

The developmental course of illicit substance use from age 12 to 22: links with depressive, anxiety, and behavior disorders at age 18

Jennifer E. Lansford,¹ Stephen Erath,² Tianyi Yu,³ Gregory S. Pettit,²
Kenneth A. Dodge,¹ and John E. Bates⁴

¹Center for Child and Family Policy, Duke University, Durham, NC, USA; ²Department of Human Development and Family Studies, Auburn University, Auburn, AL, USA; ³Department of Psychology, University of Michigan, Ann Arbor, MI, USA; ⁴Department of Psychology, Indiana University, Bloomington, IN, USA

Background: Previous theory and research suggest links between substance use and externalizing behavior problems, but links between substance use and internalizing problems are less clear. The present study sought to understand concurrent links among diagnoses of substance use disorders, internalizing disorders, and behavior disorders at age 18 as well as developmental trajectories of illicit substance use prior to and after this point. **Methods:** Using data from 585 participants in the Child Development Project, this study examined comorbidity among substance use, behavior, and internalizing disorders at age 18 and trajectories of growth in illicit substance use from age 12 to age 22. **Results:** In this community sample, meeting diagnostic criteria for comorbid internalizing disorders, a behavioral disorder (conduct disorder or oppositional defiant disorder) alone, or both internalizing and behavioral disorders predicted higher concurrent substance use disorders (abuse, dependence, or withdrawal). Meeting diagnostic criteria for an anxiety disorder alone or depression alone did not predict higher concurrent substance use diagnoses. Over time, youths with behavioral disorders at age 18 showed a pattern of increasing substance use across early adolescence and higher levels of substance use than those with no diagnosis at age 18. Substance use declines from late adolescence to early adulthood were observed for all groups. **Conclusions:** Substance use disorders were more highly comorbid with behavior disorders than with internalizing disorders at age 18, and behavior disorder and comorbid behavior-internalizing disorders at age 18 were related to trajectories characterized by steep increases in illicit substance use during adolescence and high rates of illicit substance use over time. **Keywords:** Comorbidity, behavior disorders, externalizing disorders, internalizing disorders, substance use.

Substance use during adolescence and early adulthood is of considerable concern to parents, policy-makers, and researchers alike, both because of the immediate risks posed by substance use itself (e.g., increased risk of motor vehicle accidents or unsafe sexual behavior while under the influence of substances) and because of the long-term negative consequences that may accrue from patterns of substance use over time. For example, even occasional, light users of marijuana are less likely to graduate from college, are more likely to engage in delinquent behaviors such as violence and stealing, and report poorer physical health than do abstainers; heavier and more regular users are at risk of even more serious problems (Tucker, Ellickson, Orlando, Martino, & Klein, 2005). By the 12th grade, 46% of adolescents have tried marijuana (Johnston, O'Malley, Bachman, & Schulenberg, 2004), and 9% of 12–17-year-olds are diagnosed with substance use disorders (Substance Abuse and Mental Health Services Administration, 2004), suggesting that problems associated with substance use are prevalent. The present study had two main goals.

First, we sought to understand concurrent links among diagnoses of age 18 substance use disorders, internalizing disorders, and behavior disorders. Second, we sought to examine relations between diagnoses of internalizing and behavior disorders at age 18 and developmental trajectories of substance use both prior to and after this point.

Comorbidity between substance use and other disorders

Until recently, comorbidity during adolescence was studied primarily in clinical populations, which posed a set of challenges in interpreting the research findings (Armstrong & Costello, 2002). In particular, because individuals with more than one problem are more likely to seek treatment than are individuals with just one problem, the prevalence rates for comorbidity assessed in clinical samples may exceed those in the broader population, and certain combinations of disorders may lead individuals to seek treatment more often than other combinations, again leading to misperceptions if one attempts to generalize to non-clinical samples (Armstrong & Costello, 2002). Recently, however, a substantial

Conflict of interest statement: No conflicts declared.

© 2008 The Authors

Journal compilation © 2008 Association for Child and Adolescent Mental Health.

Published by Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA

body of literature on adolescents in community samples has shown that higher levels of externalizing problems are related to more substance use (Costello, 2007). For example, in a group of rural adolescents followed for 42 months starting at the age of 12 years, those adolescents who initially showed higher levels of externalizing problems were more likely to initiate substance use over time (Lillehoj, Trudeau, Spoth, & Madon, 2005). Similarly, Fergusson, Horwood, and Ridder (2007) found that conduct problems as early as ages 7–9 years predicted substance use, abuse, and dependence in young adulthood.

Problem-behavior theory (Jessor & Jessor, 1977) would suggest that social controls that inhibit one set of problem behaviors (e.g., substance use) may be the same social controls that inhibit other sets of problem behaviors (e.g., externalizing problems). In addition, individual differences in proneness to problem behavior may involve attitudes, beliefs, and expectations such as greater tolerance of deviance or lower value on educational achievement that extend across domains of problem behaviors (Jessor & Jessor, 1977). Furthermore, engagement in different kinds of problem behaviors might be perpetuated by involvement in a deviant peer group that provides both opportunities and motivation to engage in such behaviors (e.g., Dishion, Andrews, & Crosby, 1995). Therefore, there are good theoretical reasons to expect comorbidity between substance use disorders and other kinds of behavior disorders.

Empirical findings with respect to links between substance use and internalizing problems are less consistent than those for links between substance use and behavior problems. For example, Neighbors, Kempton, and Forehand (1992) found that substance use among juvenile delinquents was related to more symptoms of anxiety and depression. Wittchen et al. (2007) found that even after controlling for externalizing disorders, internalizing disorders (depressive and bipolar disorders, and anxiety less consistently) predicted subsequent marijuana use. Furthermore, Hallfors, Waller, Bauer, Ford, and Halpern (2005) found that substance use predicted future depression. Yet other studies have reported no association between substance use and internalizing problems (Windle & Wiesner, 2004). Still other studies have found that internalizing problems are related to less substance use. For example, Steele, Forehand, Armistead, and Brody (1995) found that for boys, higher internalizing scores in early adolescence predicted less marijuana and hard substance use in young adulthood.

Two main theories have been posited in the literature that could account for these discrepant findings. The self-medication theory (e.g., Khantzian, 1985) is that individuals who are anxious, depressed, or both may attempt to assuage their negative emotions by turning to substances (e.g., to make themselves feel more relaxed). This theory would, therefore, predict a

positive correlation between higher levels of internalizing problems and more substance use. A risk-avoidance theory (e.g., Wills, Windle, & Cleary, 1998), on the other hand, would predict that higher levels of internalizing problems would be related to less substance use because individuals who are anxious are more likely to fear taking risks (including risks related to using substances) and are less likely to be in social situations that would be conducive to using substances (see Siebenbruner, Englund, Egeland, & Hudson, 2006).

Trajectories of substance use over time

Several studies have documented trajectories of smoking (e.g., Chassin, Presson, Pitts, & Sherman, 2000) and binge drinking (Hill, White, Chung, Hawkins, & Catalano, 2000) during adolescence and early adulthood. There have been fewer studies of trajectories of illicit substance use. Most studies of illicit substance use have either included cross-sectional data or have included just two waves of data in a longitudinal design (Windle & Wiesner, 2004). However, there are some notable exceptions (Kandel & Chen, 2000; Newcomb & Bentler, 1989). Windle and Wiesner (2004) analyzed four waves of data during adolescence and identified five trajectory groups that characterized different patterns of marijuana use: Abstainers, Experimental Users, Decreasers, Increasers, and High Chronics. Similarly, Connell, Dishion, and Deater-Deckard (2006) also found five trajectory groups when they tracked patterns of substance use in 698 adolescents for four years from Grade 6 to Grade 9: (1) no use, (2) low/rare use, (3) early accelerating use, (4) late-accelerating use, and (5) early high but decreasing use. Guo et al. (2002) identified four distinct trajectories of marijuana use from age 13 to 18: early highs, escalators, late onsetters, and nonusers. Ellickson, Martino, and Collins (2004) followed 5,833 individuals from the age of 13 to 23 and also found four trajectory groups of marijuana use (in addition to abstainers): early high users (who had high levels of use at age 13 and who decreased to a moderate level over time), stable light users (who consistently showed low levels of use), steady increasers (who increased use over time), and occasional light users (who initiated use at age 14 and continued to use at low levels over time).

The present study

The present study addressed two primary research questions using data from a multisite community sample followed from age 12 to 22. The first question was to what extent behavior disorders, anxiety disorders, depressive disorders, and substance use disorders are comorbid at age 18. On the basis of previous research, we hypothesized that behavior disorders and substance use disorders would show a

great deal of comorbidity. However, the nature of the association between internalizing disorders and substance use disorders is less clear from the extant literature, in which the samples have differed in age and gender composition, substances used, and operationalization of internalizing problems. We were able to test alternate hypotheses suggested by the self-medication theory that internalizing disorders would be comorbid with substance use disorders and the risk-avoidance theory that internalizing disorders would not be comorbid with substance use disorders. The second question was how developmental trajectories of substance use from age 12 to age 22 are related to diagnoses of behavior and internalizing disorders at age 18. We hypothesized that behavior disorders would be associated with higher levels of illicit substance use in adolescence and an increase in illicit substance use over the adolescent years. As with the first research question, we were able to test alternate hypotheses regarding the links between internalizing disorders and trajectories of illicit substance use.

Method

Participants

The families in the current investigation were participants in an ongoing, multisite longitudinal study of child development (Dodge, Bates, & Pettit, 1990). Participants were recruited when the children entered kindergarten in 1987 or 1988 at three sites: Knoxville and Nashville, TN and Bloomington, IN. Parents were approached at random during kindergarten pre-registration and asked if they would participate in a longitudinal study of child development. About 15% of children at the targeted schools did not pre-register. These participants were recruited on the first day of school or by subsequent contact. Of those asked, approximately 75% agreed to participate. The sample consisted of 585 families at the first assessment in kindergarten. Males comprised 52% of the sample. Eighty-one percent (81%) of the sample were European American, 17% were African American, and 2% were from other ethnic groups. Follow-up assessments were conducted annually through age 22. Seventy-nine percent of the original 585 families provided age 22 data, but the sample of 535 for the growth curve analyses included 91% of the original sample that provided data on illicit substance use in at least one year between the age of 12 and 22. The 535 participants were of higher SES in kindergarten than were the 50 original participants who did not provide illicit substance use data, $t(568) = 2.42, p < .05$ and were more likely to be female, $\chi^2(1) = 7.12, p < .01$; but these two groups did not differ significantly by ethnicity. IRB approval was granted, and participants provided informed consent at each wave of data collection.

Procedures and measures

Psychiatric diagnoses. At the age of 18, the National Institute of Mental Health Diagnostic Interview

Schedule was administered to participants during an in-person assessment by a trained interviewer in order to measure young adult psychiatric symptoms and DSM-IV diagnoses. Interviewers recorded participants' responses in a computer program designed to handle complicated skip patterns that were invoked depending on participants' responses to each question (e.g., follow-up questions about specific aspects of a disorder were skipped if the participant did not meet the diagnostic criteria for having the disorder). A large number of studies have examined the psychometric properties of the DIS. In general, these show acceptable convergent validity (e.g., Fantoni-Salvador & Rogers, 1997) and good to excellent reliability (e.g., Hasin et al., 2006).

Participants were classified with an anxiety disorder at age 18 if they met diagnostic criteria for any of the following disorders: specific phobia, panic attack, social phobia, agoraphobia, generalized anxiety, post-traumatic stress, obsessive compulsive, or separation anxiety. Depressive diagnoses included major depressive disorder and dysthymic disorder. Behavior problem diagnoses included oppositional defiant disorder and conduct disorder.

Substance use. Illicit substance use data for the present study were collected at ages 12, 16, 17, 18, 21, and 22. At age 12, adolescents were asked how many times in the last year they (a) smoked marijuana; and (b) used other drugs. Each item was rated on an 8-point scale (0 = never, 1 = once or twice, 2 = once every 2–3 months, 3 = once a month, 4 = once every 2–3 weeks, 5 = once a week, 6 = 2–3 times a week, 7 = once a day). At ages 16–18 and 21–22, adolescents indicated whether in the past 12 months they had smoked marijuana, huffed or inhaled a substance, tried cocaine or crack, tried LSD or heroin, or tried any other way to get high (0 = no, 1 = yes). These measures were combined to create an indicator of *illicit substance use* (i.e., use of inhalants, marijuana, or other illegal drugs) in each year. Illicit substance use was coded '0' if participants reported no illicit substance use in the past year, '1' if they reported marijuana use in the past year, and '2' if they reported using marijuana and at least one additional illicit substance in the past year. The three-point form of this variable was selected to yield a comparable indicator across years, given the variability in the measurement forms.

Participants were classified with an illicit substance use disorder at age 18 if they met diagnostic criteria for any of the following disorders on the Diagnostic Interview Schedule (DIS): Withdrawal, dependence, or abuse of marijuana, amphetamines, cocaine, opiates, sedatives, hallucinogens, inhalants, or PCP.

Analysis plan

We began by examining comorbidity of illicit substance use disorders and internalizing and behavior disorders by presenting descriptive statistics and chi-square tests. These initial analyses included the diagnostic measure of illicit substance use (DIS), whereas subsequent analyses included the continuous, three-point measure of illicit substance use. We next examined correlations among illicit substance use variables and

correlations between illicit substance use and gender and ethnicity over time from age 12 to age 22. We then conducted growth curve analyses of illicit substance use from age 12 to age 22. First, we investigated the time course of illicit substance use from age 12 to age 22 by fitting an unconditional latent growth curve model using the Mplus statistical program (Muthén & Muthén, 2004). Second, we examined demographic and diagnostic covariates of illicit substance use by fitting a conditional latent growth curve model. Participants with substance use data for at least one year were included in these analyses ($n = 535$). Mplus uses full information maximum-likelihood estimation to generate unbiased parameter estimates and appropriate standard errors for respondents with random missing data (Muthén & Muthén, 1998). Because internalizing and behavior disorders were diagnosed at age 18, time was centered at age 18 for all growth curve analyses.

Results

Diagnostic comorbidity at age 18

The numbers of participants who met diagnostic criteria for illicit substance use disorders and various internalizing and behavior disorders at age 18 are shown in Table 1. In addition, the rates of illicit substance use disorders among participants with no internalizing or behavioral diagnosis, anxiety only, depression only, comorbid internalizing disorders (i.e., anxiety and depression), behavior disorder only, and comorbid behavior-internalizing disorders (i.e., behavior disorder and anxiety or depression) are presented in Table 1. Overall, 66% of participants who met criteria for a substance use disorder also met criteria for at least one internalizing or behavior disorder, and 23% of participants with an internalizing or behavior disorder also met criteria for a substance use disorder.

Chi-square analysis revealed significant differences in the rates of substance use disorders among participants with different internalizing or behavior disorders, $\chi^2(5, n = 449) = 42.97, p < .001$. As shown in Table 1, the likelihood of a substance use diagnosis among participants with anxiety only, $\chi^2(1, n = 321) = .23, ns$, and depression only, $\chi^2(1, n = 308) = .26, ns$, was not significantly different from the likelihood of a substance use diagnosis among participants with no internalizing or behavioral diagnosis. The likelihood of a substance use diagnosis was elevated among participants with comorbid internalizing disorders, $\chi^2(1, n = 311) = 6.28, p < .05$, behavior disorder, $\chi^2(1, n = 326) = 19.15, p < .001$, and comorbid behavior-internalizing disorders, $\chi^2(1, n = 331) = 35.69, p < .001$, compared to participants with no internalizing or behavior diagnosis. In other words, comorbid internalizing and behavior disorder diagnoses were associated with a higher likelihood of substance use disorder, but anxiety or depression alone did not

Table 1 Comorbidity among substance use, behavior, and internalizing disorders at age 18

Internalizing/ Behavior Disorder at age 18	Substance use diagnosis at age 18 ¹		Chi-square ²
	No substance diagnosis ($n = 393$)	Substance diagnosis ($n = 56$)	
No diagnosis ($n = 287$)	268 (93%)	19 (7%)	–
Anxiety only ($n = 34$)	31 (91%)	3 (9%)	.23
Depression only ($n = 21$)	19 (90%)	2 (10%)	.26
Comorbid internalizing ($n = 24$)	19 (79%)	5 (21%)	6.28*
Behavior disorder only ($n = 39$)	28 (72%)	11 (28%)	19.15***
Comorbid behavior- internalizing ($n = 44$)	28 (64%)	16 (36%)	35.69***

Note. $n = 449$. Overall Pearson $\chi^2(5) = 42.97, p < .001$.

¹Substance diagnoses included withdrawal, dependence, and abuse of marijuana, amphetamines, cocaine, opiates, sedatives, hallucinogens, and inhalants. Substance diagnoses did not include alcohol disorders. ²Pearson chi-square analyses tested whether the likelihood of a substance use disorder at age 18 differed between participants with no internalizing or behavioral diagnosis at age 18 and participants within each diagnostic group at age 18.

significantly increase the likelihood of a substance use disorder.¹

Correlations among demographic and substance use variables over time

Means, standard deviations, and correlations among illicit substance use variables at each time point are shown in Table 2. Illicit substance use was relatively stable across time. Correlations in contiguous years ranged from .64 to .70, and cross-year correlations ranged from .14 to .58. The mean level of illicit substance use across all participants was relatively low at age 12 ($M = .07$), increased substantially between ages 12 and 16 ($M = .46$) to age 18 ($M = .56$),

¹Chi-square analyses also revealed significant differences in rates of alcohol use disorders (withdrawal, dependence, abuse), assessed via the DIS, among participants with different behavior or internalizing disorders, $\chi^2(5, n = 441) = 31.09, p < .001$. The likelihood of an alcohol use diagnosis among participants with anxiety only, $\chi^2(1, n = 314) = .00, ns$, and depression only, $\chi^2(1, n = 301) = .04, ns$, was not significantly different from the likelihood of a substance use diagnosis among participants without an internalizing or behavior diagnosis. The likelihood of an alcohol use diagnosis was elevated among participants with comorbid internalizing disorders, $\chi^2(1, n = 305) = 3.89, p < .05$, behavior disorder, $\chi^2(1, n = 320) = 17.01, p < .001$, and comorbid behavior-internalizing disorders, $\chi^2(1, n = 325) = 21.08, p < .001$, compared to participants without an internalizing or behavior diagnosis.

Table 2 Correlations among substance use variables from age 12 to age 22

Variables	1	2	3	4	5	6	7	8
1. Gender	–							
2. Ethnicity	–	–						
3. Age 12 substance use	-.08	-.03	–					
4. Age 16 substance use	-.01	-.05	.22***	–				
5. Age 17 substance use	-.05	-.08	.23***	.68***	–			
6. Age 18 substance use	-.09	-.13**	.18***	.58***	.70***	–		
7. Age 21 substance use	-.16**	-.07	.15**	.43***	.48***	.51***	–	
8. Age 22 substance use	-.16***	-.07	.14**	.42***	.48***	.45***	.64***	–
Mean	–	–	.07	.46	.52	.56	.46	.52
Standard deviation	–	–	.28	.66	.73	.73	.68	.68
<i>n</i>	585	585	427	458	422	443	464	466

Note. *ns* for correlations range from 364 to 466. Illicit substance use was coded as 0 = none, 1 = marijuana use, 2 = marijuana plus other illicit substance. Substance use scores were log-transformed for analyses. Male coded as 0 and female coded as 1. European American coded as 0 and ethnic minority coded as 1. **p* < .05, ***p* < .01, ****p* < .001.

then decreased slightly by age 21 (*M* = .46) and age 22 (*M* = .52).

Demographic correlations revealed that males reported higher levels of substance use at ages 21 and 22 than females. European Americans reported higher levels of substance use at age 18 than ethnic minorities.

Growth curve analysis of illicit substance use from age 12 to age 22

Unconditional baseline model. Linear and quadratic models were initially fit. A delta chi-square analysis revealed that the model including a quadratic slope fit the data better than the model including an intercept and linear slope only $\chi^2(4, N = 535) = 178.83, p < .001$. Thus, the unconditional growth model of illicit substance use from ages 12 to 22 included three growth parameters: (1) an intercept parameter centered at age 18, (2) a linear slope parameter representing the rate of linear change over time, and (3) a quadratic parameter representing nonlinear change over time. The intercept, slope, and quadratic growth parameters were allowed to covary.

As shown in Table 3, the baseline latent growth model for illicit substance use fit the data well: $\chi^2(9, N = 535) = 23.08$, comparative fit index (CFI) = .99, Tucker Lewis index (TLI) = .98, and root-mean-square error of approximation (RMSEA) = .054. The average intercept (.148, *p* < .001), average slope (.006, *p* < .001), and average quadratic slope (–.003, *p* < .001) were each significantly different from zero, indicating that illicit substance use was greater than zero at age 18, increased over the years of investigation, and declined in early adulthood. Significant variance existed in both the intercept and quadratic slope factors but not in the linear slope factor (see Table 3); thus, the conditional growth model tested demographic and diagnostic covariates of the intercept and quadratic slope factors but not the linear slope factor.

Conditional growth model. Conditional latent growth models were fit to test whether demographic and diagnostic variables were associated with variances in the intercept and quadratic slope factors. Delta chi-square tests compared the fit of the model with covariates estimated versus covariates constrained to zero. Demographic covariates were estimated first, followed by diagnostic covariates. Estimating demographic covariates of the intercept improved model fit, $\chi^2(2, N = 535) = 25.06, p < .001$, compared to the model with all covariates constrained to zero. Estimating diagnostic covariates of the intercept and quadratic slope further improved model fit, $\chi^2(9, N = 535) = 68.26, p < .001$, compared to the model with demographic covariates of the intercept estimated and diagnostic covariates constrained to zero.²

As shown in Table 3, the set of demographic and diagnostic variables accounted for 18.0% of the variance in the intercept of illicit substance use and 24.1% of the variance in the quadratic slope of illicit substance use. The conditional model fit the data well, $\chi^2(35, N = 535) = 67.83$, comparative fit index (CFI) = .97, Tucker Lewis index (TLI) = .95, and root-mean-square error of approximation (RMSEA) = .04.

Gender (male), depression, behavior disorder, and comorbid behavior-internalizing disorders were

²Standard errors of the model could not be computed when anxiety, depression, and comorbid internalizing were included as covariates of the quadratic slope. We conducted an analysis to test whether fixing these estimates to zero would misrepresent the data. The model included the same three growth parameters (i.e., intercept, linear slope, quadratic slope) and anxiety, depression, and comorbid internalizing diagnoses as covariates of the quadratic slope (excluding these diagnostic variables as covariates of the intercept, and excluding behavior disorder and comorbid behavior-internalizing diagnoses as covariates of the intercept and quadratic slope). This simpler analysis allowed the model to fit the data, and revealed that anxiety, depression, and comorbid internalizing were not significantly associated with the quadratic slope. Therefore, these estimates were fixed to zero in the final model.

Table 3 Associations among internalizing and behavioral diagnoses and growth in illicit substance use from age 12 to age 22

	Growth parameters for illicit substance use ¹	
	Intercept	Quadratic Slope
Unconditional Model		
<i>M (SE)</i>	.148 (.007)***	-.003 (.000)***
Variance (<i>SE</i>)	.020 (.002)***	.001 (.000)***
Demographic variables		
Gender ²	-.038 (.014)***	.000 (.001)
Ethnicity ³	-.034 (.018)	.000 (.001)
Diagnostic variables ⁴		
Anxiety only	.014 (.019)	-
Depression only	.051 (.024)*	-
Comorbid internalizing	.040 (.023)	-
Behavior disorder only	.131 (.025)***	-.005 (.001)***
Comorbid behavior-internalizing	.162 (.024)***	-.005 (.001)***
<i>M (SE)</i>	.139 (.011)***	-.001 (.000)***
Res variance (<i>SE</i>)	.017 (.002)***	.000 (.000)***
<i>R</i> ²	.180	.241

Note. *N* = 535. Fit of unconditional model: χ^2 (9) = 23.08, CFI = .99, TLI = .98, RMSEA = .054. Fit of model with predictors: χ^2 (35) = 67.83, CFI = .97, TLI = .95, RMSEA = .042. Demographic and diagnostic variables were not included in the model as covariates of the linear slope because the variance of the linear slope was non-significant in the unconditional growth model, *M (SE)* = .006 (.001), *p* < .001; Variance = .000 (.000), *ns*. ¹Illicit substance use measured as 0 = none, 1 = marijuana use, 2 = marijuana plus other illicit substance. ²Male coded as 0; female coded as 1. ³European American coded as 0; ethnic minority coded as 1. ⁴No diagnosis coded as 0; diagnosis coded as 1. **p* < .05, ***p* < .01, ****p* < .001.

each significantly associated with higher illicit substance use at age 18 (intercept). In addition, behavior disorder and comorbid behavior-internalizing disorders were significantly associated with the quadratic slope (see Table 3). As illustrated in Figure 1, participants with no diagnosis, anxiety only, depression only, and comorbid internalizing diagnoses showed a similar trajectory of substance use characterized by a mild increase followed by a mild decline from adolescence through young adulthood. Participants with behavior disorders and comorbid behavior-internalizing disorders showed a trajectory of steep increases in substance use across the adolescent years, reaching relatively high levels of substance use in late adolescence, and a relatively steep decline in substance use by young adulthood. On average, adolescents with a behavior disorder (alone or comorbid with an internalizing disorder) used either marijuana or some other illicit substance by age 18. Despite their steeper decline in substance use during young adulthood, participants with comorbid behavior-internalizing disorders at age 18 reported significantly higher levels of substance use at age 22 than did participants with no internalizing or behavioral diagnosis at age 18, $F(1, 299) = 5.96$, *p* < .05. No other diagnostic groups reported significantly higher substance use at age 22 than did partici-

ants with no internalizing or behavioral diagnosis at age 18.³

Discussion

Overall, we found that substance use disorders were more highly comorbid with behavior disorders than with internalizing disorders at age 18, and behavior disorder and comorbid behavior-internalizing disorders at age 18 were related to trajectories characterized by steep increases in illicit substance use during adolescence and high rates of illicit substance use over time. The patterns of comorbidity that we found are similar to those reported in other studies. For example, 66% of our participants who met criteria for a substance use disorder also met criteria for an internalizing or behavioral disorder, compared to 60% of the participants in Armstrong and Costello's (2002) meta-analysis of comorbidity in community samples.

Our growth model results showed that depression was associated with higher levels of substance use at age 18. The chi-square results showed that having a depressive disorder plus an anxiety disorder was associated with slightly higher rates of substance use disorder. In contrast, anxiety alone was not associated with higher levels of substance use or higher rates of substance use disorders. Co-occurrence of depressive disorders and substance use also has been more frequently reported in previous studies than has co-occurrence of anxiety disorders and substance use (e.g., King, Iacono, & McGue, 2004). It is possible that the self-medication theory better explains links between depression and substance use than anxiety and substance use. That is, individuals who are depressed may be more likely to use substances to self-medicate unless they are also anxious and fearful of taking risks (such as using drugs or merely attending social events where drugs are likely to be available). It is important to note that self-medication theory not only posits that self-medication is an effort to feel better but that there will be links between specific types of disorders and specific medications (e.g., depressed individuals will

³Continuous measures of teacher-reported externalizing and internalizing behaviors in childhood were also tested as predictors of illicit substance use trajectories from ages 12 to 22. Externalizing behavior at age 5 was associated with the intercept and quadratic slope of illicit substance use, and externalizing behavior at age 12 was associated with the intercept of illicit substance use; estimates were in the same direction as the behavior disorder covariate. However, when these earlier measures of externalizing behavior were included in the growth model with the more proximal diagnostic covariates, earlier externalizing behavior was not significantly associated with substance use growth parameters. Internalizing behavior at ages 5 and 12 was not significantly associated with substance use growth parameters in models with or without diagnostic covariates.

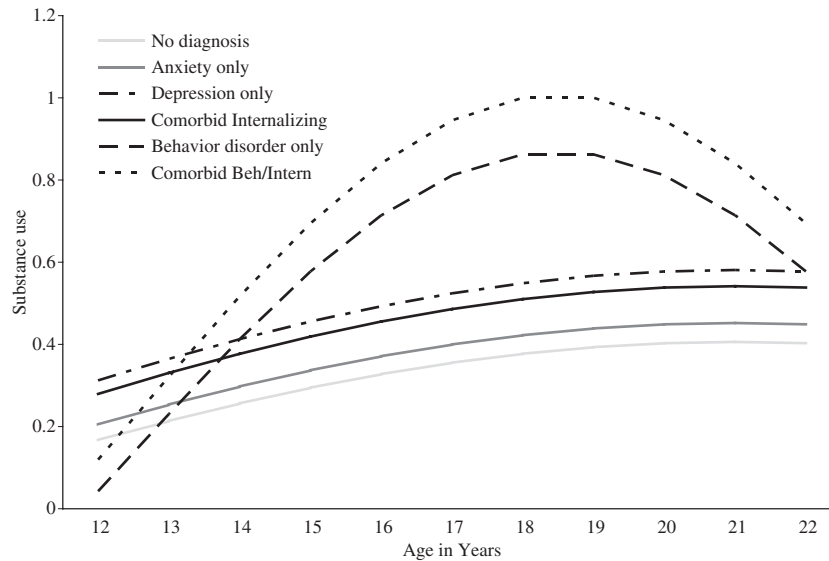


Figure 1 Growth in illicit substance use from age 12 to age 22 by diagnostic status. Illicit substance use was coded as 0 = none, 1 = marijuana use, 2 = marijuana plus other illicit substance

choose stimulating drugs, whereas anxious individuals will choose tranquilizing or sedating drugs; Khantzian, 1985). Our aggregate measure of any illicit substance use did not distinguish between different types of substances. Future research that includes separate indicators of different kinds of substances will be able to address the aspect of self-medication theory that posits selection of substances linked with specific disorders.

An alternate interpretation of the link between depression and illicit substance use is that depression can be a consequence of social problems resulting from externalizing behaviors, which would include the effects of using illicit substances. With respect to anxiety, it is possible that if some anxious people use illicit substances and others do not, self-medication and risk avoidance mechanisms may cancel one another out. It is also possible that anxiety and substance use are simply unrelated during this developmental period.

Our findings were similar to those of other studies showing links between substance use and behavior problems, particularly conduct disorders (e.g., Sung, Erkanli, Angold, & Costello, 2004). Examining trajectories of illicit substance use both before and after psychiatric diagnoses is consistent with the idea that psychiatric disorders are predictors as well as consequences of substance use (Measelle, Stice, & Hogansen, 2006). Trajectories of substance use for individuals with behavior disorders and comorbid behavior-internalizing disorders were especially notable in our study for their steep increases in substance use across the adolescent years. By the age of 18, individuals who were diagnosed as having a behavior disorder (alone or comorbid with an internalizing disorder) showed a trajectory of illicit substance use across adolescence that was considerably higher than those individuals who were

not diagnosed as having a behavior or internalizing disorder at age 18.

Initially, the declines we found in substance use in early adulthood (age 21–22) may seem surprising, but this pattern is consistent with findings using data from the Monitoring the Future study, which also show decreasing substance use in early adulthood (Bachman et al., 2002). Bachman et al. suggest that new responsibilities involving marriage, pregnancy, and parenthood in early adulthood may lead to declines in substance use. The steeper decline in substance use we found in early adulthood for the groups with behavior disorders and comorbid behavior-internalizing disorders may be related to a decline in externalizing behaviors in early adulthood among these participants.

One limitation of our study is that our measure of illicit substance use over time focused just on whether the individual had used marijuana or any other illicit substances within a 12-month period. Frequency of use and problematic use (e.g., addiction, dependency, withdrawal) are also important features in understanding the developmental course of illicit substance use (Glantz & Pickens, 1992); future research that incorporates these different aspects of illicit substance use will complement the perspective offered in the present study. In addition, although abuse of prescription drugs may have been reported by participants under the general question of having tried 'any other way to get high,' we did not ask specifically about the use of prescription drugs for nonmedical reasons. Nearly 25% of high school seniors have used prescription drugs without medical supervision according to the latest data from the Monitoring the Future study (Johnston, O'Malley, Bachman, & Schulenberg, 2007), making this an important topic for future inquiry. An additional limitation is that our sample

was limited primarily to European Americans and African Americans so the findings may not generalize to individuals from other racial, ethnic, or cultural groups. Finally, although the CDIS-IV is a well-validated tool for assessing psychiatric diagnoses that makes sense to use with a large community sample when it is not possible to have clinical psychologists or psychiatrists conduct in-depth interviews to make diagnoses, it is possible that clinicians could have reached different conclusions about the diagnoses of the participants.

One implication of these findings is that comorbidity of substance use and other types of disorders should be taken into account when planning preventive interventions or treatment approaches. In particular, given the high rates of co-occurrence between substance use and conduct disorders, it is reasonable to ask whether an intervention designed to prevent conduct disorders may also prevent substance use disorders or vice versa (see Glantz, 2002). On the other hand, given the more limited co-occurrence between substance use and internalizing disorders, preventive interventions and treatments may need to be tailored more specifically to these different problems rather than expecting that a single intervention would reduce both. Future research could evaluate these possibilities empirically in the context of longitudinal studies of early preventive interventions.

In summary, the present study makes two main contributions to the literature. First, we document rates of comorbidity between specific behavior and internalizing disorders and substance use disorders in a community sample of adolescents, and importantly, differentiate depressive from anxiety disorders in the presentation of these rates. Second, we chart trajectories of illicit substance use from the age of 12 to 22 in relation to specific comorbid disorders at age 18. Together, these findings advance understanding of the developmental course of illicit substance use as well as substance use disorders.

Acknowledgements

The Child Development Project has been funded by grants MH42498, MH56961, MH57024, and MH57095 from the National Institute of Mental Health, HD30572 from the National Institute of Child Health and Human Development, and DA016903 from the National Institute on Drug Abuse. We are grateful to the parents, children, and teachers who participated in this research.

Correspondence to

Jennifer E. Lansford, Center for Child and Family Policy, Duke University, Box 90545, Durham, NC 27708, USA; Tel. and Fax: +217-586-2870; Email: lansford@duke.edu

References

- Armstrong, T.D., & Costello, E.J. (2002). Community studies on adolescent substance use, abuse, or dependence and psychiatric comorbidity. *Journal of Consulting and Clinical Psychology, 70*, 1224–1239.
- Bachman, J.G., O'Malley, P.M., Schulenberg, J.E., Johnston, L.D., Bryant, A.L., & Merline, A.C. (2002). *The decline of substance use in young adulthood: Changes in social activities, roles, and beliefs*. Mahwah, NJ: Erlbaum.
- Chassin, L., Presson, C.C., Pitts, S.C., & Sherman, S.J. (2000). The natural history of cigarette smoking from adolescence to adulthood in a Midwestern community sample: Multiple trajectories and their psychosocial correlates. *Health Psychology, 19*, 223–231.
- Connell, A.M., Dishion, T.J., & Deater-Deckard, K. (2006). Variable- and person-centered approaches to the analysis of early adolescent substance use: Linking peer, family, and intervention effects with developmental trajectories. *Merrill-Palmer Quarterly, 52*, 421–448.
- Costello, E.J. (2007). Psychiatric predictors of adolescent and young adult drug use and abuse: What have we learned? *Drug and Alcohol Dependence, 88S*, S97–S99.
- Dishion, T.J., Andrews, D., & Crosby, L. (1995). Antisocial boys and their friends in early adolescence: Relationship characteristics, quality and interaction process. *Child Development, 66*, 139–151.
- Dodge, K.A., Bates, J.E., & Pettit, G.S. (1990). Mechanisms in the cycle of violence. *Science, 250*, 1678–1683.
- Ellickson, P.L., Martino, S.C., & Collins, R.L. (2004). Marijuana use from adolescence to young adulthood: Multiple developmental trajectories and their associated outcomes. *Health Psychology, 23*, 299–307.
- Fantoni-Salvador, P., & Rogers, R. (1997). Spanish versions of the MMPI-2 and PAI: An investigation of concurrent validity with Hispanic patients. *Assessment, 4*, 29–39.
- Fergusson, D.M., Horwood, L.J., & Ridder, E.M. (2007). Conduct and attentional problems in childhood and adolescence and later substance use, abuse, and dependence: Results of a 25-year longitudinal study. *Drug and Alcohol Dependence, 88S*, S14–S26.
- Glantz, M.D. (2002). Introduction to the special issue on the impact of childhood psychopathology interventions on subsequent substance abuse: Pieces of the puzzle. *Journal of Consulting and Clinical Psychology, 70*, 1203–1206.
- Glantz, M.D., & Pickens, R.W. (1992). *Vulnerability to drug abuse*. Washington, DC: American Psychological Association.
- Guo, J., Chung, I., Hill, K.G., Hawkins, J.D., Catalano, R.F., & Abbott, R.D. (2002). Developmental relationships between adolescent substance use and risky sexual behavior in young adulthood. *Journal of Adolescent Health, 31*, 354–362.
- Hallfors, D.D., Waller, M.W., Bauer, D., Ford, C.A., & Halpern, C.T. (2005). Which comes first in adolescence – sex and drugs or depression? *American Journal of Preventive Medicine, 29*, 163–170.
- Hasin, D., Samet, S., Nunes, E., Meydan, J., Matseane, K., & Waxman, R. (2006). Diagnosis of comorbid

- psychiatric disorders in substance users assessed with the Psychiatric Research Interview for Substance and Mental Disorders for DSM-IV. *American Journal of Psychiatry*, 163, 689–696.
- Hill, K.G., White, H.R., Chung, I.J., Hawkins, J.D., & Catalano, R.F. (2000). Early adult outcomes of adolescent binge drinking: Person- and variable-centered analyses of binge drinking trajectories. *Alcoholism: Clinical and Experimental Research*, 24, 892–901.
- Jessor, R., & Jessor, S.L. (1977). *Problem behavior and psychosocial development: A longitudinal study of youth*. New York: Academic Press.
- Johnston, L.D., O'Malley, P.M., Bachman, J.G., & Schulenberg, J.E. (2004). *Monitoring the Future national results on adolescent drug use: Overview of key findings, 2003*. Bethesda, MD: National Institute on Drug Abuse.
- Johnston, L.D., O'Malley, P.M., Bachman, J.G., & Schulenberg, J.E. (2007). *Monitoring the Future national results on adolescent drug use: Overview of key findings, 2006 (NIH Publication No. 07-6202)*. Bethesda, MD: National Institute on Drug Abuse.
- Kandel, D.B., & Chen, K. (2000). Types of marijuana users by longitudinal course. *Journal of Studies on Alcohol*, 61, 367–378.
- Khantzian, E.J. (1985). The self-medication hypothesis of addictive disorders: Focus on heroin and cocaine dependence. *American Journal of Psychiatry*, 142, 1259–1264.
- King, S.M., Iacono, W.G., & McGue, M. (2004). Childhood externalizing and internalizing psychopathology in the prediction of early substance use. *Addiction*, 99, 1548–1559.
- Lillehoj, C.J., Trudeau, L., Spoth, R., & Madon, S. (2005). Externalizing behaviors as predictors of substance initiation trajectories among rural adolescents. *Journal of Adolescent Health*, 37, 493–501.
- Measelle, J.R., Stice, E., & Hogansen, J.M. (2006). Developmental trajectories of co-occurring depressive, eating, antisocial, and substance abuse problems in female adolescents. *Journal of Abnormal Psychology*, 115, 524–538.
- Muthén, B., & Muthén, L. (1998). *Mplus user's guide: The comprehensive modeling program for applied researchers*. Los Angeles, CA: Muthén & Muthén.
- Muthén, B., & Muthén, L. (2004). *Mplus user's guide* (3rd edn). Los Angeles, CA: Muthén & Muthén.
- Neighbors, B., Kempton, T., & Forehand, R. (1992). Co-occurrence of substance abuse with conduct, anxiety, and depression disorders in juvenile delinquents. *Addictive Behaviors*, 17, 379–386.
- Newcomb, M.D., & Bentler, P.M. (1989). Substance use and abuse among children and adolescents. *American Psychologist*, 2, 242–248.
- Siebenbruner, J., Englund, M.M., Egeland, B., & Hudson, K. (2006). Developmental antecedents of late adolescence substance use patterns. *Development and Psychopathology*, 18, 551–571.
- Steele, R.G., Forehand, R., Armistead, L., & Brody, G. (1995). Predicting alcohol and drug use in early adulthood: The role of internalizing and externalizing behavior problems in early adolescence. *American Journal of Orthopsychiatry*, 65, 380–388.
- Substance Abuse and Mental Health Services Administration. (2004). *Results from the 2003 national survey on drug use and health: National findings (NHSDA Series H-25, DHHS Publication No. SMA 04-3964)*. Rockville, MD: Author.
- Sung, M., Erkanli, A., Angold, A., & Costello, E.J. (2004). Effects of age at first substance use and psychiatric comorbidity on the development of substance use disorders. *Drug and Alcohol Dependence*, 75, 287–299.
- Tucker, J.S., Ellickson, P.L., Orlando, M., Martino, S.C., & Klein, D.J. (2005). Substance use trajectories from early adolescence to emerging adulthood: A comparison of smoking, binge drinking, and marijuana use. *Journal of Drug Issues*, 35, 307–332.
- Wills, T.A., Windle, M., & Cleary, S.D. (1998). Temperament and novelty seeking in adolescent substance use: An application of Cloninger's theory. *Journal of Substance Abuse*, 6, 1–20.
- Windle, M., & Wiesner, M. (2004). Trajectories of marijuana use from adolescence to young adulthood: Predictors and outcomes. *Development and Psychopathology*, 16, 1007–1027.
- Wittchen, H.-U., Fröhlich, C., Behrendt, S., Günther, A., Rehm, J., Zimmermann, P., Lieb, R., & Perkonig, A. (2007). Cannabis use and cannabis use disorders and their relationship to mental disorders: A 10-year prospective-longitudinal community study in adolescents. *Drug and Alcohol Dependence*, 88S, S60–S70.

Manuscript accepted 19 February 2008