Study is one of the few community studies that collects prospective data on drug use and incorporates diagnostic measures of mental health. Finally, in this study we used a state-of-the-art statistical analysis technique. Growth curve analyses are relatively new to the alcohol and drug field, and few studies have used them to examine the association between drug use and psychopathology (for an exception, see Hussong, Curran, & Chassin, 1998).

This study shows that higher levels of psychopathology in early adolescence are related to higher levels of alcohol and marijuana

use during adolescence. However, symptoms of psychopathology do not appear to affect the developmental progression of substance use during adolescence. Thus, drug abuse prevention programs should target youths with preadolescent symptoms of psychopathology.

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Received August 3, 2000

Revision received November 9, 2000

Accepted November 10, 2000 ■