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Consequences of an Adolescent Onset and Persistent Course of Alcohol Dependence in Men: Adolescent Risk Factors and Adult Outcomes

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Abstract

Background—While there is an extensive literature on the correlates of alcohol use disorders (AUD; alcohol abuse and dependence), there are relatively few prospective studies of representative birth cohorts that have examined the unique effects of an adolescent onset and persistent course of AUD on a wide range of psychosocial variables.

Methods—A longitudinal, community-based sample of 530 men was used to examine the impact of an adolescent onset (AUD+ at age 17) and persistent course (AUD+ at age 29) of AUD on adolescent and adult functioning including substance use, antisocial behavior, mental health problems, overall psychosocial functioning, environmental risk and protective factors, and social outcomes such as peer and romantic relationships, marriage, educational and occupational attainment, and parenthood.

Results—An adolescent onset of AUD ($n = 57$) was associated with severe deficits across multiple domains of psychosocial functioning in adolescence. Measures of behavioral disinhibition in adolescence were strong predictors of a persistent course of AUD ($n = 93$). Nearly 40% of men with an adolescent onset were able to desist by age 29, and were similar, but not identical to men who never experienced an AUD in terms of adult functioning. Men with an adolescent onset and persistent course of AUD exhibited the most severe deficits in functioning.

Conclusion—Results emphasize the importance of examining developmental course to understand the etiology of AUD. Our findings are optimistic in that individuals who desist from AUD are able to achieve high levels of psychosocial functioning. Our findings suggest that future research on the persistence of AUD into adulthood should focus on the contributions of behavioral disinhibition and social environment variables including peer and romantic relationships.

Alcohol use disorders (AUD; i.e., *DSM*-defined alcohol abuse and dependence; American Psychiatric Association, 1994) are a major public health concern associated with various problems including auto accidents (Chou et al., 2006), violence and criminality (Caetano et al., 2001; Collins, 1981; Greenfield & Weisner, 1995), medical and mental health problems (Chou et al., 1996; Grant et al., 2004; Mertens et al., 2003), reduced educational attainment (King et al., 2006; Chatterji, 2006; Turnbull et al., 1990; Wood et al., 2000), and marital discord (Kearns-Bodkin & Leonard, 2005; Turnbull et al., 1990) resulting in substantial economic costs and lost productivity (Harwood et al., 1998; Rice, 1993). AUD is highly prevalent especially among men. Specifically, the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) reported a 12-month prevalence rate of 12.4% (6.9% alcohol abuse,

5.4% alcohol dependence) and a lifetime prevalence rate of 42.0% (24.6% alcohol abuse, 17.4% alcohol dependence) for AUD in men (Hasin et al., 2007).

Due to such a high prevalence, AUD captures a clinically heterogeneous population. Consequently, alcohol researchers have sought to clarify this heterogeneity by identifying subtypes of alcoholics (Babor, 1996). A consistent theme across multiple typology systems (Babor et al., 1992; Cloninger, 1987; Zucker et al., 1994) is an early onset type characterized by antisocial behavior, polysubstance abuse, and more severe dependence (Type II), and a later onset type (Type I) that tends to exhibit elevated negative affect but less severe dependence, antisocial behavior, comorbid substance use, and fewer childhood risk factors (e.g., conduct and attention problems). Empirical findings generally support this distinction with some evidence that Type II is also more familial and heritable (Babor et al., 1992; Cloninger et al., 1981). One limitation of this research noted by Clark (2004), however, is that it tends to be retrospective, focused on adults with chronic alcohol dependence that are defined as early onset using varying criteria (e.g., up to age 25: Cloninger, 1987; up to age 30; Schuckit et al., 1993). Instead, a prospective study of a representative birth cohort is needed to examine the impact of an early onset of AUD on adult functioning, and to distinguish these effects from the consequences of a persistent course of AUD.

Developmental Perspective of AUD: Onset and Persistence

It is also necessary to devote more attention to the onset of AUD during the transition between late adolescence and young adulthood. The prevalence of AUD increases steadily throughout adolescence, but is followed by a dramatic increase between the late teens and early 20s (Chassin et al., 2004; Chen & Kandel, 1995; Johnston et al., 2001). A near equally dramatic decline in AUD prevalence then follows from the mid to late 20s (Chassin et al., 2004; Chen & Kandel, 1995; Johnstone et al., 1996) as individuals begin to take on adult responsibilities incompatible with continued substance abuse (e.g., marriage, fatherhood, greater demands at work). This pattern of especially high rates of AUD in the early 20s followed by marked declines in the late 20s has led some researchers to describe AUD as a “developmental disorder of young adulthood” (Sher & Gotham, 1999). This indicates that adolescence and young adulthood are developmentally distinct periods, and failure to distinguish onset of AUD for these two periods will likely obscure important differences (Clark, 2004). For example, Clark et al. (1998) found that compared to adults with a substance use disorder (SUD) who reported an adult onset, adolescents with a SUD and adults with a SUD who reported an adolescent onset exhibited an earlier age of initiation of use, faster progression to dependence, and higher rates of comorbid disorders. An important gap in the literature is the paucity of prospective studies that examine the impact on later adult psychosocial functioning of an adolescent onset of AUD compared to a more common onset of AUD in young adulthood (Clark, 2004).

In addition to onset, another important developmental construct is that of a persistent versus desistent course of AUD. Taking a developmental psychopathology perspective, disorders can be profitably conceptualized as deviations from normative developmental processes (Cicchetti, 1993). As such, AUD that begins too early (i.e., in adolescence) and persists too long (i.e., into the late 20s) relative to the normative developmental trajectory is most likely to be indicative of a psychopathologic condition with concomitant detrimental effects on psychosocial functioning. In particular, it is important to distinguish the long-term effects of an adolescent onset from those due to the persistent course of AUD, a topic that has yet to receive sufficient analysis. As a corollary, little is understood about the impact of AUD that exhibits a desistent course. More specifically, can individuals recover from the deleterious effects of an adolescent onset of AUD?

Etiology of AUD: Importance of Behavioral Disinhibition

Multiple etiological factors contribute to AUD. Substantial evidence, however, indicates that behavioral disinhibition is a key developmental pathway to substance use disorders, especially those with an early onset (Iacono et al., 2008). Behavioral disinhibition is conceptualized as a general liability dimension expressed as a spectrum of traits, disorders, and behaviors that reflect an inability to inhibit socially undesirable or restricted actions (Iacono et al., 2008; Krueger et al., 2007). Behavioral disinhibition is initially expressed as disruptive behavior disorders in childhood, followed by early initiation and rapid escalation of substance use and antisocial behavior in adolescence, and finally substance use disorders and antisocial personality disorder in adulthood. Twin studies have shown that behavioral disinhibition is highly heritable and accounts for the comorbidity among different substance use disorders and antisocial behavior (Kendler et al., 2003; Krueger et al., 2002; Young et al., 2000). Behavioral disinhibition is also associated with neurocognitive deficits (Morgan & Lilienfeld, 2000; Raine et al., 2005) and exposure to psychosocial risk such as academic problems, deviant peer affiliation, and family-level stressors (poverty, marital discord among parents, parental substance use disorders, and poor parent-child relationship quality) (Blazei et al., 2006). While behavioral disinhibition is clearly implicated in early onset substance use disorders, its role in the persistence of substance use disorders is less delineated. For example, desistence of AUD in early adulthood is associated with marriage, a stable job, and educational attainment (Bachman et al., 1997). Rather than a causal effect of role transitions, however, these associations could be due to selection processes such that disinhibited individuals are less likely to assume the typical responsibilities of adulthood. As such, one of our primary goals was to examine whether behavioral disinhibition in adolescence predicted a persistent course of AUD after controlling for an early onset.

Given the link between early onset substance use disorders and behavioral disinhibition, we used the framework of their known correlates to organize our examination of the associations between adolescent AUD and multiple domains of adolescent psychosocial functioning. While each psychosocial outcome has already been linked with AUD, our goal was to examine associations with the course variables of onset and persistence. We grouped our available measures into 3 broad categories including substance use and mental health problems (antisocial behavior, internalizing distress), overall psychosocial functioning (personality, academic functioning, intellectual ability), and environmental risk and protective factors (parent and family characteristics, stressful life events, deviant peer affiliation). Whenever possible multiple measures were used to assess each domain.

Additionally, we examined the long-term effects of adolescent AUD on adult psychosocial functioning such as substance use and mental health problems and social outcomes associated with a successful transition into adult roles and responsibilities. For example, what is the effect of an adolescent onset of AUD on young adult substance use, mental health, and social outcomes such as educational and occupational attainment, marriage, and parenthood? Another topic that has yet to receive adequate attention is whether risk factors associated with an adolescent onset also portend a persistent course of AUD. That is, after controlling for an early onset, do any adolescent risk factors index mechanisms that contribute to the persistence of AUD? Finally, we sought to identify variables that contribute to the maintenance of active AUD, such as aspects of the social environment like deviant peer affiliation or a romantic partner's attitudes toward substance use.

We sought to answer these questions by tracking the developmental course of AUD in a large community-based birth cohort of men assessed from age 17 to 29. We structured our analyses around the developmental constructs of an adolescence onset (vs. an early adult onset) and a persistent (vs. desistent) course of AUD. Our approach was primarily exploratory in that we compared rationally derived groups (as opposed to empirically derived trajectories) based on

a wide array of variables to further characterize the related but distinct developmental processes of onset and persistence of AUD in terms of risk and protective and adult outcomes. While this approach is useful in identifying patterns and leads for future research, it is limited in regards to drawing causal inferences. Our primary goals were to answer the following questions:

1. What is the association between an adolescent onset of AUD and various domains of psychosocial functioning in late adolescence?
2. What risk factors in adolescence predict a persistent course of AUD?
3. What are the unique effects of an adolescent onset and persistent course of AUD on adult outcomes? That is, does an adolescent onset of AUD have long-term effects on adult psychosocial functioning? Or, can individuals recover such that effects of AUD on adult outcomes are primarily due to a persistent course of AUD?

Materials and Methods

Sample

Participants were twins who constitute the older male cohort of the Minnesota Twin Family Study (MTFS), a longitudinal-epidemiological study investigating the development of substance use disorders and related conditions. Participants enter the study the year they turn 17 years old, and are then offered the opportunity to participate in 3 follow-up assessments. The MTFS design also includes a female twin sample, but this sample has yet to complete the final age 29 assessment. Eligible families were located using publicly available birth records and databases, targeting the birth years from 1972 to 1978. Over 90% of eligible families were located and over 80% of located families agreed to participate. Participating families did not differ from non-participating families in terms of parental occupational status, educational attainment, and history of mental health treatment. Consistent with the demographics of Minnesota for the target birth years, 98% of the twins are Caucasian. All participants provided informed consent or assent as appropriate at the intake and follow-up assessments. An internal review board approved all study protocols. Previous reports provide a comprehensive description of the design and goals of the MTFS (Iacono et al., 1999; Iacono et al., 2006).

The 17-year old intake assessment is followed by assessments at the target ages of 20, 24, and 29. Men who are unable to participate in a given assessment are still recruited to participate in later assessments. The intake assessment covers lifetime symptoms while each follow-up assessment covers the time since the participant's last assessment. Utilizing this procedure, we were able to obtain some follow-up information on virtually all participants [only 16 (2.8%) participants failed to participate in any follow-up assessment]. The participation rates for each assessment are as follows: age 17, 578 (100%); age 20, 481 (83.2%); age 24, 526 (91.0%); age 29, 530 (91.7%). The actual mean ages of participants at the target assessments are as follows: 17.5 ($SD = 0.4$) years, 20.7 ($SD = 0.5$) years, 24.3 ($SD = 1.1$) years, and 29.7 ($SD = 0.6$) years.

For the purposes of analyses, participants were assigned to rationally derived groups based on the onset and persistence of their AUD. AUD was defined as the presence of 2 or more symptoms of *DSM-III-R* (the current diagnostic system at the intake assessment; American Psychiatric Association, 1987) defined alcohol abuse or dependence at a given assessment (a threshold of 2 rather than 3 symptoms was used to increase sensitivity and statistical power). Symptoms of alcohol abuse and dependence were assessed using the Substance Abuse Module (Robins, Baber, & Cottler, 1987) of the Composite International Diagnostic Interview (Robins et al., 1988). Trained staff with at least a bachelor's degree in psychology administered interviews, and a team of 2 clinical graduate students reviewed all interviews prior to assigning symptoms. A reliability study of the diagnostic procedures yielded kappa reliabilities of $>.91$ for diagnoses of alcohol abuse and dependence (Iacono et al., 1999).

Adolescent onset was defined as AUD being present at age 17; early adult onset was defined as AUD first being present at either age 20 or 24. A persistent course was defined as AUD being present at age 29, and at a previous assessment. A desistent course was defined as 0 symptoms of alcohol abuse or dependence at age 29, with AUD being present at a previous assessment. This resulted in 4 groups that characterized different developmental courses of AUD: adolescent onset, persistent course ($n = 35$); adolescent onset, desistent course ($n = 22$); early adult onset, persistent course ($n = 58$); early adult onset, desistent course ($n = 84$). All groups were also compared to a control group who did not exhibit AUD at any assessment ($n = 226$). This approach classified over 80% of men that participated in the age 29 assessment. Participants were excluded from the analysis if onset of AUD was between ages 24 to 29 (a relatively late onset of unknown course; $n = 20$) or if their course of AUD was indeterminate ($n = 85$). For example, if AUD was present between ages 17 to 24 and the participant reported 1 symptom of AUD at the age 29, making it difficult to determine whether the participant was persisting or desisting.

Measures of Adolescent Risk Factors at age 17 and Adult Outcomes at age 29

The 17-year old assessment entails gathering information using multiple methods (interviews, self-reports, rating scales) and informants (self, mother, teacher). At age 17, we grouped our available measures into 3 broad domains of risk factors and psychosocial functioning including: substance use and mental health problems, psychosocial functioning, and environmental risk and protective factors. The measures of substance use and abuse included alcohol, nicotine, and illicit drugs (12 measures) while mental health problems included antisocial behavior and behavioral disinhibition (5 measures), internalizing distress (2 measures), and treatment or hospitalization for an emotional problem (1 measure). Overall psychosocial functioning was assessed using measures of personality (3 measures), academic functioning (achievement, attitudes, and behavior; 4 measures), and intellectual ability (4 measures). Environmental risk and protective factors included parental characteristics (socioeconomic status, psychopathology, and parent-child relationship quality; 6 measures); stressful life events (family-level stressors, school and legal stressors; 3 measures); peer affiliation (2 measures). Outcomes assessed at age 29 again included the domains of substance use (8 measures) and mental health problems (antisocial behavior, major depression, history of treatment for an emotional problem or suicide attempt; 4 measures) as well as social outcomes (marriage, children, educational and occupational attainment; 12 measures) and measures of the current social environment (peer affiliation, romantic partner's drinking and attitudes toward substance use; 5 measures). The various measures are described in the Appendix. Evidence for the validity and reliability for most of the measures has been reported in previous publications that are cited in the Appendix.

Statistical Analysis

The 4 developmental AUD groups were compared on each measure using a 2×2 ANOVA with main effects for Onset (adolescent vs. early adult), Persistent (vs. desistent) course, and the Onset \times Persistent course interaction. Significance levels (i.e., p -values) of the effects and degrees of freedom for the F -statistics were adjusted using linear mixed models (LMM) in SPSS (Peugh & Enders, 2005) to account for the correlated twin observations. Due to the large number of tests, only effects with corrected p -values $< .01$ are described as statistically significant. Interaction terms with p -values $> .10$ were removed from the model. Because LMMs do not provide a straight forward measure of effect size, we use the partial eta squared (η^2) calculated from the unadjusted ANOVA models to index the size of the unique effects of Onset and Persistent course on the dependent variables. That is, the partial η^2 provides a measure of the incremental predictive power of the AUD course variables (Onset and Persistence) after statistically controlling for each other and ever having an AUD. Five of the age 29 outcomes are categorical variables; therefore, odds ratios are used for the effect size

and generalized estimating equations were used to adjust p -values for the correlated twin observations. Additionally, in separate LMMs, all AUD groups were compared to the control group using a dummy coded variable such that the control group was coded as 0 and the respective AUD group was coded as 1.

Results

Substance Use and Mental Health Problems at Age 17

Table 1 provides the means and standard deviations of each AUD group for the substance use, antisocial behavior/behavioral disinhibition, and mental health measures as well as the F -statistics and effect sizes for the main effects of Onset and Persistent course for the 2×2 ANOVAs. An adolescent onset of AUD was associated with every measure of substance use and abuse at age 17. In contrast, the only significant association for a persistent course of AUD (after controlling for an adolescent onset) was for number of intoxications with a trend-level association for access to substances ($p = .015$). Effect sizes for adolescent onset were especially large for measures of drinking and nicotine use. For example, men with an adolescent onset reported drinking alcohol an average of over 2–3 times per month, consuming an average of over 7 drinks per occasion, and over 20 drinks for their maximum consumption while also smoking an average of more than half a pack of cigarettes (i.e., >10) per day. An adolescent onset was also associated with illicit drug use and dependence indicating adolescent AUD is associated with polysubstance use and abuse. Additionally, for number of marijuana uses, the Onset \times Persistent course interaction exhibited trend-level significance, $F(1, 191.4) = 4.0$, $\eta^2 = .024$, $p = .046$, which was due to men with an adolescent onset-persistent course reporting substantially more marijuana uses than all other AUD groups. Compared to the control group, men with an early adult onset reported slightly greater access to substances, a younger age of first drink, drinking greater quantities of alcohol (both on average and maximum consumption), and more intoxications. Men with an early adult onset of AUD, however, were not elevated on any measure of nicotine or illicit drug use and dependence. In contrast, men with an adolescent onset of AUD were significantly different from the control group on every measure of substance use and abuse.

An adolescent onset of AUD was also associated with every measure of antisocial behavior and behavioral disinhibition especially symptoms of adult antisocial behavior (the adult criteria for antisocial personality disorder). Interestingly, a persistent course was also associated with several measures of antisocial behavior and behavioral disinhibition. Also, for scores on the Behavioral Disinhibition scale, the Onset \times Persistent course interaction exhibited trend-level significance, $F(1, 147.9) = 6.0$, $\eta^2 = .035$, $p = .016$, which was due to substantially higher scores for men with an adolescent onset-persistent course compared to all other AUD groups. Notably, men with an early adult onset and persistent course (but not those with an early adult onset and desistent course) differed from the control group on each measure except conduct disorder. Compared to the control group, men with an adolescent onset of AUD were also elevated on nearly all the measures of antisocial behavior. In terms of mental health problems, adolescent AUD exhibited modest associations with a teacher rating of internalizing distress and mental health problems (participating in counseling or treatment for an emotional problem, psychiatric hospitalization), but not symptoms of major depression.

Psychosocial Functioning at age 17: Personality, Academic Functioning, and Intellectual Ability

Table 2 reports the means and standard deviations of the AUD groups and results of the group comparisons for the personality, academic functioning, and intellectual ability measures. There was some evidence of discriminant relations between personality and the AUD groups with lower Behavioral Constraint scores associated with a persistent course, and a trend-level

association ($p = .013$) between Negative Emotionality scores and an adolescent onset. Compared to the control group, only men with a persistent course of AUD exhibited significantly lower Behavioral Constraint scores. An adolescent onset of AUD was associated with lower grade point average (GPA), lower expected educational attainment (e.g., finish high school, 4-year degree, etc.), lower academic engagement and motivation, and more disciplinary problems at school (e.g., tardiness, truancy, suspensions, etc.). Compared to the control group, only men with an adolescent onset of AUD differed on the measures academic functioning, indicating that an adolescent onset of AUD is associated with overall academic dysfunction in late adolescence. A persistent course of AUD was unrelated to academic functioning. In terms of intellectual abilities, an early onset was associated with lower verbal IQ.

Environmental Risk and Protective Factors at age 17

Table 3 reports the means and standard deviations of each AUD group and results of the group comparisons for the environmental measures at age 17. An adolescent onset of AUD was associated with lower scores on a composite of paternal (but not maternal) education, occupational status, and income. An adolescent onset was also associated with worse father-child relationship quality, fewer prosocial peers, and more antisocial peers. An adolescent onset of AUD was also associated with several stressful life events including school problems (e.g., failing a class, suspended), problems due to alcohol or drugs, and legal problems (e.g., trouble with police other than for traffic violations, being arrested). A persistent course of AUD exhibited trend-level associations with paternal externalizing disorder symptoms and antisocial peers (both p 's = .023), but was otherwise unrelated to environmental variables at age 17. Compared to the control group, differences on measures of parental characteristics, stressful life events, and deviant peer affiliation were primarily limited to men with an adolescent onset of AUD, though men with an early onset-persistent course also reported significantly more legal and substance use-related problems at age 17 and trend-level differences for paternal externalizing disorder symptoms ($p = .015$) and antisocial peers ($p = .013$).

Adult Outcomes at age 29

Tables 4 and 5 report the means and standard deviations for each AUD group and the results of the group comparisons on the measures of adult outcomes at age 29 are reported. In terms of drinking measures during period of heaviest use (i.e., lifetime), all AUD groups were significantly higher than the control group. Also, a persistent course (controlling for an adolescent onset) was associated with a greater average quantity and a higher number of drinks for maximum consumption. This indicates that while an adolescent onset is associated with excessive alcohol use, polysubstance abuse, and various other problems at age 17, persistent AUD is associated with continued and even more excessive alcohol use in young adulthood. Regarding substance use and abuse during the mid to late 20s, a persistent course was associated with each measure of alcohol, nicotine, and illicit drug use and abuse. Notably, men with a desistent course (whether adolescent or early adult onset) moderated their drinking patterns to normative levels by age 29 as evidenced by an average number of drinks per occasion that was similar to the control group. Interestingly, an adolescent onset of AUD remained significantly associated with each measure of illicit drug use and abuse as well as with maximum consumption. The association with drug dependence, however, was primarily due to men with an adolescent onset-persistent course reporting an especially high number of symptoms relative to all other AUD groups resulting in a trend-level effect for the Onset \times Persistent course interaction, $F(1, 193.1) = 3.5$, $\eta^2 = .023$, $p = .062$. Notably, compared to the control group, all AUD groups reported a greater number of drug classes used, but relations with all other measures of substance use and abuse were limited to men with a persistent course of AUD.

Regarding mental health and social outcomes, a persistent course of AUD primarily accounts for the continued association between AUD and adult antisocial behavior, legal problems and

problems with alcohol or drugs, and ever being separated or divorced. An adolescent onset of AUD was also associated with a slightly earlier age of cohabiting and fathering a child. Ever being married and age of 1st marriage, however, were unrelated to either onset or persistence of AUD. Additionally, a long-term consequence of an adolescent onset of AUD was lower educational attainment, but neither onset nor persistence of AUD were associated with occupational status or income.

Finally, men's current social environment had a strong and pervasive impact on the persistence of their AUD. Specifically, fewer prosocial peers, more antisocial peers, a greater number of sex partners, and a romantic partner's greater drinking and more permissive attitudes toward substance use were strongly associated with persistent AUD. An adolescent onset of AUD was also associated with antisocial peers, but this was due to a significant Onset \times Persistent course interaction, $F(1, 182.5) = 9.5$, $\eta^2 = .049$, $p = .002$, such that men with an adolescent onset-persistent course had significantly more antisocial peers than all other AUD groups.

Discussion

The Impact of Early Onset AUD on Adolescent Psychosocial Functioning

This is one of the few prospective studies of a community-based birth cohort of men that has attempted to delineate the effects of an adolescent onset and persistent course of AUD on adolescent and young adult psychosocial functioning. We found an adolescent onset of AUD is associated with dramatic deficits in multiple domains of adolescent psychosocial functioning. This was true whether men went on to exhibit a persistent or desistent course of AUD. Boys with adolescent AUD are polysubstance users as evidenced by frequent and excessive use of alcohol and nicotine as well as use and abuse of illicit drugs. The overall finding is consistent with the notion that adolescent substance abuse is indicative of a general propensity to norm violation, that is, behavioral disinhibition. Also consistent with this notion were the strong associations with measures of antisocial behavior and behavioral disinhibition. Boys who would later onset for AUD in early adulthood also reported greater drinking than the control group on each measure of alcohol use at age 17; indicating a vulnerability to more serious alcohol abuse is present in adolescence. Boys whose AUD onset in young adulthood, however, were not elevated on any measure of nicotine or illicit drug use, suggesting either a specific vulnerability to alcohol or protective factors to the general disinhibitory vulnerability in adolescence.

Adolescent AUD also had a strong association with all aspects of academic functioning in adolescence, which likely accounts for its long-term impact on educational attainment in adulthood. Adolescent AUD was also modestly associated with mental health problems including internalizing distress, treatment for an emotional problem, and the personality trait of negative emotionality. Adolescent AUD was also associated with lower verbal IQ, which is consistent with previous research linking mild neuropsychological deficits to childhood onset and persistent antisocial behavior (Moffitt et al., 1993). An adolescent onset also accounted for most of the associations between AUD and environmental variables including parental socioeconomic status, poor parent-child relationship quality, lack of prosocial peers, and deviant peer affiliation. Adolescent AUD was also associated with several stressful life events, though these events may be consequences rather than causes of AUD including school failure and suspensions, contacts with police and legal problems, and other problems due to use of alcohol and drugs.

Adolescent Risk Factors that Predict a Persistent Course of AUD

Measures of behavioral disinhibition in adolescence consistently predicted a persistent course of AUD even after controlling for an adolescent onset of AUD. Men with an early adult onset

and persistent course provide especially compelling evidence for this finding, as they exhibited higher scores than the control group on each measure of behavioral disinhibition at age 17 despite not yet meeting criteria for AUD (in contrast, men with an early adult onset and desistent course were not elevated on any measure of behavioral disinhibition at age 17). No other adolescent risk factor was associated with a persistent course of AUD.

Scores of the personality measure Behavioral Constraint exhibited a special sensitivity and specificity to this association as only the two persistent groups had lower scores than the control group. This is notable as men with an adolescent onset and desistent course reported engaging in more antisocial acts at age 17, but exhibited less deviant scores on personality-based measures of behavioral disinhibition (i.e., Behavioral Constraint and the Behavioral Disinhibition scale). This suggests that behavioral disinhibition is a trait-like characteristic that includes cognitive and affective components (not just behavior as measured diagnostic interviews and behavioral checklists) of a general psychological orientation to the world that is stable across time and predictive of various important life outcomes. Also notable was that men with adolescent onset and persistent AUD exhibited the most extreme scores on each measure of behavioral disinhibition at both age 17 and 29, indicating behavioral disinhibition is key risk factor for both an adolescent onset and persistent course of AUD. Not coincidentally, men with adolescent onset and persistent AUD exhibited the greatest impairment in virtually all domains of psychosocial functioning in both adolescence and adulthood.

The Unique Effects of an Adolescent Onset and Persistent Course of AUD on Adult Psychosocial Functioning: Can men recover from AUD?

This is one of the few studies to parse the unique effects of onset and persistence of AUD on adult outcomes, and the results are especially illuminating as onset and persistence exhibited an interesting pattern of differential effects. Perhaps not surprisingly, persistence of AUD seems to be the major factor in continued overall substance use including nicotine and illicit drug use. An adolescent onset, however, was also associated with maximum consumption for alcohol and measures of drug use during the mid to late 20s (though the association with drug dependence symptoms is moderated by a persistent course of AUD). This indicates that an adolescence onset of AUD has a long-lasting impact on men's substance use patterns. However, men with a desistent course of AUD were indistinguishable from the control group in terms of average quantity of drinks of alcohol per occasion during the mid to late 20s (i.e., last 6 years), indicating that even men with adolescent onset AUD can moderate their drinking to normative levels by age 29. Also of note, the mean number of drinks for maximum consumption during period of heaviest use did not differ from age 17 for men with an adolescent onset-desistent course, while all the other AUD groups (including the control group) exhibited dramatic increase on this drinking measure. This suggests that men with an adolescent onset-desistent course may peak relatively early in terms of their alcohol misuse, and that important developmental processes occur early in the transition from adolescence to adulthood that help set the stage for a desistent course. Persistence also accounted for the association between AUD and adult antisocial behavior, further evidence of the strong link between behavioral disinhibition and persistent AUD.

Onset and course of AUD also exhibited an interesting pattern of associations with social outcomes. An adolescent onset of AUD was associated with a slightly earlier age of cohabitation and fathering a child, while a persistent course was associated with ever being separated or divorced. Notably, neither onset nor persistence of AUD was associated with ever being married or age of 1st marriage. This suggests that while an adolescent onset of AUD slightly accelerates the time line for taking on certain adult roles and responsibilities, the impact of these roles and responsibilities on continued alcohol abuse is unclear, and in the case of marriage may relate more to characteristics of the relationship rather than simply entering the

role of spouse. Also, while it appears persistent AUD has a deleterious effect on marriage; the direction of causation of this association remains unclear. More fine-grained analyses of the timing and consequences of these milestones are necessary to determine their causal impact on desistence of AUD.

An adolescent onset of AUD was associated with lower educational attainment. Given the importance of education to various social outcomes, adolescent AUD represents a “snare” that can impede progress along several psychosocial dimensions (Moffitt, 1993). Interestingly, however, the impact of AUD was not detected for occupational status or income. Some have posited that because men with an adolescent onset are more likely to enter the work force early, they initially earn greater income than men who never abuse alcohol or men with a later onset of AUD (Newcomb, 1996; Sher & Gotham, 1999). It will be interesting to examine whether differences in occupational status and income emerge as these men progress through middle adulthood. Persistent AUD was associated with continued legal problems and problems with alcohol or drugs, indicative of ongoing impairment due to active substance abuse.

Though we cannot infer causality based on our current analyses, our measures of the social environment were particularly revealing as to potential mechanisms underlying the persistence of AUD. That is, men who persist in alcohol abuse have fewer prosocial peers, more antisocial peers, and a romantic partner with high levels of alcohol use and more permissive attitudes toward substance use. Perhaps more than most other environmental variables, friendships and romantic relationships are associated with selection and reciprocal effects (Caspi, 2003). That is, men who abuse alcohol are likely to actively or passively select peers and romantic partners who are similar in regards to their substance use, and these relationships reinforce and maintain continued substance abuse. In contrast, men who desist from AUD tend to select peers and romantic partners that do not reinforce continued alcohol abuse, which may be a causal factor in moderating drinking to normative levels. A key area of future research will be to utilize the prospective and genetically informative nature of the MTFs sample to examine the causal effect of peer and romantic relationships on persistence of AUD.

In sum, the answer to the question of whether men can recover from AUD is a qualified yes. At age 29, men with a desistent course of AUD are very similar, but not indistinguishable, from men who never had an AUD. These differences are almost entirely due to the long-term consequences of an adolescent onset of AUD, which primarily impacts educational attainment and to a lesser extent substance use. Notably, a sizeable proportion (38.6%) of men with an adolescent onset desisted by age 29. The finding of their adequate to good psychosocial functioning in adulthood strikes an especially optimistic note given the severity and pervasiveness of their impairments in late adolescence. A key challenge for future research will be to delineate the mechanisms during the transition from adolescence to adulthood that contribute to a persistent versus desistent course. More generally, our findings are consistent with a developmental psychopathology conceptualization of AUD, that is, AUD that occurs too early and persists too long is especially problematic. As such, men with an early adult onset and desistent course of AUD exhibited few pre-morbid risk factors (other than greater drinking) and largely avoided any negative consequences associated with AUD. In contrast, men with an adolescent onset and persistent course of AUD exhibited dramatic deficits across multiple domains of psychosocial functioning. Men with an adolescent onset-desistent course or an early adult onset-persistent course fall somewhere in the middle, with impairments in functioning being greatest during times of active substance abuse. In some ways, these two groups seem to cross each other with one increasing and the other decreasing in terms of psychosocial functioning through young adulthood. It will be interesting to examine if the gap between the two continues to widen.

While our study is well designed, fairly unique, and yielded interesting results, it is not without limitations. First, the sample is composed almost entirely of European American men; as such we make no claims as to the generalizability of our findings to women and other racial/ethnic groups. Also, as might be anticipated for a community-based sample, the number of men with an adolescent onset of AUD was relatively small which limits statistical power to detect differences between the persistent and desistent subgroups. Second, alternative alcohol use phenotypes such as dimensional measures of adverse consequences and heavy drinking may provide more sensitive measures of current and future dysfunction for the period of adolescence than *DSM* alcohol abuse/dependence criteria, categorical system primarily designed for adults and subject to problems of both under- and overinclusiveness. The advantage of using AUDs, however, is that they are the most studied phenotypes of pathological alcohol use, and so provide a common referent for the research literature; are highly correlated with alternative dimensional measures (as seen in the present results); and have broad societal implications such that it is important to study these diagnostic constructs in their specific instantiation. Third, our analyses are largely descriptive as we made few attempts to infer causality, other than to control for the effects of onset and persistent course on each other. Finally, there are more sophisticated statistical approaches to handling longitudinal data that assign all members of the sample to empirically derived trajectory groups as opposed to our strategy of using rationally derived groups, which excluded about 20% of sample members who could not be classified using our criteria. Given the scope and complexity of the problem of AUD, we took this approach because it provided a sound theoretical and statistical framework by which to interpret associations with a large number of potentially relevant variables. Our primary aim was to validate the constructs of onset and persistence for AUD as well as to identify variables that seem important to the etiology of these course variables. Future work will utilize more complex statistical models of longitudinal change as well as other methods to better examine the causal effects of specific variables on both onset and persistence of AUD.

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Appendix of Measures

Substance Use Measures

Assessment of substance use and abuse was conducted using the Substance Abuse Module (SAM) of the Composite International Diagnostic Interview. The SAM includes coverage of nicotine, alcohol, and illicit drug use and abuse. Symptoms of abuse and dependence were assigned based on *DSM-III-R* criteria, the current diagnostic system at the intake assessment. We included several alcohol use measures to help validate the AUD course variables. Age of 1st drink was defined as the age the participant first consumed alcohol without their parent's permission. Frequency of alcohol use in the past year was a 0 to 10 scale (0= never, 1= <1 × year, 2= < 1 × month, 3= 1 × month, 4= 2–3 × month, 5= 1–2 × week, 6= 3–4 × week, 7= 1 × day, 8= 1 × day, 9= 2 × day, 10= >3 × day). Average number drinks are the typical number of drinks a participant consumed per drinking occasion during the past 12 months. Number of intoxications was an estimate the number of times the participant drank to intoxication. Because this variable exhibited substantial positive skew, it was log(x + 1) transformed for analyses, and 100 was used as the maximum value when reporting means and standard deviations in Table 1. Maximum number drinks consumed in 24 hours are the number of standard alcoholic drinks the participant reported consuming in a single day (Malone et al., 2002). Due to positive skew, 50 drinks was set as the maximum value for this variable.

Nicotine use variables included symptoms of nicotine dependence, number of days a participant used nicotine in a typical month (0 to 30 days), and the typical number of cigarettes (or equivalent form of tobacco) smoked in a day. Assessment of illicit drugs included

amphetamines, cannabis, cocaine, hallucinogens, inhalants, opioids, PCP, and sedatives. The drug class for which the participant endorsed the most symptoms was used as their number of drug dependence symptoms. As marijuana was the most prevalent drug of use, we also included number of lifetime marijuana uses as an index of illicit drug use. Due to positive skew, this variable was $\log(x + 1)$ transformed for all analyses, and 100 was set as the maximum value for the means and standard deviations reported in Table 1. The final drug use variable was the number of different drug classes the participant had tried. Scores on this variable ranged from 0 to 4 (or more) drug classes at age 17, and 0 to 5 (or more) drug classes at age 29 (Derringer et al., 2008).

The final substance use variable was access to substances that is a computer administered questionnaire that inquires about accessibility to alcohol, nicotine, and marijuana (e.g., How can you get alcohol? Nicotine? Marijuana? – from home, sibling, friends, could by some, adult could buy for me, etc.). The questionnaire includes 7-items per substance. The mean z-score across substances was taken as an overall measure of access to substances, and converted to a T-score metric.

Antisocial Behavior/Behavioral Disinhibition

Measures of antisocial behavior and behavioral disinhibition were obtained from structured clinical interviews and self-report questionnaires. Antisocial personality disorder was assessed using a structured interview designed by MTFs staff compared to the Structured Clinical Interview for DSM-III-R Axis II. Symptoms were rated as absent (0), present at subthreshold (0.5), and present at full threshold (1). The child and adult symptoms were separated to provide measures of conduct disorder and adult antisocial behavior, respectively. Early adolescent problem behavior is a sum of 5 behaviors that occurred before age 15: alcohol use, nicotine use, drug use, police contact, and sexual intercourse (McGue & Iacono, 2005). The substance use measures were obtained from responses to questions on the SAM. Police contact (involvement with the police other than for traffic violations) and sexual intercourse were obtained from responses to questions on the Life Events Interview, structured interview inquiring about various events and stressors (Bilig et al., 1996; Bemmels et al., 2008). The Delinquent Behavior Inventory is a 36-item (Cronbach's $\alpha = .96$) self-report measure regarding various antisocial acts in adolescence (Taylor et al., 2000). The Behavioral Disinhibition scale is a 12-item scale (Cronbach's $\alpha = .67$) derived from the Socialization scale of the California Personality Inventory that includes personality and behavioral based items related to behavioral disinhibition (Taylor et al., 1999).

Mental Health

Symptoms of major depressive disorder were ascertained from the Structured Clinical Interview for *DSM-III-R* (SCID-III-R). Symptoms were coded as absent (0), subthreshold (0.5), and full threshold (1) with a diagnostic kappa reliability of .89. The teacher rating of internalizing distress is a 12-item scale obtained from teachers regarding anxiety, depression, and stress reaction (Cronbach's $\alpha = .85$, inter-rater reliability = .66; Hicks et al., in press). The teacher rating of internalizing distress is reported in a T-score metric. The mental health problems variable is a sum of items from the LEI that includes ever receiving counseling or treatment for an emotional problem and ever being hospitalized for a psychiatric condition. Mental health problems at age 29 also included ever attempting suicide.

Personality

Personality was assessed using the Multidimensional Personality Questionnaire (MPQ; Tellegen & Waller, 2008). The MPQ is a well-validated omnibus measure of normal-ranger

personality traits that includes 11 primary scales and 3-higher order factors including Positive Emotionality, Negative Emotionality, and Behavioral Constraint. Positive Emotionality is an index of an individual propensity to experience positive emotions by affiliating with others, influencing others, and striving to accomplish goals as well as overall feelings of subjective well-being. Negative Emotionality is an index of a person's tendency to experience anxiety and worry, to break down easily under stress, to feel victimized and suspicious of others, and to be aggression, hostile, and vindictive. Behavioral Constraint is a reverse measure of behavioral disinhibition and reflects a person's tendency to be cautious and planful, to avoid thrills and danger, and to endorse conventional social norms and values. Cronbach α 's for the 3 factors are $>.85$ and 30-day test-retest reliabilities are $.89$. All personality variables are reported in a T-score metric.

Academic Functioning

Academic functioning was assessed using the Academic History Questionnaire (Johnson et al., 2006), a form completed by both the participant and their mother. Scores for the participant and mother were averaged for each variable which included: cumulative grade point average (GPA; $r = .80$ between participant and mother reports, and $r = .89$ with actual student transcripts); ratings regarding their expectation of the twin's ultimate educational attainment (e.g., complete high school, complete college, etc.; $r = .64$ between participant and mother report); a 7-item scale regarding positive attitudes and engagement in school (e.g., has a good attitude about school, enjoys attending school; $\alpha = .83$); a 7-item scale regarding disciplinary actions due to rule breaking (e.g., detention, sent to principal's office, sent home, suspended, expelled; $\alpha = .85$). The academic engagement and disciplinary problems variables were converted to a T-score metric.

Intellectual Functioning

Participants completed an abbreviated version of the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981). The abbreviated WAIS-R assessment included two verbal subtests (Vocabulary and Information) and two performance subtests (Block Design and Picture Arrangement). These subtests were selected for their high correlation with overall verbal, performance, and full scale IQ. Participants also completed the reading subtest of the Wide Range Achievement Test Revised (WRAT-R), scores of which provided an estimate reading grade equivalent.

Parent and Family Characteristics

Maternal and paternal education level (number of years), occupational status using the Hollingshead coding system, and annual income (coded on a 1 to 13 scale) were obtained from interviews. An overall measure of socioeconomic status for the participant's family of origin was calculated by taking the mean z-score of parental education level, occupational status, and annual income. Maternal and paternal lifetime symptoms of antisocial behavior and substance use disorders were assessed using the same structured interviews as those completed by their male offspring. Parental externalizing composites were calculated by taking the mean z-score of symptoms of adult antisocial behavior, alcohol, nicotine, and drug dependence. Quality of parent-child relationships was assessed using the Parental Environment Questionnaire (PEQ), a 50-item self-report questionnaire that assesses multiple dimensions of the parent-child relationship (e.g., conflict, involvement; scale α 's range from $.82$ to $.69$; Elkins et al., 1997; McGue et al., 2005). Twins completed separate PEQ ratings regarding their relationship with their mother and father. Parents also rated their relationship with each twin as well as the quality of the relationship between each twin and the other parent (e.g., mother rated the relationship between each twin and their father). Therefore, up to 3 ratings were available for the mother-

child and father-child relationship. The measure of mother-child and father-child relationship problems used in the analyses was the mean of the 3 informant ratings on the first principal component among the PEQ scales (the scales exhibit a dominant 1st component; mean correlation across informants was .41). All parent characteristic variables were converted to a T-score metric to ease interpretation.

Stressful Life Events

Measures of stressful life events were obtained from the LEI completed by each twin. Family-level stressful life events is a tally of 18 life events covering the domains of parental divorce and discord as well as family money, legal, and mental health problems. As these events should be concordant for members of a twin pair, the correlation between twin reports provides an estimate of reliability ($r = .81$; inter-rater reliability was .89; Hicks et al., 2009). School problems included 6 life events: changed schools, failed a course, held back in school, went to summer school, suspended or expelled, and worried about how he was doing in school. Legal problems and problems with alcohol or drugs included 4 life events: trouble with police not for traffic violations, had to go to court, spent time in a juvenile detention center, and gotten into trouble because of use of alcohol or drugs. At age 29, legal problems and problems with alcohol or drugs included 4 life events: trouble with the police other than for traffic violations, had to go to court, spent time in jail, and getting into trouble because of use of alcohol or drugs. Financial problems included 5 life events: receiving money from a government agency, losing a job, being unemployed for 6 months or more, ever having financial problems as an adult, and ever going bankrupt.

Peers

At age 17, peer affiliation was assessed by teacher reports (Walden et al., 2004). Participants nominated 3 current or recent teachers to complete a comprehensive rating form regarding the participant's personality, behavior, grades, and peer group. Teachers rated a given participant's peers on a 5-point scale relative to that participant's classmates (1 = *lowest 5% of students*, 2 = *lower 30% of students*, 3 = *middle 30% of students*, 4 = *upper 30% of students*, 5 = *highest 5% of students*). The teacher ratings included an antisocial peer scale (5-items, $\alpha = .85$; e.g., good fighters, bad influence) and a prosocial scale (5-items, $\alpha = .87$; e.g., good students, involved in school activities). Ratings were averaged across teachers. The inter-rater reliability (intra-class correlation for the mean of two raters) for the teacher ratings was .71.

At age 29, participants completed a 27-item self-report questionnaire describing the members of their peer group with ratings made on a 4-point scale (1 = *None of my friends are like that*, 2 = *Just a few of my friends are like that*, 3 = *Most but not all of my friends are like that*, 4 = *All or nearly all of my friends are like that*). The peers questionnaire included an antisocial peer scale (15-items, $\alpha = .82$; e.g., my friends enjoy getting drunk, get into fights, can't seem to hold a job) and a prosocial peer scale (9-items, $\alpha = .60$; e.g., my friends work hard, do volunteer work, have regular jobs).

Social Outcomes

Social outcomes related to marriage, children, and educational and occupational attainment was obtained from questions from the LEI and the Social Adjustment Interview (SAI). Both the LEI and SAI assess major role transitions and the age at which they occur including moving in with a romantic partner (i.e., cohabitation), marriage, separation or divorce from spouse, and becoming a parent. The LEI at age 29 also inquires about the number of sexual partners since the last assessment (the highest value was set at ≥ 20 to reduce positive skew). The SAI also includes questions to determine educational attainment, occupational status, and annual

income. Educational attainment was coded as a 12-point scale ranging from failing to complete high school to completing a doctorate or professional degree. Occupational status was coded using the Hollingshead system. Income was reported in number of U. S. dollars before taxes with the highest value capped at \geq \$250,000 to reduce positive skew.

Romantic Partner's Drinking and Attitudes toward Substance Use

Participants who were currently married, living with a romantic partner, or currently dating the same person for at least 3 months completed a questionnaire that assessed their romantic partner's drinking patterns over the past 12 months and attitudes toward substance use. Items covering romantic partner's drinking included frequency of drinking (10-point scale from *never* to *3 or more times a day*), average quantity, proportion of time drunk to intoxication (5-point scale from *never* to *every time or nearly every time*). A composite score was calculated by taking the mean z-score for the 3 items and then converted to a T-score metric. Participants also reported how he thought their romantic partner would respond (*Strongly Agree, Agree, Disagree, Strongly Disagree*) to questions on an 11-item scale ($\alpha = .84$) regarding her attitudes toward his substance use (e.g., my spouse/partner would be upset if he/she knew I was smoking; my spouse/partner would purchase alcohol if I asked him/her to; my spouse's/partner's friends use marijuana). Scores on this scale are reported in a T-score metric.

Table 1
Substance Use, Antisocial Behavior/Behavioral Disinhibition, and Mental Health Problems at age 17.

Substance use and abuse	Never (n=226)	Adult Onset, Desist (n=84)	Adult Onset, Persist (n=58)	Adol Onset, Desist (n=22)	Adol Onset, Persist (n=35)	Adolescent Onset (η^2)	Persistent Course (η^2)
Access to substances	46.8 (9.2)	48.5 (7.6)	52.8 (10.5)**	57.8 (8.7)**	60.8 (9.6)**	.159**	.043 [†]
Age of 1 st drink	16.9 (2.5)	15.7 (1.9)*	15.7 (1.9) [†]	13.7 (2.8)**	13.5 (2.0)**	.177**	.000
Frequency alcohol use, past year	2.2 (1.2)	3.1 (1.4)**	3.3 (1.6)**	5.0 (1.2)**	5.3 (1.1)**	.285**	.012
Average number of drinks, past year	0.9 (2.7)	1.9 (3.0)*	2.4 (3.5)**	7.4 (4.7)**	7.9 (4.8)**	.305**	.004
# Intoxications	1.6 (7.4)	3.0 (5.9) [†]	7.4 (16.1)**	31.5 (30.1)**	43.4 (35.1)**	.442**	.044*
Maximum # drinks 24 hours	3.4 (5.3)	6.7 (6.7)**	8.4 (7.2)**	21.2 (9.2)**	22.9 (9.3)**	.416**	.012
Nicotine use (# days per month)	4.4 (9.3)	6.6 (10.2)	7.9 (10.4)	20.8 (12.4)**	23.0 (11.7)**	.275**	.005
# Cigarettes smoked per day	1.9 (5.9)	1.8 (3.8)	3.2 (8.6)	12.3 (12.8)**	11.7 (10.2)**	.218**	.003
Nicotine dependence	0.3 (1.1)	0.3 (1.1)	0.4 (0.8)	2.3 (2.4)**	3.2 (2.3)**	.329**	.017
# Marijuana uses	2.4 (14.8)	3.7 (16.3)	1.7 (9.3)	9.8 (23.4)**	22.6 (36.4)**	.178**	.017
# Different drug classes tried	0.2 (0.8)	0.3 (0.6)	0.3 (0.6)	1.1 (1.7)**	1.4 (1.7)**	.162**	.003
Drug dependence	0.1 (0.8)	0.2 (1.0)	0.1 (0.8)	0.7 (1.4)*	1.1 (2.2)**	.065**	.001
Antisocial Behavior/Behavioral Disinhibition							
Early adolescent problem behavior	0.7 (0.9)	1.0 (1.0)	1.1 (0.9)*	1.7 (1.3)**	2.5 (1.3)**	.167**	.038 [†]
Delinquent behavior inventory	3.2 (3.1)	4.0 (3.2)	5.8 (3.9)**	7.6 (5.5)**	11.7 (5.5)**	.187**	.081**
Behavioral disinhibition scale	2.6 (2.0)	3.1 (2.2)	3.7 (2.1)**	4.3 (3.0) [†]	6.9 (2.2)**	.140**	.080*
Conduct disorder	1.2 (1.6)	1.7 (2.0)	1.9 (1.8)**	3.2 (2.5)**	3.4 (2.2)**	.101**	.004
Adult antisocial behavior	0.5 (0.8)	0.5	1.1 (1.0)**	2.4 (1.9)**	3.0 (1.6)**	.321**	.043*
Mental Health Problems							
Major Depression	0.8 (2.0)	0.4 (1.1)	0.7 (1.8)	1.1 (2.6)	1.1 (2.1)	.022	.005
Teacher rating internalizing	52.5 (10.8)	52.8 (11.4)	53.1 (11.0)	60.2 (12.4)*	58.3 (13.3) [†]	.048 [†]	.001
Treatment for emotional problem	0.1 (0.3)	0.1 (0.3)	0.2 (0.4)	0.5 (0.6)**	0.4 (0.6)*	.056*	.000

[†] $p < .05$;

*
 $p < .01$;
**
 $p < .001$.

Adol = Adolescent. Adol onset = AUD present at age 17; Adult onset = AUD present at age 20 or 24; Persist = AUD present at age 29; Desist = 0 AUD symptoms at age 29. Values in the columns for the AUD groups are the means and standard deviations for the respective group and measure. Symbols indicating significance levels on these values indicate whether the mean for the given AUD group is significantly different from the mean of the Never group (i.e., individuals who never meet criteria for an AUD between age 17 to 29). The partial eta squared (η^2) in the Adolescent Onset and Persistent Course columns are a measure of predictive power of the given variable after controlling for the other.

Table 2
 Psychosocial Functioning Indexed by Personality, Academic Functioning, and Intellectual Ability at age 17.

	Never (n=226)	Adult Onset, Desist (n=84)	Adult Onset, Persist (n=58)	Adol Onset, Desist (n=22)	Adol Onset, Persist (n=35)	Adolescent Onset (η^2)	Persistent Course (η^2)
<u>Personality</u>							
Positive Emotionality	49.9 (9.9)	50.3 (8.4)	50.6 (8.1)	52.7 (7.7)	52.2 (9.5)	.009	.000
Negative Emotionality	49.9 (9.4)	52.0 (8.7)	49.6 (8.7)	54.8 (8.5) [†]	54.3 (10.6) [†]	.034 [†]	.011
Behavioral Constraint	49.1 (8.8)	48.3 (9.3)	43.6 (8.8)**	46.6 (11.5)	42.2 (6.4)**	.005	.060*
<u>Academic Functioning</u>							
GPA	2.9 (0.7)	2.9 (0.8)	2.7 (0.7)	2.0 (1.0)**	2.2 (0.7)**	.129**	.001
Expected attainment	4.7 (0.9)	4.8 (1.0)	4.7 (0.9)	3.8 (1.3)**	3.9 (1.1)**	.129**	.001
Engagement	49.8 (8.7)	50.2 (9.2)	48.8 (9.8)	38.3 (12.8)**	39.8 (12.6)**	.160**	.001
Disciplinary problems	49.8 (9.2)	49.9 (10.4)	51.7 (10.8)	59.6 (9.8)**	58.0 (10.0)**	.100**	.002
<u>Intellectual Ability</u>							
Verbal IQ	101.0 (13.8)	99.7 (13.2)	97.6 (12.6) [†]	91.3 (12.0) [†]	92.7 (8.6) [†]	.053*	.002
Performance IQ	108.4 (17.1)	110.2 (16.1)	107.8 (17.1)	102.6 (13.5)	110.5 (18.9)	.004	.005
Full scale IQ	104.5 (14.4)	104.3 (12.6)	101.9 (12.9)	95.6 (9.8)	99.9 (11.3)	.037 [†]	.001
Reading grade equivalent	10.1 (2.2)	10.0 (2.1)	10.1 (2.3)	9.3 (2.8)	9.6 (2.7)	.011	.000

[†] $p < .05$;

* $p < .01$;

** $p < .001$.

Adol = Adolescent. Adol onset = AUD present at age 17; Adult onset = AUD present at age 20 or 24; Persist = AUD present at age 29; Desist = 0 AUD symptoms at age 29. Values in the columns for the AUD groups are the means and standard deviations for the respective group and measure. Symbols indicating significance levels on these values indicate whether the mean for the given AUD group is significantly different from the mean of the Never group (i.e., individuals who never meet criteria for an AUD between age 17 to 29). The partial eta squared (η^2) in the Adolescent Onset and Persistent Course columns are a measure of predictive power of the given variable after controlling for the other.

Table 3

Environmental Risk and Protective Factors at age 17.

	Never (n=226)	Adult Onset, Desist (n=84)	Adult Onset, Persist (n=58)	Adol Onset, Desist (n=22)	Adol Onset, Persist (n=35)	Adolescent Onset (η^2)	Persistent Course (η^2)
<u>Parent Characteristics</u>							
Mother education, occupational status, and income	50.2 (10.1)	50.1 (10.1)	50.9 (11.8)	48.8 (8.6)	45.7 (8.8) †	.024	.000
Father education, occupational status, and income	50.7 (9.8)	52.6 (10.7)	51.8 (11.0)	47.4 (8.7)	43.9 (7.6)**	.090**	.007
Mother Externalizing	48.6 (8.4)	49.1 (9.4)	51.2 (12.3)	55.9 (13.1)*	50.9 (8.8)	.018	.004
Father Externalizing	48.2 (8.1)	48.1 (8.7)	52.9 (12.6) †	51.3 (16.5)	55.4 (10.1)*	.012	.039†
Mother-child relationship quality	50.6 (8.4)	48.9 (9.3)	49.0 (8.9)	44.7 (16.4)*	44.8 (10.8)*	.031	.000
Father-child relationship quality	52.0 (8.3)	51.5 (8.3)	52.0 (7.7)	44.2 (13.3)*	45.6 (10.3)**	.097**	.002
<u>Stressful life events</u>							
Family-level stressful life events	2.2 (2.5)	2.2 (2.5)	3.0 (2.9)	3.7(3.3)	3.6 (3.3) †	.024	.008
School problems	1.0 (1.6)	1.0 (1.8)	1.5 (2.0) †	2.3 (2.3) †	2.7 (2.4)**	.075**	.015
Legal and alcohol/drug problems	0.2 (0.6)	0.3 (0.8)	0.6 (1.1)*	2.0 (1.6)**	2.0 (1.4)**	.267**	.008
<u>Peers</u>							
Prosocial peers	51.7 (9.2)	53.1 (9.4)	50.3 (10.6)	43.1 (12.1)*	42.2 (10.0)**	.130**	.012
Antisocial peers	47.8 (8.1)	47.8 (8.0)	52.0 (10.1) †	60.3 (13.4)**	63.7 (13.3)**	.210**	.036†

† $p < .05$;* $p < .01$;** $p < .001$.

Adol = Adolescent. Adol onset = AUD present at age 17; Adult onset = AUD present at age 20 or 24; Persist = AUD present age 29; Desist = 0 AUD symptoms at age 29. Values in the columns for the AUD groups are the means and standard deviations for the respective group and measure. Symbols indicating significance levels on these values indicate whether the mean for the given AUD group is significantly different from the mean of the Never group (i.e., individuals who never meet criteria for an AUD between age 17 to 29). The partial eta squared (η^2) in the Adolescent Onset and Persistent Course columns are a measure of predictive power of the given variable after controlling for the other.

Table 4

Substance Use and Mental Health Outcomes at age 29.

	Never (n=226)	Adult Onset, Desist (n=84)	Adult Onset, Persist (n=58)	Adol Onset, Desist (n=22)	Adol Onset, Persist (n=35)	Adolescent Onset (η^2)	Persistent Course (η^2)
<u>Period of heaviest use</u>							
Average number of drinks	4.8 (2.8)	6.6 (3.1)**	9.3 (2.8)**	8.3 (2.7)**	9.4 (3.1)**	.019	.074**
Max # drinks in 24 hours	13.3 (7.7)	18.9 (7.9)**	25.4 (8.5)**	21.2 (7.1)**	27.9 (10.3)**	.016	.127**
<u>Substance Use Last 6 years</u>							
Average number of drinks	2.8 (2.0)	3.2 (1.8)	5.9 (2.8)**	3.3 (2.3)	6.9 (3.1)**	.012	.265**
Max # drinks in 24 hours	9.6 (6.8)	9.9 (4.5)	20.7 (6.7)**	12.6 (7.5)†	24.5 (10.4)**	.046*	.394**
Nicotine dependence	0.8 (1.5)	1.0 (1.6)	2.0 (2.0)**	1.4 (2.2)	2.5 (2.0)**	.013	.072**
# Marijuana uses	7.1 (24.2)	8.7 (25.0)	19.7 (35.7)**	23.0 (42.7)†	45.8 (48.0)**	.051*	.083**
# Different drug classes used	0.6 (1.1)	1.1 (1.6)*	1.9 (2.2)**	2.1 (2.3)**	2.9 (2.5)**	.050*	.034†
Drug dependence	0.1 (0.8)	0.3 (1.4)	0.7 (1.8)**	0.5 (1.3)	2.1 (2.5)**	.037†	.059*
<u>Mental Health Last 6 years</u>							
Adult antisocial behavior	0.6 (0.7)	0.9 (0.9)*	1.6 (1.2)**	0.9 (1.2)	2.1 (1.2)**	.010	.127**
Legal and alcohol/drug problems	0.2 (0.6)	0.2 (0.6)	1.2 (1.5)**	0.3 (0.6)	1.3 (1.4)**	.002	.168**
Major depression	1.0 (2.2)	0.5 (1.6)	1.0 (2.1)	0.9 (2.0)	1.7 (3.1)	.013	.019
Mental health problems	0.2 (0.5)	0.2 (0.6)	0.2 (0.6)	0.2 (0.5)	0.3 (0.7)	.002	.002

† $p < .05$;* $p < .01$;** $p < .001$.

Adol = Adolescent. Adol onset = AUD present at age 17; Adult onset = AUD present at age 20 or 24; Persist = AUD present age 29; Desist = 0 AUD symptoms at age 29. Values in the columns for the AUD groups are the means and standard deviations for the respective group and measure. Symbols indicating significance levels on these values indicate whether the mean for the given AUD group is significantly different from the mean of the Never group (i.e., individuals who never meet criteria for an AUD between age 17 to 29). The partial eta squared (η^2) in the Adolescent Onset and Persistent Course columns are a measure of predictive power of the given variable after controlling for the other.

Table 5

Social Outcomes and Social Environment at age 29.

	Never (n=226)	Adult Onset, Desist (n=84)	Adult Onset, Persist (n=58)	Adol Onset, Desist (n=22)	Adol Onset, Persist (n=35)	Adolescent Onset	Persistent Course
<u>Marriage and children</u>							
Cohabitate by age 21	19.6%	11.9%	19.0%	40.9% [†]	40.0%*	3.90**	1.68
Ever married	65.5%	60.7%	51.7%	54.5%	45.7% [†]	0.73	0.67
Ever separated or divorced	4.0%	2.4%	15.5%*	9.1%	20.0%**	2.23	5.30*
Ever fathered a child	42.7%	45.2%	34.5%	50.0%	40.0%	1.13	0.67
Fathered a child by age 23	6.2%	6.0%	13.8%*	22.7%*	22.9%*	2.93*	2.00
<u>Partial η²</u>							
Age 1 st cohabitate	23.3 (2.9)	24.1 (2.8)	23.9 (2.9)	21.9 (1.9)**	22.7 (3.6)	.049 [†]	.000
Age 1 st married	24.8 (2.3)	25.3 (2.1)	25.1 (3.3)	24.0 (2.6)	24.4 (3.7)	.024	.000
Age 1 st fathered a child	25.8 (2.8)	26.6 (2.4)	24.7 (3.9)	24.0 (3.2)	23.1 (3.3)*	.090 [†]	.061 [†]
<u>Education, Work, Finances</u>							
Educational attainment	6.2 (2.5)	6.5 (2.2)	5.9 (2.3)	4.4 (2.4)*	4.4 (2.3)*	.101**	.002
Occupational status	3.4 (1.8)	3.4 (1.5)	3.9 (1.7)	4.0 (1.8)	4.2 (1.6)	.018	.018
Income (\$)	49.4K (24.7K)	59.8K (65.8K)	53.5K (30.4K)	54.1K (27.2K)	56.5K (23.5K)	.000	.002
Financial problems	0.6 (1.0)	0.6 (0.9)	0.7 (0.9)	0.6 (1.0)	1.3 (1.3)*	.017	.026 [†]
<u>Social Environment</u>							
Prosocial peers	50.8 (10.6)	50.3 (8.7)	43.5 (9.2)**	50.2 (10.0)	42.4 (9.8)**	.001	.125**
Antisocial peers	50.0 (8.7)	52.9 (7.7)*	59.4 (9.3)**	52.5 (10.5)	68.2 (10.6)**	.045*	.228**
# sex partners	2.1 (2.4)	2.3 (2.8)	3.9 (4.2)*	2.3 (1.7)	4.8 (5.4)**	.004	.056*
Romantic partner's drinking	46.6 (8.7)	49.1 (8.1)	56.8 (10.4)**	44.8 (7.8)	55.6 (12.7)**	.013	.171**
Romantic partner's attitudes toward substance use	46.6 (9.9)	48.2 (9.3)	55.2 (8.5)**	48.5 (7.5)	58.0 (9.0)**	.007	.153**

[†] $p < .05$;

* $p < .01$;

** $p < .001$.

Adol = Adolescent. Adol onset = AUD present at age 17; Adult onset = AUD present at age 20 or 24; Persist = AUD present at age 29; Desist = 0 AUD symptoms at age 29. Values in the columns for the AUD groups are the means and standard deviations for the respective group and measure. Symbols indicating significance levels on these values indicate whether the mean for the given AUD group is significantly different from the mean of the Never group (i.e., individuals who never meet criteria for an AUD between age 17 to 29). The partial eta squared (η^2) in the Adolescent Onset and Persistent Course columns are a measure of predictive power of the given variable after controlling for the other. $K = 1000$.