Published in final edited form as:

J Res Adolesc. 2014 December 1; 24(4): 630–645. doi:10.1111/jora.12053.

Adolescent Pathways to Co-Occurring Problem Behavior: The Effects of Peer Delinquency and Peer Substance Use

Kathryn C. Monahan,

University of Pittsburgh, Department of Psychology, 210 S. Bouquet St., Pittsburgh, PA 15260

Isaac C. Rhew,

University of Washington, Department of Psychiatry and Behavioral Sciences, Center for the Study of Health and Risk Behaviors, 1100 NE 45th St, #300, Box 354944, Seattle, WA 98105

J. David Hawkins, and

Social Development Research Group, School of Social Work, University of Washington, 9725 Third Ave NE, Suite #401, Seattle WA 98115, 206.685.1997

Eric C. Brown

Social Development Research Group, School of Social Work, University of Washington, 9725 Third Ave NE, Suite #401, Seattle WA 98115, 206.685.1997

Abstract

Delinquency and substance use are more likely to co-occur in adolescence compared to earlier and later developmental periods. The present study examined developmental pathways to co-occurring problem behavior from 6th-10th grade ($N=2,002$), testing how peer delinquency and substance use were linked to transitioning between abstaining, delinquency, substance use, and co-occurring problem behavior. Developmentally, most youth transition from abstinence to delinquent behavior, and then escalate to co-occurring problem behavior. Once co-occurring problem behavior onsets, remitting to single problem behavior or abstinence is unlikely. The impact of peers on problem behavior are domain specific when individuals transition from abstaining to a single problem behavior, but are more general with respect to escalation of and desistance from problem behavior.

Keywords

delinquency; substance use; peer group; developmental psychopathology

Adolescence is marked by increased involvement in a wide variety of problem behaviors, including antisocial and criminal behavior (Farrington, 2009), alcohol use (Johnston, O'Malley, Bachman, & Schulenberg, 2009), and drug use (Chassin, Hussong, & Beltran, 2009). For both official arrest records and self-reported delinquency, involvement in antisocial behavior peaks in the mid to late teenage years. In 2010, 1,154,096 juveniles were arrested in the United States (Federal Bureau of Investigation, 2010). That same year, data

from the Monitoring the Future national school-based survey showed that, among 12th graders, 50% had used some illicit drug in their lifetime, 70% had consumed alcohol, and 19% were current smokers (Johnston, O'Malley, Bachman, & Schulenberg, 2012). The high prevalence of involvement in delinquency and substance use is particularly troubling because youth who engage in these problem behaviors have an increased likelihood of adversity in multiple domains, including poorer physical health, lower life expectancy, poorer psychosocial adjustment, and a more difficult transition to adulthood (Duberstein Lindberg, Boggess, & Williams, 2000).

For most youth, involvement in problem behavior during adolescence does not become chronic; however, for a small subset of individuals, adolescent problem behavior represents long-term atypical developmental processes, and, for these youth, problem behavior continues well into adulthood. Indeed, evidence of such heterogeneity in developmental patterns of psychopathology -- with most youth ceasing and some youth persisting in problem behavior -- has been found for a variety of problem behaviors, including heavy drinking (Windle, Mun, & Windle, 2005), smoking (Chassin, Presson, Pitt, & Sherman, 2000), alcohol and drug use (Chassin, Flora, & King, 2004), and antisocial behavior (Moffitt, Caspi, Harrington, & Milne, 2002; Monahan, Steinberg, & Cauffman, 2009).

One of the most studied theories of heterogeneity in developmental pathways to problem behavior is Moffitt's taxonomy of offending (Moffitt, 1993; Moffitt et al., 2002). Moffitt distinguished between the vast majority (90 percent or more, depending on the study) of individuals whose antisocial behavior is limited to adolescence ("adolescence-limited offenders") and the small proportion of those whose antisocial behavior begins in childhood and persists into adulthood ("life-course persistent offenders"). Importantly, Moffitt suggested that different etiological factors explain these groups' involvement in antisocial behavior. Adolescent-limited offenders' involvement in antisocial behavior is hypothesized to be a normative consequence of their desire to feel more mature and of peer pressure or the emulation of higher-status agemates. In contrast, when individual antisocial behavior persists into adulthood it is thought to be rooted in early neurological and cognitive deficits that, combined with environmental risk, lead to early conduct problems and lifelong antisocial behavior.

Empirical investigations of Moffitt's theory generally have found support for the taxonomy during adolescence, with some youth reporting chronic problem behavior across adolescence and early adulthood and others whose antisocial behavior appeared to be limited to adolescence. In particular, individuals who began problem behavior earlier tend to show the highest levels of a specific problem behavior during adolescence, but were also at increased risk of involvement in multiple types of problem behaviors, a finding consistent with evidence that delinquency and substance use tend to co-vary more strongly during adolescence compared to earlier and later developmental periods (Gillmore et al., 1991; McGee & Newcomb, 1992). Indeed, males demonstrating conduct problems during adolescence had a greater risk of substance use and dependence by age 18 (Moffitt, Caspi, Dickson, Silva, & Stanton, 1996). Followed into adulthood, at ages 26 (males) and 32 (males and females), individuals who followed a life-course persistent path demonstrated greater risk for substance use and dependence while those whose antisocial behavior were

limited to adolescence showed elevated, but not as severe, levels of substance use and dependence (Moffitt et al., 2002; Odgers, Moffitt, Broadbent, Dickson, & Hancox, 2008). Thus, among youth, involvement in one type of problem behavior was associated with increased risk of comorbid involvement in other types of problem behavior.

Across adolescence, evidence suggests that there is a common developmental progression to involvement in different types of problem behavior. Generally, young adolescents tend to commit minor delinquent acts before initiating substance use (Elliott, 1994; Huba & Bentler, 1983; Kuperman et al., 2001). Further, prospective research has shown that delinquency was a predictor of substance misuse and substance-related clinical disorders (Harford & Muthen, 2000; White, 1990). These findings are consistent with developmental theories positing that antisocial behavior is an important pathway leading to the development of substance abuse and dependence (Zucker, 1994), and that early onset delinquency places a youth at greater risk for maladaptive development in multiple domains, including substance use and risky sexual behavior (Moffitt et al., 2002).

Despite the identification of this common sequence of involvement in problem behaviors, there are exceptions to this developmental progression. For example, while some delinquent youth went on to engage in co-occurring delinquency and substance use, other youth did not (Moffitt et al., 2002). Further, for some youth who engage in substance use, delinquency is not a precursor (Bui, Ellickson, & Bell, 2000; French et al., 2000). Understanding heterogeneity in these developmental pathways allows for identification of developmentally appropriate targets of intervention. Moreover, understanding unique etiological predictors of various pathways is important to understanding the progression to co-occurring problem behavior and designing appropriate treatment. To date, however, little research has examined heterogeneity in developmental pathways to co-occurring problem behavior. Moreover, it remains unclear what etiological factors may contribute to differential problem behavior pathways during adolescence.

It is likely that a number of factors contribute to escalating problem behavior and differentiate between problem behavior pathways throughout adolescence. One risk factor that may be particularly strong with respect to predicting transition to different behavioral states (i.e., abstaining from problem behavior, involvement in one type of problem behavior, involvement in multiple types of problem behavior) is interaction with peers who engage in problem behaviors. There are a number of theoretical reasons to expect that peer behaviors may be a particularly salient predictor of problem behavior and, in particular, the development of co-occurring problem behavior. Differential association theory (Matsueda, 1988; Sutherland, 1973) posits that through interactions with others, individuals learn values and attitudes. Youth may encounter opportunities for interaction with prosocial others or opportunities to interact with those engaged in problem behavior. Thus, if a youth associates with individuals who engage in a problem behavior, he or she will have greater opportunity to become involved in that behavior because he or she is hypothesized to learn the values, attitudes, techniques, and motives for criminal behavior. The mechanisms by which this might happen is informed by social learning theory (Akers, 1977), which suggests that behavior is learned when it is rewarded and it is not learned or is extinguished when it is not rewarded or is punished. If an individual is rewarded for becoming engaged in problem

behavior - perhaps by increased acceptance by peers or loyalty (Warr, 2002) - a youth is likely to continue to be involved in problem behavior.

The influences of peers on problem behavior may be particularly strong during adolescence, likely because of increases in the amount of time spent with peers, the importance of peer relationships (B. B. Brown & Larson, 2009), and greater susceptibility to peer influence (Steinberg & Monahan, 2007) compared to earlier or later developmental periods. One of the most robust findings in the literature on adolescent antisocial behavior is that individuals with deviant peers were more likely to engage in antisocial behavior than individuals without deviant peers (Monahan et al., 2009). Similarly, peer substance use has been one of the strongest predictors of adolescent substance use (Oxford, Harachi, Catalano, & Abbott, 2001). Across adolescence, individuals are associated increasingly with delinquent and substance using peers. For example, at age 11, approximately 85% of adolescents reported that none of their friends use alcohol, but by age 18 less than 10% reported no alcohol-using friends (Warr, 1993). A similar, though less dramatic, developmental trend in peer associations was found for delinquent behavior, suggesting that associations with peers who are engaging in problem behavior generally increases across adolescence.

To date, however, it is unclear to what extent peer group characteristics such as delinquency or substance use are general or specific predictors of adolescent problem behavior. Does peer involvement in one type of problem behavior predict problem behavior only in that domain (e.g., peer delinquency is predictive only of one's own delinquency), or is peer involvement in a specific type of behavior a general risk factor for multiple types of problem behavior (e.g., peer delinquency predicts one's own delinquency *and* substance use or escalating to co-occurring problem behavior)? On one hand, it is reasonable to expect that interacting with peers who engage in certain types of problem behavior may be a specific risk factor for that problem behavior. This account is consistent with differential association theory, which would suggest that peer behavior would provide differential opportunity to learn norms favorable to the specific act. On the other hand, it is possible that associating with any type of 'bad' peers, regardless of the specific type of problem behavior the peers engage in, places a youth at greater risk for involvement in multiple types of problem behavior. Peers who engage in one type of problem behavior could be more receptive to or accepting of other types of problem behavior, providing greater social reinforcement of the behavior. This account is more akin to a social learning perspective (Akers, 1977) or deviancy training model (Dishion, Spracklen, Andrews, & Patterson, 1996), where pro-problem behavior norms in one domain may lead to greater reinforcement of *any* problem behavior. Finally, it remains unclear how the associations between peers and problem behavior may vary across adolescence. Some research suggests that peer socialization effects on delinquency – the effects of peer delinquency on an adolescent's own delinquency – are strongest in mid adolescence and decline as youth transition into adulthood (Monahan et al., 2009). Whether this trend applies to early adolescence or to other problem behaviors, such as substance use and co-occurring delinquency and substance use, is unknown.

One important limitation of past research on pathways to and predictors of co-occurring problem behavior during adolescence is that it often failed to take into account that adolescents can have periods of problem behavior followed by periods of abstaining from

problem behavior. Studies often either categorize problem behaviors, grouping individuals as having initiated or ever engaged in a problem behavior, or use continuously distributed indexes of delinquency or substance use to understand how the two domains of problem behavior are related. The disadvantage to these approaches is that they may mask heterogeneity in the developmental patterning of problem behavior during adolescence. For example, imagine a youth who reports delinquency at Time 1, no delinquency at Time 2, and delinquency again at Time 3. Using an onset-oriented analytic approach, the individual would have been identified as “delinquent” across all three time periods, even though the individual had abstained from any delinquency during the second time period. Similarly, using statistical approaches that average patterns of problem behavior over time would have produced an average level of some delinquency across all time points, obscuring that the individual had gone through a period of time without any delinquent behavior. The same issue is true for understanding co-occurring problem behavior. At some times individuals may be engaged in multiple types of problem behaviors, while at other times they may revert to engaging in only one problem behavior or abstain altogether. Given that involvement in any problem behavior can increase likelihood for maladaptation, it is important to understand the developmental patterning of involvement or non-involvement across time. Understanding periods of abstention from problem behavior – delinquency or substance use – may be important for understanding developmental pathways to co-occurring problem behavior, yet most analytic approaches ignore these periods.

To overcome this potential limitation of past studies and to more clearly understand developmental pathways to co-occurring problem behavior, in the present study we used a categorical latent variable Markov chain model approach to study co-occurring problem behavior. We specified four groups at each time point: abstainers, delinquent only youth, substance use only youth, and co-occurring problem behavior youth. At each time point, we allowed individuals to move freely among these latent classes. Thus, individuals could have reported any combination of abstaining, single problem behavior, or co-occurring problem behavior across time. Notably, the abstainer latent class allowed for the inclusion of individuals who never have engaged in problem behavior and those who have desisted, either permanently or temporarily, from problem behavior. This approach provided insight into the developmental patterning of delinquency and substance use over time among adolescents and also allowed examination of how peer group delinquency and substance use may have predicted transitions to single and co-occurring problem behavior. Studying these transitions from early to mid-adolescence allowed us to examine these processes in a developmental period when problem behaviors are prevalent and generally escalate.

After identifying developmental patterns of behavior, we tested how sex was related to the probability of transitioning between latent classes. Next, we tested whether peer delinquency and peer substance use were specific or general predictors of a transition to co-occurring problem behavior or a transition from problem behavior to abstaining. We also tested whether peer characteristics predicted transitioning from problem behavior to abstaining. Finally, we examined whether peer influences on problem behavior varied across development.

Method

Participants

Participants in the present study were 2,002 (51% male) youth from the control sample of the Community Youth Development Study (CYDS), a community-randomized controlled trial of the Communities That Care prevention system (E. C. Brown et al., 2009; Hawkins et al., 2008). Youth were from 12 communities in 7 states: Colorado, Illinois, Kansas, Maine, Oregon, Utah, and Washington. The present study used annual data from the CYDS panel sample when youth were in the 6th through 10th grades. On average, youth were 12.09 years old ($SD = .40$) at the sixth-grade interview. The sample was primarily White (61%), and 26% of the sample reported Hispanic ethnicity.

Procedures

All fifth-grade public school students in the 2003 – 2004 academic year and all sixth-grade public school students in the 2004 – 2005 academic year in participating communities assigned to the control condition were eligible to participate if they remained in participating schools for at least one semester. The final active longitudinal panel in control communities consisted of 2,002 students in 36 elementary and middle schools who completed a survey in Grade 5 or Grade 6. Retention in the study was excellent, and 94.6% of the students in the panel completed the survey in the 10th grade.

At each wave of data collection, students completed the Youth Development Survey (Social Development Research Group, 2005–2007), a self-administered, paper-and-pencil questionnaire designed to be completed in a 50-minute classroom period. To ensure confidentiality, identification numbers, but no names or other identifying information, were included on the surveys. Parents of the students provided written informed consent for their children's participation in the study; students read and signed assent statements indicating that they were fully informed of their rights as research participants. Upon completing the surveys, students received small incentive gifts worth approximately \$5 to \$8 (E. C. Brown et al., 2009; Hawkins et al., 2008). These procedures were approved by the Human Subjects Review Committee of the University of Washington.

Measures

Delinquent behavior—Individuals were asked to report how many times during the past year (e.g., “never,” “1 or 2 times,” “3 to 5 times,”) they had engaged in seven different delinquent acts (e.g., stealing, damaging property, shoplifting, attacking someone with intention of hurting them, carrying a gun, beating someone up, and being arrested). A binary indicator for any delinquent behavior, compared to no delinquent behavior, was calculated for each grade. The measure showed good reliability across time (α 's range from .70-.77 across time).

Substance use—Students self-reported on past-month use of alcohol, cigarettes, smokeless tobacco, marijuana, inhalants, and prescription drugs not prescribed by a doctor at each annual survey from Grade 6 through Grade 10 (e.g., “On how many occasions (if any) have you had beer, wine, or hard liquor during the past 30 days?”; “How frequently have

you smoked cigarettes during the past 30 days?”; “On how many occasions (if any) have you used marijuana during the past 30 days?”). A binary indicator for any substance use compared to no substance use in the past 30 days was calculated for each grade. The advantage to using a global index of substance use is that it maps onto the peer substance use measure (see subsequent section).

Analyses were also run using alcohol use in the past 30 days (the most prevalent of the substances) instead of the global substance use measure. The pattern of results is identical to that presented here. Consequently, we present the global substance use analyses for parsimony.

Peer delinquency—Youth self-reported on six items about the delinquency of their best friends annually (e.g., *“In the past year, how many of your best friends have stolen something worth more than \$5?”*; *“In the past year, how many of your best friends have been arrested?”*; *“In the past year, how many of your best friends have attacked someone with the idea of seriously hurting them?”*). Items were standardized and averaged. The measure showed good internal consistency (α 's range from .68-.87 across time).

Peer substance use—Each year, adolescents self-reported on four items about their closest friends' use of alcohol, cigarettes, marijuana, and other drugs (e.g., *“In the past year, how many of your best friends have tried beer, wine, or hard liquor (for example, vodka, whiskey, or gin) when their parents didn't know about it?”*; *“In the past year, how many of your best friends have smoked cigarettes?”*; *“In the past year, how many of your best friends have used marijuana?”*). All items were standardized and averaged. The measure showed good internal consistency (α 's range from .80-.85 across time).

Plan of Analyses

The proportion of individuals with missing data was small (7.4%) and missing data were dealt with via multiple imputation (Schafer & Graham, 2002). Using NORM version 2.03 (Schafer, 2000), 40 separate datasets that included data from all five waves of data were imputed. Imputation models included student demographics, delinquent behavior, substance use, peer delinquency, peer substance use, and community of residence. It has been recommended that the number of variables to include in the multiple imputations should be limited to 100 or less in order to reduce excessive computing time and because of limited added benefit to stability of imputation estimates (Graham, 2009). Because of the longitudinal nature of this study, the number of variables included the imputation model would vastly exceed 100 if we were to impute at the item level over the five years of data included in this study. According to Graham and colleagues, imputing at the scale-level is appropriate under conditions of strong internal consistency and strong unidimensionality with homogenous factor loadings. Examinations of these properties of the peer delinquency and peer substance use scales in our sample supported the use of imputation at the scale level (Graham, Van Horn, & Taylor, 2012), and peer delinquency and peer substance use were imputed at the scale level. Delinquent behavior and substance use were imputed at their original scales (e.g., 0 [*never*] to 7 [*40 or more times*]) and then dichotomized for

analyses post imputation. All data analyses were conducted across the 40 imputed datasets and aggregated according to Rubin's rules (Rubin, 1987).

After imputing data, we used a latent class Markov chain model to estimate four groups of individuals at each grade based on delinquent behavior and substance use. Models were estimated in Mplus (Muthén & Muthén, 2010). Using self-reported delinquent behavior and substance use as binary indicators, at each age we estimated a four class solution: (1) abstainers who had a very high probability of reporting 'no' on both delinquency and substance use; (2) delinquent only youth who had a very high probability of reporting *yes* to delinquent behavior, but very low probability of reporting 'yes' to substance use; (3) substance use only youth who had a very high probability of reporting 'no' to delinquent behavior, and very high probability of reporting 'yes' to substance use; and (4) co-occurring problem behavior youth who had a very high probability of reporting 'yes' to both delinquent behavior and substance use. One advantage to this method of estimating classes of individuals is that it allows estimation of the probabilities of remaining in the same class or shifting to a different class across grades. Moreover, estimating classes in a latent class framework, as opposed to creating the groups *a priori*, allows measures of delinquency and substance use to have some level of measurement error (see Masyn, 2007 for an example of estimating latent classes accounting for measurement error). Note that the class that we call 'abstainers' consists of two types of individuals: abstainers who have never been involved in delinquency and substance use and abstainers who had been previously involved in delinquent behavior or used substances but not at the most recent time point.

The term Markov chain refers to a model for repeated measures of one or more discrete variables where change in a categorical outcome (either latent or observed) over time is described through a set of transitional matrices. The level or class of the categorical outcome is referred to as a *state* and the transitional matrices indicate the conditional probability for being in a specific state in one time period conditional on the occupied state in the prior time period (Langeheine & Van de Pol, 2002). The latent class membership at one grade was regressed on the previous grade, deriving conditional probabilities that an individual remained in the same latent class or transitioned to a different latent class. For example, we estimated the probability that an individual in the abstainer class in the sixth grade remained in the abstainer class in the seventh grade or transitioned to a delinquent only, substance use only, or co-occurring behavior class in the seventh grade. Examining these transitional probabilities across development identifies common developmental pathways to co-occurring problem behavior, with relatively higher transitional probabilities indicating more common developmental progressions among behavioral states. At each grade, individuals could belong to any of the four latent classes, irrespective of prior behavior.

When estimating the transitional probabilities between latent classes over time, it is possible to introduce covariates that predict shifting to a different latent class. In the present study, we are interested in examining how sex, peer delinquency and peer substance use were associated with transitioning from abstaining to involvement in only one type of problem behavior (i.e., delinquency or substance use), from abstaining to involvement in co-occurring problem behavior of both delinquency and substance use, from single problem behavior to abstaining (i.e., from delinquency only or substance use only to abstaining), and

from co-occurring problem behavior to single problem behavior or to abstaining (see Figure 1 for an illustration of the statistical model with peer delinquency and peer substance use; models with sex were ran separately to reduce the complexity of the model). Consequently, we estimated how sex and peer delinquency and peer substance use at one grade account for transitioning at the subsequent grade from (a) abstaining to delinquent only behavior compared to remaining abstinent (b) abstaining to substance use only behavior compared to remaining abstinent, (c) abstaining to co-occurring problem behavior compared to remaining abstinent, (d) delinquent only to co-occurring problem behavior compared to remaining delinquent, (e) substance use only to co-occurring problem behavior compared to remaining substance using only, (f) delinquent only to abstaining compared to remaining delinquent, (g) substance use only to abstaining compared to remaining substance using only, (h) co-occurring problem behavior to abstaining compared to remaining engaged in co-occurring problem behavior, (i) co-occurring problem behavior to delinquent behavior only compared to remaining engaged in co-occurring problem behavior, and (j) co-occurring problem behavior to substance use only compared to remaining engaged in co-occurring problem behavior. Each model was tested separately and peer delinquency and peer substance use were allowed to correlate with each other at each grade.

In additional models, we also tested a series of nested models that examined if the association between peer delinquency and peer substance use and transitioning among problem behavior states varied across development. In the first model, the associations between peer predictors and the transition between latent classes was fixed to be equal across grades. In the second model, these associations were allowed to vary across grades. We used log likelihood difference test for imputed data, comparing the log likelihood in a series of nested models and using a chi-square distribution to determine if the difference in model fit is significant (Enders, 2010). If there is a significant difference in the log likelihood, the more complex model is selected as providing better fit to the data.

Although youth in the present study are drawn from multiple schools, we do not account for this clustering of students within school for three reasons: First, incorporating school-level nesting in the categorical latent variable Markov chain model would have added a level of complexity (i.e., increased dimensions of numeric integration that require a very long time for model convergence) that would have largely prohibited the analytic approach utilized here. Second, during the period when students were in Grades 6 through 10, as students moved to new schools and communities, some schools in the study included only one or two students from the panel. Third, intraclass correlation coefficients (ICCs) measuring the proportion of variance due to between school variation in the examined outcomes across Grades 6 to 10 tended to be small (e.g., almost all ICCs less than 5%).

Results

Developmental Pathways to Co-Occurring Problem Behavior

First, we examined patterns of transitions during one year among the four latent classes (abstainers, delinquent only, substance use only, and co-occurring problem behavior) at each grade. Across all grades, abstainers were consistently the largest class, although the numbers of individuals in the abstaining class declined over time, from 67.8% of the sample in the

6th grade to 42.0% of the sample in the 10th grade. In contrast, involvement in problem behaviors increased over time. The delinquency only group consisted of 22% of the sample in 6th grade; by the 10th grade, 26% of the sample was engaging in delinquent behavior only. Notably, at each age substance use only was the smallest group; however, this group also showed increases in prevalence through grade 10 (from 2.3 to 8.0%). The prevalence of the co-occurring problem behavior group grew the most over time, beginning with only 7.6% of the sample in the 6th grade, and increasing to 24.0% of the sample in the 10th grade.

The conditional probabilities of transitioning between latent classes revealed that there were typical developmental pathways or progressions to co-occurring behavior problems during adolescence (Table 1). Across all grades, youth in the abstainer class were most likely to remain abstainers at the next grade. Abstainers who did transition to a different class were most likely to transition to delinquency only (between 18% and 25% of youth over time). The probability of transitioning directly from the abstainer class to substance use only or co-occurring problem behavior was very low across all grades (less than 6%). Thus, among adolescents who had previously abstained from delinquency and substance use, the most common developmental pathway to problem behavior began with engaging exclusively in delinquency.

Once individuals were in the delinquency only class, they were most likely to remain so across grades. Most youth who were delinquent at one grade were likely to continue involvement exclusively in delinquent behavior in the next grade (between 42% and 48%). Those who did transition to a different latent class were most likely to move into the abstainer class, followed by the co-occurring class. The probability of shifting from delinquency only to abstainer class and from the delinquency class to the co-occurring class remained relatively stable over time. Importantly, among individuals in the delinquency only class, the probability of transitioning to the substance use only class at the subsequent grade was very low (between 3% and 5% at each grade). The logistic regression of the transition from delinquent behavior to substance use was significant between 8th and 9th, and 9th and 10th grades, but not earlier: 6th to 7th grade: $b = 0.57$, $se = 0.43$, $p = 0.19$; 7th to 8th grade: $b = 0.45$, $se = 0.38$, $p = 0.24$; 8th to 9th grade: $b = 0.61$, $se = 0.31$, $p = 0.05$; 9th to 10th grade: $b = -0.65$, $se = 0.27$, $p = 0.02$. Because this transition between delinquent only behavior to substance use only behavior was not significant across grade (indicating that the developmental pathway was very rare), we did not test how covariates were related to this transition.

Youth who reported only substance use were the smallest class at each grade, and as a result, transitional probabilities to other classes reflected very small numbers of youth. Youth who used only substances were most likely to transition to the abstainer class from the sixth to seventh grade. At later grades, youth who previously had used substances only were most likely to transition to the abstainer or the co-occurring latent class. The likelihood of transitioning from only substance use to abstinence grew smaller with age (from 48% to 22%), while the likelihood of transitioning to co-occurring problem behavior increased with age (from 17% to 40%). Some youth did transition from only substance use to only delinquency, but this was the least prevalent transition, and, fewer than 6% of the 5.7% of

the sample in the substance use only class in the ninth grade transitioned to only delinquent behavior in the 10th grade. In fact, the logistic regression of the pathway between substance use only to delinquency only was not significant at any age except between 8th and 9th grades: 6th to 7th grade: $b = 0.57$, $se = 0.42$, $p = 0.19$; 7th to 8th grade: $b = 0.35$, $se = 0.44$, $p = 0.42$; 8th to 9th grade: $b = 1.06$, $se = 0.45$, $p = 0.02$; 9th to 10th grade: $b = -0.44$, $se = 0.55$, $p = 0.43$. Because the transition between substance use only and delinquency only was not significant at each grade, we did not subsequently test how peer group characteristics were related to this association.

Across time, individuals in the co-occurring problem behavior latent class were very unlikely to transition to abstinence or substance use only by the next grade. Indeed, the most common pathway was for co-occurring youth to remain engaged in co-occurring problem behavior over time (with stability ranging from 50% at younger ages to 70% at older ages). Notably, the likelihood of transitioning from the co-occurring class to the delinquent only class decreased over time, beginning at 33% in sixth grade and declining to 13% by ninth grade. Once adolescents reported co-occurring problem behavior, they were likely to remain engaged in both delinquency and substance use through tenth grade.

Sex and Transitioning Between Latent Classes

In a series of analyses, we tested how sex was associated with the probability of shifting between latent classes. We found evidence that males were more likely to shift from the delinquency class to the abstainer class ($b = 0.24$, $se = 0.04$, $p < 0.05$) and the substance use class to the abstainer class ($b = 0.34$, $se = 0.05$, $p < 0.05$) than were females. Once females became involved in single-problem behavior, they were less likely to revert to abstaining than males. Sex was not associated with any other latent class transitions.

Peer Characteristics and Transitioning from Abstaining to Delinquency or Substance Use

We next tested how peer delinquency and peer substance use were related to (a) transitioning from abstinence to delinquent behavior and (b) transitioning from abstinence to substance use (Table 2). Associating with delinquent peers was linked with transitioning from abstinence to delinquent behavior. Peer substance use was not related to transitioning from abstinence to delinquent behavior. In contrast, peer substance use was related significantly to transitioning from abstinence to being involved in substance use. Notably, having fewer delinquent peers was predictive of transitioning from abstinence to substance use. Having more peers involved in a behavior was associated with youth becoming involved in the same behavior.

Subsequently, we tested if the association between peer delinquency and peer substance use and transitioning to a single problem behavior varied across grade. Specifically, we compared a model in which the effects of peer covariates on transitioning to a single problem behavior were constrained to be equal to a model with the effects of peer covariates allowed to vary across grades. Using the log likelihood ratio test for imputed data, results showed no effects of changes in peer delinquency and peer substance use on transitioning from abstinence to delinquent behavior, $F(4, 314.98) = .01$, $p > .05$, or from abstinence to substance use, $F(4, 314.14) = .01$, $p > .05$. The association between peer delinquency and

peer substance use and transitioning to a single problem behavior did not vary across the grades studied.

Peer Characteristics and Transitioning to Co-Occurring Problem Behavior

Next, we tested (a) how peer delinquency and substance use were associated with transitioning from abstinence to co-occurring problem behavior compared to remaining abstinent, (b) how peer delinquency and substance use were associated with transitioning from only delinquent behavior to co-occurring problem behavior compared to remaining only delinquent across grades, and (c) how peer delinquency and substance use were associated with transitioning from only substance use behavior to co-occurring problem behavior compared to remaining only involved in substance use across grades (Table 3).

Across all three models, having more delinquent peers and having more substance using peers were both associated with greater likelihood of transitioning to co-occurring problem behavior compared to remaining abstinent or involved in only one problem behavior. Thus, unlike the transitions from abstinence to only one problem behavior where peer influences on individual behavior were behavior specific, both peer delinquency and peer substance use were linked with escalation to co-occurring problem behavior, regardless of the initial problem behavior state of the individual. These findings suggest that once an adolescent is involved in any problem behavior, associating with peers who are involved in any type of problem behaviors increases risk for escalation to co-occurring problem behavior.

We tested if the effects of peer delinquency or peer substance use were stronger predictors of escalating to co-occurring problem behavior. We compared a model where the effects of the two variables were constrained to be equal to a model where they were allowed to vary. The effects of changes in peer delinquency and peer substance use were not significantly different from each other in models testing transitions from abstinence to co-occurring problem behavior, $F(4, 286.60) = .03, p > .05$; in models testing transitions from only delinquent behavior to co-occurring problem behavior, $F(4, 285.27) = .03, p > .05$; and in models testing transitions from only substance use to co-occurring problem behavior, $F(4, 288.54) = .02, p > .05$. Therefore, after accounting for the correlation between peer delinquency and peer substance use, the effects of peer delinquency and peer substance use were comparable in predicting a transition to co-occurring problem behavior.

We then tested whether the association between peer delinquency and peer substance use, and the transition to co-occurring problem behavior varied developmentally, comparing a model where the effects were constrained to be equal across development to a model where the effects were allowed to vary across development. For each model, the effects of peer delinquency and peer substance use on the transition to co-occurring problem behavior did not significantly vary across the developmental periods in the present study for transitioning from abstinence to co-occurring problem behavior, $F(4, 316.04) = .01, p > .05$; for transitioning from only delinquent behavior to co-occurring problem behavior, $F(4, 316.62) = .01, p > .05$; and for transitioning from only substance use to co-occurring problem behavior, $F(4, 314.40) = .02, p > .05$.

Peer Characteristics and Transitioning from Delinquency or Substance Use to Abstaining

We next tested how peer delinquency and peer substance use were related to (a) transitioning from delinquent behavior only to abstinence and (b) transitioning from substance use only to abstinence (Table 4). For both delinquent and substance using youth, having fewer delinquent and substance using peers was associated with transitioning to abstaining at the subsequent grade, compared with remaining the same latent class. There were no differences in the magnitude of the association between peer delinquency and peer substance use on the transition to abstaining in either the peer delinquency model, $F(4, 283.79) = .01, p > .05$; or the substance use only model, $F(4, 289.24) = .01, p > .05$.

We tested if the association between peer delinquency and peer substance use and transitioning from single problem behavior to abstaining varied across grade by comparing a model in which the effects of peer covariates were constrained to be equal to a model with the effects of peer covariates allowed to vary across grades. Results did not show developmental differences in the association between peer characteristics and transitioning from delinquent behavior to abstinence, $F(4, 316.23) = .01, p > .05$; or from substance use to abstinence, $F(4, 315.73) = .01, p > .05$.

Peer Characteristics and Transitioning from Co-Occurring Problem Behavior to Abstaining

Next, we tested (a) how peer delinquency and substance use were associated with transitioning from co-occurring problem behavior to abstinence compared to remaining involved in co-occurring problem behavior, (b) how peer delinquency and substance use were associated with transitioning from co-occurring problem behavior to only delinquent behavior compared to remaining involved in co-occurring problem behavior, and (c) how peer delinquency and substance use were associated with transitioning from co-occurring problem behavior to only substance use compared to remaining involved in co-occurring problem behavior (Table 5).

Compared to individuals who remained in the co-occurring class, youth who transitioned from co-occurring problem behavior to abstaining were associated with fewer delinquent and substance using peers prior to the transition. There were no differences in the magnitude of the association between peer delinquency and peer substance use and transition from co-occurring behavior to abstaining, $F(4, 282.71) = 0.001, p > .05$. Interestingly, compared to those who remained in the co-occurring class, individuals who transitioned from the co-occurring class to the delinquent only class reported *higher* peer delinquency in the previous grade (when they were identified as co-occurring), but *lower* peer substance use. Finally, compared to youth who remained in the co-occurring class, those who transitioned to substance use only reported lower peer delinquency at the grade where they were identified as co-occurring, but no differences in peer substance use compared to those who remained co-occurring.

Finally, we tested for developmental differences in the association between peer delinquency, peer substance use, and the transition from co-occurring problem behavior. We found no evidence of developmental variation: for transitioning from co-occurring problem behavior to abstinence, $F(4, 315.29) = .01, p > .05$; for transitioning from co-occurring

problem behavior to delinquent behavior only, $F(4, 311.95) = .01, p > .05$; and for transitioning from co-occurring problem behavior to substance use only, $F(4, 314.36) = .01, p > .05$.

Discussion

While adolescence is a time of increased risk for involvement in a variety of problem behaviors, youth who report involvement in multiple types of problem behavior are at increased risk for maladaptive development both in adolescence and well into adulthood. Results of this study indicate that there are common developmental pathways to co-occurring problem behavior during adolescence. Consistent with work suggesting that delinquency is a gateway to substance use (Elliott, 1994), most youth in this study who engaged in problem behaviors began with delinquency and subsequently escalated to concurrent delinquency and substance use.

However, these results suggest that this developmental progression to co-occurring problem behavior is not necessarily linear. Indeed, some youth who were engaged in either delinquent behavior or substance use at one period reported abstaining in later periods, and this was especially true for males. Females are less likely to abstain after engaging in delinquency or substance use. Developmental patterns appeared to be more stable for adolescents reporting co-occurring problem behaviors. Among adolescents engaged in both delinquency and substance use, there was a low probability of transitioning back to involvement in only one problem behavior or to abstaining, suggesting that behavior may be more malleable *prior* to onset of co-occurring problem behavior. Thus, intervention may be important before individuals escalate to co-occurring problem behavior. In particular, the prevention of delinquency, the most typical precursor to co-occurring problem behavior in adolescence, may be an especially salient focus for universal prevention efforts, while targeted intervention may be needed for those who have already onset delinquency.

One intriguing developmental pattern observed in this study is that among younger adolescents, there was not a significant likelihood of transitioning from delinquent behavior-only to substance use only; yet in middle adolescence (8th to 10th grades), this developmental pathway did emerge. Given that this is the first investigation of this type into the progression of delinquency, substance use, and co-occurring behavior, caution must be exercised in interpreting this finding. Nevertheless, if this pattern is repeated in other studies, it would suggest that there may be a small group of adolescents who abandon delinquent behavior to exclusively engage in substance use and that this pathway may emerge in middle adolescence.

Consistent with prior research (Heinze, Toro, & Urberg, 2004; Monahan et al., 2009; Oxford et al., 2001), peer problem behavior was a strong predictor of involvement in either delinquency or substance use as well as in co-occurring problem behavior in this study. However, the influence of peers on problem behavior appears to depend on whether one seeks to explain involvement in either delinquency or substance use, co-occurring problem behavior, or abstaining from problem behavior. Specifically, for involvement in either delinquency or substance use, peer influences appear to be behavior specific. Associating

with delinquent peers was associated with transitioning from abstaining to delinquency and associating with substance using peers was associated with transitioning from abstinence to substance use, above and beyond the effects of peer involvement in the other problem behavior. However, once youth reported either delinquency or substance use, peer delinquency and substance use both made independent contributions to escalation to co-occurring problem behavior. Indeed, *any* increase in peer problem behavior, be it delinquency or substance use, was associated with escalation to co-occurring problem behavior. Similarly, among youth involved in delinquency, substance use, or co-occurring problem behavior in a particular period, lower levels of peer delinquency and peer substance use predicted subsequent abstinence. Thus, having less exposure to *any* peer problem behavior appears to predict desistance from problem behavior. Consistent with theory, associating with peers engaged in problem behavior does predict individual problem behavior, perhaps because of learned norms favorable to that specific behavior (Sutherland, 1973). Moreover, continued association with peers engaged in any type of problem behavior places youth at risk for escalation to co-occurring problem behavior, perhaps through reinforcement of problem behavior (Akers, 1977; Warr, 2002).

One interesting finding from this study is that among adolescents who abstained from any problem behavior, greater peer substance use and lower peer delinquency were both associated with subsequent engagement in substance use only. It is possible that in order to follow this atypical developmental progression (i.e., abstinence to substance use), a specific set of peer circumstances is required, one in which substance use is increasingly common among peers but delinquent behavior by peers is less so. We found additional evidence for this possibility in the impact of peers on transitioning from co-occurring problem behavior to substance use only. Adolescents who transitioned from co-occurring problem behavior to substance use only reported lower levels of peer delinquency, but no differences in the level of peer substance use compared to those who remained engaged in co-occurring problem behavior. Future studies that investigate this possibility are warranted.

Another notable finding is that the influences of peers on problem behavior were consistent across the developmental period studied here (Grades 6 through 10). Past research that has followed youth during a longer developmental course (ages 14 to 22) has found that the effects of peers on problem behavior wane as youth reach late adolescence, at least with respect to delinquent behavior (Monahan et al., 2009). While the present study did not observe developmental differences in the association between peers and delinquent behavior, the age range studied here may be insufficient to find such effects. Indeed, evidence suggests that individuals are more susceptible to peer influence in middle adolescence than in later adolescence and early adulthood (Steinberg & Monahan, 2007). Whether the influences of peers on delinquency, substance use, or co-occurring problem behavior change across a longer period of development is an important question for further study.

Our study is strengthened by following a large sample of adolescents from 6th through 10th grades, allowing examination of developmental patterns of co-occurring problem behavior during a period of the lifespan in which problem behavior is prevalent and escalating. Moreover, the analytic approach offered considerable advantage. Because we were able to

identify and predict periods of abstinence from problem behaviors as periods of problem behavior over time, we were able to identify the malleability and developmental patterning of delinquency and substance use. We found that among youth involved in either delinquency or substance use, periods of abstinence from problem behavior were common. More research that examines these periods of abstinence may be useful for designing intervention programs targeted at already-involved delinquent or substance using adolescents.

The present study was limited in several respects. First, it relied on self-report. Generally, adolescents are accurate reporters of their own delinquency and substance use (Del Boca & Noll, 2000; Huizinga & Elliott, 1986), but corroboration of self-report measures would have been ideal. Modeling the four problem behavior groups in a latent framework helped account for the possibility of measurement error in self-reports. Another limitation in this study is that our measures of delinquent behavior and substance use referred to different time spans (past year for delinquent behavior and past 30 days for substance use). However, 30 day use is highly correlated with past year substance use and dichotomization of both the delinquency and substance use measures may have minimized the influence of this limitation since we are focuses on use or not and not frequency of problem behavior. While examining *any involvement* compared to *none* allowed us to analyze patterns of abstention, future studies should investigate relationships between the degree of involvement in delinquency or substance use and the co-occurrence of these problem behaviors.

Some previous research suggests that adolescents may show different developmental patterns of escalation *within* delinquent or antisocial behavior, progressing from nonviolent to violent antisocial behavior (Kelley, Loeber, Keenan, & DeLamatre, 1997; Loeber, Keenan, & Zhang, 1997). In our data, our measure of delinquency was best described by a single latent factor and could not be distinguished into different types of delinquency. This could be because we did not have adequate variance of items to detect these groups. However, our measure of delinquency referring to a single construct is consistent with evidence that juveniles do not specialize in criminal acts (Klein, 1984). Consequently, measures that combine across different types of antisocial acts can better measure the whole of juvenile delinquency.

With respect to our self-reported measure of peer problem behavior, some research suggests that perceptions of peer behavior are a more salient predictor of subsequent behavior than peer-reported or behavioral measures of peer behavior (Iannotti & Bush, 1992). Research that has compared indirect assessments of peer delinquency (self-reports) and direct assessments of peer delinquency (through social network nomination) has found that self-reports tend to under-report delinquent behavior compared to direct assessments, but that indirect assessments of peer delinquency tend to have a higher correlation with self-reported behavior, at least partially because of overlap in reporter (Weerman & Smeenk, 2005). Although direct and indirect reports of peer delinquency are often correlated, it is difficult to determine how accurate adolescents are about reporting on peer delinquency. One of the limitations of direct assessments of peer delinquency is that they are often limited in both the number of peers (often only assessing a few close friends) and likely do not reflect the behavior of the entire peer group (social network data collection is often school based and

limited to school friends). Thus, while self-reported peer delinquency may demonstrate a higher correlation with outcome behavior, it may do so because it is assessing the broader peer group, not just the behavior of a few selected peers that would be captured in a direct measurement method. Furthermore, given that adolescents have rapidly changing affiliations and friendships (Warr, 2002), self-report of peer delinquency may more accurately reflect the current state of the peer group. It is also the case that the pattern of results seen here, with peer characteristics being linked to changes in behavior, could be due to peer selection processes (i.e., individuals selecting friends on the basis of their own delinquency or substance use), due to socialization into problem behavior by this peer group, or some combination thereof. Temporally, our measure of peer delinquency comes before our measure of problem behavior, which provides some evidence for peer socialization processes underlying the pattern of findings here.

Finally, the communities in the present study were medium to small towns (populations less than 50,000), which may limit generalizability. However, while levels of risk factors and problem behaviors may vary across urban and rural areas, the processes and associations between risk and problem behaviors appear to be identical (Oetting, 1997). Thus, it is reasonable to believe that developmental processes and pathways towards co-occurring problem behavior observed here would operate similarly in other contexts.

Adolescents who become engaged in co-occurring problem behavior are at risk for a number of developmental problems (Duberstein Lindberg et al., 2000). The present study indicates that there are common developmental pathways to co-occurring problem behavior and suggests that prevention and intervention approaches that target early delinquency may be successful in disrupting this developmental sequence. Once youth are involved in either delinquency or substance use, they appear to be more vulnerable to co-occurring problem behavior when exposed to any peers who engage in these problem behaviors. Further, once co-occurring problem behavior has onset, it is highly likely to continue. Thus, universal interventions may be best utilized to prevent delinquency, while indicated preventive interventions with those who have already initiated delinquent behavior may be necessary to prevent escalation to co-occurring problem behavior during adolescence.

Acknowledgments

This work was supported by a research grant from the National Institute on Drug Abuse (R01 DA015183-03), with co-funding from the National Cancer Institute, the National Institute of Child Health and Human Development, the National Institute of Mental Health, the Center for Substance Abuse Prevention, and the National Institute on Alcohol Abuse and Alcoholism. The content of this paper is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

References

- Akers, RL. Deviant behavior: A social learning approach. Belmont, CA: Wadsworth; 1977.
- Brown, BB.; Larson, J. Peer relationships in adolescence. In: Lerner, RM.; Steinberg, L., editors. Handbook of adolescent psychology, Vol. 2: Contextual influences on adolescent development. 3rd ed. Hoboken, NJ: John Wiley & Sons; 2009. p. 74-103.
- Brown EC, Graham JW, Hawkins JD, Arthur MW, Abbott RD, Oesterle S, Baldwin MM. Design and analysis of the Community Youth Development Study longitudinal cohort sample. Evaluation Review. 2009; 33:311–334. [PubMed: 19509119]

- Bui KVT, Ellickson PL, Bell RM. Cross-lagged relationships among adolescent problem drug use, delinquent behavior, and emotional distress. *Journal of Drug Issues*. 2000; 30:283–303.
- Chassin L, Flora DB, King KM. Trajectories of Alcohol and Drug Use and Dependence From Adolescence to Adulthood: The Effects of Familial Alcoholism and Personality. *Journal of Abnormal Psychology*. 2004; 113(4):483–498. [PubMed: 15535782]
- Chassin, L.; Hussong, A.; Beltran, I. Adolescent substance use. In: Lerner, RM.; Steinberg, L., editors. *Handbook of adolescent psychology: Vol. 1. Individual bases of adolescent development*. 3rd ed. Hoboken, NJ: John Wiley & Sons; 2009. p. 723–763.
- Chassin L, Presson CC, Pitt SC, Sherman SJ. The natural history of cigarette smoking from adolescence to adulthood in a Midwestern community sample: Multiple trajectories and their psychosocial correlates. *Health Psychology*. 2000; 19:223–231. [PubMed: 10868766]
- Del Boca FK, Noll JA. Truth or consequences: the validity of self-report data in health services research. *Addiction*. 2000; 95(Supplement 3):S347–S360. [PubMed: 11132362]
- Dishion T, Spracklen K, Andrews D, Patterson G. Deviancy Training in Male Adolescent Friendships. *Behavior Therapy*. 1996; 27(3):373–390.
- Duberstein Lindberg, L.; Boggess, S.; Williams, S. Multiple threats: The co-occurrence of teen health risk behaviors. 2000. Retrieved January 15, 2011, from <http://www.urban.org/publications/410248.html>
- Elliott DS. Serious violent offenders: Onset, developmental course, and termination -- The American Society of Criminology 1993 Presidential Address. *Criminology*. 1994; 32(1):1–21.
- Farrington, DP. Conduct disorder, aggression, and delinquency. In: Lerner, RM.; Steinberg, L., editors. *Handbook of adolescent psychology: Vol. 1. Individual bases of adolescent development*. 3rd ed. Hoboken, NJ US: John Wiley & Sons; 2009. p. 683–722.
- Federal Bureau of Investigation. *Crime in the United States*. 2010.
- French MT, McGeary KA, Chitwood DD, McCoy CB, Inciardi JA, McBride D. Chronic drug use and crime. *Substance Abuse*. 2000; 21:95–109. [PubMed: 12466650]
- Gillmore MR, Hawkins JD, Catalano RF Jr, Day LE, Moore M, Abbott R. Structure of problem behaviors in preadolescence. *Journal of Consulting and Clinical Psychology*. 1991; 59(4):499–506. [PubMed: 1918552]
- Group, SDR. Community Youth Development Study, Youth Development Survey [Grades 5–7]. Social Development Research Group, School of Social Work, University of Washington; 2005–2007.
- Harford TC, Muthen BO. Adolescent and young adult antisocial behavior and adult alcohol use disorders: A fourteen-year prospective follow-up in a national survey. *Journal of Studies on Alcohol*. 2000; 61(4):524–528. [PubMed: 10928722]
- Hawkins JD, Catalano RF, Arthur MW, Egan E, Brown EC, Abbott RD, Murray DM. Testing Communities That Care: The rationale, design and behavioral baseline equivalence of the Community Youth Development Study. *Prevention Science*. 2008; 9(3):178–190. [PubMed: 18516681]
- Heinze HJ, Toro PA, Urberg KA. Antisocial Behavior and Affiliation With Deviant Peers. *Journal of Clinical Child and Adolescent Psychology*. 2004; 33(2):336–346. [PubMed: 15136198]
- Huba GJ, Bentler PM. Test of a drug use causal model using asymptotically distribution free methods. *Journal of Drug Education*. 1983; 13(1):3–14.
- Huizinga D, Elliott DS. Reassessing the reliability and validity of self-report delinquency measures. *Journal of Quantitative Criminology*. 1986; 2(4):293–327.
- Iannotti RJ, Bush PJ. Perceived vs. actual friends' use of alcohol, cigarettes, marijuana, and cocaine: Which has the most influence? *Journal of Youth and Adolescence*. 1992; 21(3):375–389. [PubMed: 24263849]
- Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future national results on adolescent drug use: Overview of key findings 2009. 2009. from <http://www.monitoringthefuture.org/pubs.html>
- Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future national results on adolescent drug use: Overview of key findings, 2011. 2012. from <http://www.monitoringthefuture.org/pubs.html>

- Kelley BT, Loeber R, Keenan K, DeLamatre M. Developmental Pathways in Boys' Disruptive Delinquent Behavior. *Juvenile Justice Bulletin*. 1997
- Klein MW. Offence specialisation and versatility among juveniles. *British Journal of Criminology*. 1984; 24:185–189.
- Kuperman S, Schlosser SS, Kramer JR, Bucholz K, Hesselbrock V, Reich T, Reich W. Developmental sequence from disruptive behavior diagnosis to adolescent alcohol dependence. *American Journal of Psychiatry*. 2001; 158(12):2022–2026. [PubMed: 11729019]
- Langeheine, R.; Van de Pol, F. Latent Markov models. In: Hagenaars, J.; McCutcheon, editors. *Applied latent class analysis*. Cambridge: Cambridge University Press; 2002. p. 304–344.
- Loeber R, Keenan K, Zhang Q. Boys' Experimentation and Persistence in Developmental Pathways Toward Serious Delinquency. *Journal of Child and Family Studies*. 1997; 6(3):321–357.
- Masyn, KE. Modeling Measurement Error in Event Occurrence for Single, Non-recurring Events in Discrete-Time Survival Analysis. In: Hancock, GR.; Samuels, KM., editors. *Advances in latent variable mixture models*. Charlotte: Information Age Publishing Inc; 2007.
- Matsueda R. The current state of differential association theory. *Crime and Delinquency*. 1988; 34:277–306.
- McGee L, Newcomb MD. General deviance syndrome: Expanded hierarchical evaluations at four ages from early adolescence to adulthood. *Journal of Consulting & Clinical Psychology*. 1992; 60(5): 766–776. [PubMed: 1401392]
- Moffitt T. Adolescence-limited and life-course-persistent antisocial behavior: A developmental taxonomy. *Psychological Review*. 1993; 100(4):674–701. [PubMed: 8255953]
- Moffitt T, Caspi A, Dickson N, Silva P, Stanton W. Childhood-onset versus adolescent-onset antisocial conduct problems in males: Natural history from ages 3 to 18 years. *Development and Psychopathology*. 1996; 8(2):399–424.
- Moffitt T, Caspi A, Harrington H, Milne BJ. Males on the life-course-persistent and adolescence-limited antisocial pathways: Follow-up at age 26 years. *Development and Psychopathology*. 2002; 14(1):179–207. [PubMed: 11893092]
- Monahan KC, Steinberg L, Cauffman E. Affiliation with antisocial peers, susceptibility to peer influence, and antisocial behavior during the transition to adulthood. *Developmental Psychology*. 2009; 45(6):1520–1530. [PubMed: 19899911]
- Muthén, LK.; Muthén, BO. *Mplus user's guide*. 4th ed. Los Angeles: Muthén & Muthén; 2010.
- Odgers C, Moffitt T, Broadbent J, Dickson N, Hancox R. Female and male antisocial trajectories: From childhood origins to adult outcomes. *Development and Psychopathology*. 2008; 20(2):673–716. [PubMed: 18423100]
- Oetting, ER.; Edwards, RW.; Kelly, K.; Beauvais, F. Risk and protective factors for drug use among rural American youth. In: Robertson, EB.; Sluboda, Z.; Boyd, GM.; Beatty, L.; Kozel, NJ., editors. *NIDA Research Monograph, Number 168: Rural Substance Abuse: State of Knowledge and Issues*. Rockville, MD: U.S. Department of Health and Human Services; 1997. p. 90–130.
- Oxford ML, Harachi TW, Catalano RF, Abbott RD. Preadolescent predictors of substance initiation: A test of both the direct and mediated effect of family social control factors on deviant peer associations and substance initiation. *American Journal of Drug and Alcohol Abuse*. 2001; 27(4): 599–616. [PubMed: 11727879]
- Rubin, DB. *Multiple imputation for nonresponse in surveys*. New York: Wiley; 1987.
- Schafer, JL. *NORM for Windows 95/98/NT*. University Park, PA: Center for the Study and Prevention through Innovative Methodology at Pennsylvania State University; 2000.
- Schafer JL, Graham JW. Missing data: Our view of the state of the art. *Psychological Methods*. 2002; 7(2):147–177. [PubMed: 12090408]
- Steinberg L, Monahan KC. Age differences in resistance to peer influence. *Developmental Psychology*. 2007; 43(6):1531–1543. [PubMed: 18020830]
- Sutherland, EH. Development of the theory [Private paper published posthumously]. In: Sutherland, EH., editor. *Edwin Sutherland on analyzing crime*. Chicago: University of Chicago Press; 1973. p. 13–29.
- Warr M. Age, peers, and delinquency. *Criminology*. 1993; 31:71–40.

- Warr, M. *Companions in Crime*. Cambridge: Cambridge Studies in Criminology; 2002.
- Weerman FM, Smeenk WH. Peer similarity i delinquency for different types of friends: A comparison using two measurement methods. *Criminology*. 2005; 43:449–524.
- White, HR. The drug use-delinquency connection in adolescence. In: Weisheit, RA., editor. *Drugs, crime and the criminal justice system*. Academy of Criminal Justice Sciences monograph series. Cincinnati, OH: Anderson; 1990. p. 215-256.
- Windle M, Mun EY, Windle RC. Adolescent-to-young adulthood heavy drinking trajectories and their prospective predictors. *Journal of Studies on Alcohol*. 2005; 66:313–322. [PubMed: 16047520]
- Zucker, RA. Pathways to alcohol problems and alcoholism: A developmental account of the evidence for multiple alcoholism and for contextual contributions to risk. In: Zucker, R.; Boyd, G.; Howard, J., editors. *The development of alcohol problems: Exploring the biopsychosocial matrix of risk*. National Institute on Alcohol Abuse and Alcoholism Research Monograph No. 26. Rockville, MD: National Institute on Alcohol Abuse and Alcoholism; 1994. p. 255-289.

Figure 1.

Latent class Markov chain model with time-varying covariates.

Note. Sub. Use = Substance Use. Delinq. = Delinquency.

Table 1

Transitional Probabilities Between Latent Classes

Sixth-grade latent classes (% of sample)	Seventh-grade latent classes			
	Abstainer	Delinquent only	Substance use only	Co-occurring
Abstainer (67.8%)	.74	.20	.02	.03
Delinquent only (22.3%)	.36	.45	.02	.17
Substance use only (2.3%)	.48	.22	.13	.17
Co-occurring (7.6%)	.11	.33	.05	.51
Seventh-grade latent classes (% of sample)	Eighth-grade latent classes			
	Abstainer	Delinquent only	Substance use only	Co-occurring
Abstainer (60.6%)	.72	.19	.03	.06
Delinquent only (26.3%)	.28	.48	.02	.22
Substance use only (2.8%)	.44	.17	.12	.28
Co-occurring (10.3%)	.08	.19	.06	.68
Eighth-grade latent classes (% of sample)	Ninth-grade latent classes			
	Abstainer	Delinquent only	Substance use only	Co-occurring
Abstainer (53.0%)	.75	.18	.04	.04
Delinquent only (26.5%)	.32	.47	.04	.18
Substance use only (3.6%)	.26	.18	.27	.29
Co-occurring (16.9%)	.10	.21	.09	.60
Ninth-grade latent classes (% of sample)	Tenth-grade latent classes			
	Abstainer	Delinquent only	Substance use only	Co-occurring
Abstainer (50.7%)	.63	.25	.06	.06
Delinquent only (25.9%)	.29	.42	.05	.24
Substance use only (5.7%)	.22	.06	.33	.40
Co-occurring (17.7%)	.06	.13	.11	.70

Note. Bold numbers reflect stable group memberships across grades. Percentage of sample per latent class 10th grade. Abstainer 42.0%; Delinquent only 25.9%; Substance use only 8.1%; Co-occurring 24.0%.

Table 2

Effects of Peer Delinquency and Substance Use on Transitioning From Abstaining to Single Problem Behavior

Covariate	<i>Transitioning from abstaining to delinquent only ^a</i>		<i>Transitioning from abstaining to substance use only ^a</i>	
	b (SE)	p value	b (SE)	p value
Peer delinquency	0.16(.04)	<0.001	−0.47(.12)	<0.001
Peer substance use	−0.08(.04)	0.06	0.26(.07)	<0.001
	r	p value	r	p value
Range of correlation between peer delinquency and substance use across age	0.14 – 0.59	<0.001	0.14 – 0.59	<0.001

^a Reference group is individuals who remain in the abstaining class.

Table 3
Effects of Peer Delinquency and Substance Use on Transitioning to Co-occurring Problem Behavior

Covariate	Transitioning from abstaining to co-occurring <i>a</i>		Transitioning from delinquent only to co-occurring <i>b</i>		Transitioning from substance use only to co-occurring <i>c</i>	
	b (SE)	p value	b (SE)	p value	b (SE)	p value
Peer delinquency	0.19(0.05)	<0.001	0.15(0.04)	<0.001	0.21(0.06)	<0.001
Peer substance use	0.36(0.04)	<0.001	0.28(0.04)	<0.001	0.36(0.05)	<0.001
	r	p value	r	p value	r	p value
Range of correlation between peer delinquency and substance use across age						
	0.14 – 0.59	<0.001	0.14 – 0.59	<0.001	0.14 – 0.59	<0.001

^a Reference group is individuals who remain in the abstaining class.

^b Reference group is individuals who remain in the delinquent only class.

^c Reference group is individuals who remain in the substance use only class.

Table 4

Effects of Peer Delinquency and Substance Use on Transitioning From Single Problem Behavior to Abstaining

Covariate	<i>Transitioning from delinquent only to abstaining^a</i>		<i>Transitioning from substance use only to abstaining^b</i>	
	b (SE)	p value	b (SE)	p value
Peer delinquency	−0.21(.05)	<0.001	−0.41(.08)	<0.001
Peer substance use	−0.31(.05)	<0.001	−0.31(.06)	<0.001
	r	p value	r	p value
Range of correlation between peer delinquency and substance use across age	0.14 – 0.59	<0.001	0.14 – 0.59	<0.001

^aReference group is individuals who remain in the delinquency only class.

^bReference group is individuals who remain in the substance use only class.

Effects of Peer Delinquency and Substance Use on Transitioning From Co-occurring Problem Behavior to Single Problem Behavior or Abstaining

Table 5

Covariate	Transitioning from co-occurring to abstaining ^a		Transitioning from co-occurring to delinquent only ^a		Transitioning from co-occurring to substance use only ^a	
	b (SE)	p value	b (SE)	p value	b (SE)	p value
Peer delinquency	−0.29(0.07)	<0.001	0.12(0.04)	0.002	−0.36(0.09)	<0.001
Peer substance use	−0.31(0.05)	<0.001	−0.14(0.04)	<0.001	0.13(0.07)	0.06
	r	p value	r	p value	r	p value
Range of correlation between peer delinquency and substance use across age						
	0.14 – 0.59	<0.001	0.14 – 0.59	<0.001	0.14 – 0.59	<0.001

^aReference group is individuals who remain in the co-occurring class.