

**Characterization of South African adolescents with alcohol use disorders
but without psychiatric or polysubstance comorbidity**

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Abstract

Background: Individuals who begin drinking during early adolescence and exhibit externalizing pathology and disinhibitory/dysregulatory tendencies are more vulnerable to developing alcohol use disorders (AUD) in adulthood. Previous research has focused on in-treatment populations with substantial comorbid psychopathology and polysubstance use. Here we characterize a unique sample of treatment-naïve adolescents without such comorbidity to help identify vulnerable youth who may benefit from early intervention.

Methods: We compared externalizing propensity, disinhibitory characteristics, and school performance in adolescents with AUD (but without comorbid psychopathology or other substance use; $n=70$) to those of demographically matched controls ($n=70$). Within the AUD group, we compared measures of substance use and the disinhibitory syndrome between males and females with differing severity of externalizing propensity.

Results: Adolescents with AUD demonstrated more externalizing propensity and disinhibitory personality traits (impulsivity, novelty seeking and excitement seeking), poorer self-monitoring and response inhibition, more bullying and sexual risk-taking behavior, poorer first language performance, and greater use of alcohol, cannabis, and nicotine ($p < .05$). Within the AUD group, participants with higher externalizing propensity began drinking earlier, more frequently, and for a longer duration than those with lower externalizing symptoms ($p < .05$). Disinhibitory features (personality, cognition and behavior) were, however, not stronger in those with higher externalizing propensity.

Conclusions: We suggest that the constructs of externalizing propensity and disinhibitory syndrome are useful in characterizing treatment-naïve adolescents with

AUD but without comorbid psychopathology or polysubstance use. These results support the importance of these constructs in understanding adolescent AUDs, even when the frank externalizing diagnoses of childhood (ODD and CD) are excluded.

Keywords: Adolescence; alcohol use disorders; (alcohol) risk factors; externalizing diathesis; disinhibition; South Africa

Introduction

Concepts central to multidimensional studies of the characteristics of Substance Use Disorders (SUD) include the *externalizing diathesis* (or, at a more subtle level, the *externalizing propensity*) and the *disinhibitory/dysregulatory syndrome* (Finn et al. 2009). The externalizing diathesis refers to a predominantly inherited predisposition towards externalizing behavior that contributes toward the development of a range of externalizing psychiatric disorders (including SUD). Evidence for the heritability of the externalizing diathesis is demonstrated by an ongoing large-scale study of monozygotic and dizygotic twins that detected a moderate to large genetic influence of externalizing psychiatric disorders, over and above environmental effects (Iacono et al. 2003). Examples of externalizing pathology, as originally defined by Gorenstein and Newman (1980), included hyperactivity in children, antisocial behavior in adolescents, and psychopathy in adults. The SUD literature has focused predominantly on comorbid externalizing pathology with a socially disruptive or deviant nature, for example, oppositional defiant and conduct disorders in adolescence, and DSM Axis II cluster B pathology in adulthood, specifically borderline and antisocial personality disorders (e.g., Caspi et al. 1996, Dom et al. 2006, Krueger et al. 2002).

The externalizing diathesis is characterized by, and inextricably linked to, the disinhibitory syndrome. The disinhibitory syndrome involves inherent disinhibitory and dysregulatory personality traits and cognitive styles that are manifested in behavior. One of the central features of such behavior is the tendency to disregard potentially negative long-term consequences of behavior in favor of immediate gratification (Gorenstein and Newman 1980). Notably, the disinhibitory syndrome constitutes a temperamental antecedent for a range of externalizing disorders,

including substance-use related disorders (Benegal et al. 2007, Krueger and South 2009). Elements of the disinhibitory syndrome include disinhibitory personality traits (e.g., impulsivity, novelty seeking, sensation seeking, and excitement seeking); executive cognitive disinhibition (e.g., impaired working memory and response inhibition); and consequent behavioral disinhibition (e.g., risk-taking and antisocial behavior) (Calvert and Bucholz 2008, Clark et al. 2005, Eklund and Klinteberg 2009, Finn and Hall 2004, Finn et al. 2002, 2009, Kenny and Schreiner 2009, Nigg et al. 2006).

Researchers have recognized that both the externalizing diathesis and the disinhibitory syndrome exist as spectra, and these features, in isolation, do not necessarily lead to SUD. However, SUD tends to be more severe, and to have poorer outcomes, in individuals with severe externalizing psychopathology and high levels of undercontrolled and disinhibited behavior (Clark et al. 2006, Dawes et al. 2000, Finn et al. 2009). There is also some evidence to suggest an association between internalizing disorders (including mood and anxiety disorders) and adolescent-onset SUDs, but the findings in the literature remain mixed (Kaplow et al. 2001, Mezzich et al. 1993).

Gender differences in the externalizing diathesis and the disinhibitory syndrome add interpretative complexity to findings: males tend to demonstrate higher levels of both the externalizing diathesis and the disinhibitory syndrome than females (Kenny and Schreiner 2009, Loeber et al. 2000). Specifically, males exhibit higher levels of oppositional defiant and conduct disorders, as well as behavioral (risk-taking) and personality (sensation seeking and excitement seeking) measures of the disinhibitory syndrome when compared to females (Arnett 1996, Finn and Hall 2004, Iacono et al. 2003, Laucht et al. 2007).

To date, most studies that have attempted a multidimensional characterization of adolescents with SUD, with reference to the externalizing diathesis and the disinhibitory syndrome, have focused predominantly on populations with high rates of comorbid psychopathology and with polysubstance abuse. Examples of comorbid externalizing pathology include adolescent antisocial behavior (Krueger et al. 2002), oppositional defiant disorder (Carlson et al. 1999), ADHD, conduct disorder and antisocial personality disorder (Carlson et al. 1999, Krueger et al. 2002, Nigg et al. 2006). In all of the above studies, polysubstance abuse or dependence was present in addition to diagnosable psychopathology. As such, knowledge about AUDs in isolation, i.e. without the confounding effects of comorbid psychopathology and polysubstance abuse, is limited. The primary aim of this study was thus to identify which elements of the externalizing diathesis and the disinhibitory syndrome, including psychiatric symptoms, personality traits, cognitive style, behavioral manifestations, and substance use, might be useful in distinguishing adolescents with Alcohol Use Disorders (AUD, but without diagnosable externalizing, other psychiatric, or substance abuse comorbidity) from those without AUD.

Previous research indicates that adolescents and adults in treatment for AUDs suffer from more severe alcoholism and greater psychiatric comorbidity than those with untreated AUDs. Furthermore, individuals in treatment for AUDs constitute a small proportion of the AUD population (Di Sclafani et al. 2008, Fein 2006a, Fein and Landman 2005, Fein et al. 2004, 2006). Despite this, most studies investigating AUDs examine individuals in treatment. Due to the distinction between treated and untreated populations, it is crucially important to characterize treatment-naïve, community-dwelling adolescents with AUDs in order to define the unique effects of AUD, free from the contamination of externalizing, other psychiatric, or substance

abuse comorbidity. The characterization of adolescent AUD populations has been problematic in the United States because of the high level of polysubstance abuse (Substance Abuse and Mental Health Services Administration 2007). However, such samples have been shown to be accessible in South Africa (Ferrett et al. 2010).

We hypothesized that, compared to demographically-matched non- or light-drinking controls, our sample of adolescents with AUD would demonstrate (a) elevated symptom counts for internalizing disorders, externalizing disorders, and attention-deficit/hyperactivity disorder (ADHD), (b) higher scores on measures of impulsivity, novelty seeking, and specific elements of sensation seeking, viz. excitement seeking, (c) poorer performance on measures of working memory, response inhibition, and self-monitoring, (d) higher incidence of bullying, sexual risk-taking behavior, and school absenteeism, (e) poorer academic performance, and (f) increased alcohol and other substance use. A secondary aim was to investigate whether, within the group of adolescents with AUD, (i) disinhibitory/dysregulatory measures would be increased in those with a higher number of externalizing symptoms compared to those with a lower number, and (ii) males would show more disinhibitory/dysregulatory tendencies than females.

Materials and Methods

Participants

We recruited a sample of English- and Afrikaans-speaking adolescents from 19 schools within the Cape Flats region (within a 30 kilometer radius of the test site at Tygerberg hospital) of the greater Cape Town metropole. Seventy pairs of participants (one abusing alcohol, one not) were individually matched for age (within 1 year), sex (each group consisted of 38 females and 32 males), education level, language, and

socioeconomic status. All participants were from moderately low socioeconomic backgrounds, residing in permanent housing with potable water and electricity, but mostly without luxury items such as computers and cars. The median gross annual income level per household was ZAR 60 469.87. The mean age of the entire sample was 14.77 years (± 0.77) and subjects had completed 7.75 years (± 0.82) of education. Females ($n = 76$, 54.29%) outnumbered males ($n = 64$, 45.71%).

Procedures

Recruitment procedures involved oral presentations at schools and advertisement via word-of-mouth. Advertisements and presentations invited participants who consumed alcohol regularly, and those who did not consume alcohol, to participate. Convenience sampling procedures were used. Out of the 890 volunteers who expressed interest in participating in the study, alcohol users were selected on a first-come-first-serve basis. Matching controls for each of these individuals were selected according to similarity of sociodemographic profile (i.e., age within one year; same sex, language, race, and socioeconomic status). Volunteers who did not meet eligibility criteria for possible inclusion in the alcohol or control groups ($n = 137$) were excluded at the pre-screening stage. The sample was typical of the sociodemographic profile of the population of the specified Cape Flats region (i.e., 66% Coloured, 23% White; 60% Afrikaans, 25% English; and 74% of households with formal housing, access to electricity and potable water, but earning a gross annual income of less than ZAR 100 000 (Statistics South Africa 2007).

Volunteers were screened for eligibility after written informed assent/consent was obtained from volunteers and parents or guardians. Screening involved detailed medical history-taking, physical and psychiatric examination, and urine analysis and

breathalyzer testing (to confirm that the adolescents were not intoxicated during the testing procedures), all performed by a fully qualified and licensed psychiatrist. The Schedule for Affective Disorders and Schizophrenia for School Aged Children (6–18 years) Lifetime Version (K-SADS-PL) (Kaufman et al. 1996), a semi-structured clinician-rated diagnostic scale, was used to ascertain current and past psychiatric diagnoses, as reported by the participants.

Exclusion criteria for study participation were: mental retardation, lifetime DSM-IV Axis I diagnoses other than AUD (including depressive, anxiety, psychotic, post-traumatic stress, elimination, eating, tic, attention-deficit/hyperactivity, oppositional defiant, and conduct disorders); lifetime dosages exceeding 30 cannabis joints or 4 methamphetamine doses; current use of sedative or psychotropic medication; signs or history of fetal alcohol syndrome or malnutrition; sensory impairment; history of traumatic brain injury with loss of consciousness exceeding 10 minutes; presence of diseases that may affect the CNS (e.g., meningitis, epilepsy, HIV); less than 6 years of formal education; and lack of proficiency in English or Afrikaans.

Collateral information verifying the absence of medical, psychiatric, and psychosocial problems was obtained from consenting parents by a social worker at the consent explanation interview. School attendance was obtained from school reports, and a social worker consulted with school teachers at pre-screening interviews to confirm whether participants' behavior and performance at school were considered to be within age-appropriate parameters.

A research assistant was available to assist participants in completing the self-report demographic and personality questionnaires. All test materials were available

in the participant's language of preference. Cognitive testing was individually administered.

Meals and refreshments were provided for participants, and study participation was compensated by gift vouchers (to the value of ZAR 50 per visit), distributed at the conclusion of the testing session. All study information was kept confidential, except where statutory requirements dictated the reporting of newly identified or ongoing threats to the safety of minor participants. Eighteen of the 158 recruited subjects were excluded as screen failures.

The study protocol and procedures complied with and were conducted in strict adherence to the guidelines contained in the Declaration of Helsinki (2008). Full written approval to conduct the study was obtained from the Western Cape Education Department and the Research Ethics Committee of the Stellenbosch University Faculty of Health Sciences.

Measures

Group membership. A revised version of the Timeline Followback (TLFB) procedure (Sobell and Sobell 1992), a semi-structured, clinician-administered assessment of lifetime history of alcohol use and drinking patterns, was used in collaboration with the K-SADS-PL to elicit alcohol-use data. A standard drink was defined as one beer or wine cooler, one glass of wine, or one 1.5-oz shot of liquor (alone or in a mixed drink). AUD group membership was defined by a lifetime dosage in excess of 100 units plus a DSM-IV diagnosis of alcohol abuse or dependence. The control group were non-drinkers (who had never consumed alcohol) and light drinkers (lifetime dosage not exceeding 80 units of alcohol), with no history of an AUD.

Alcohol and other substance use. Quantitative alcohol measures included age at alcohol initiation (first use), at first intoxication, and at regular use; duration (in months), frequency (average drinking days per month) and lifetime dosage (total standard units of alcohol consumed). Within the AUD group, qualitative alcohol measures included drinking style, and alcohol preference. Drinking style was defined as occasional (less than 15 days per month), frequent (more than 15 days per month), weekend-only (binge-drinking on two weekend days), or binge-style (continuous drinking for 3 consecutive days). Preference for using beer, wine or liquor as single or combined drinks was noted.

Other substances used by the participants included nicotine, cannabis, and methamphetamine. Nicotine use was measured as a categorical variable, with participants defined as non-smokers (i.e., they had never smoked), light smokers (i.e., they did not smoke regularly and had not smoked more than 50 cigarettes), or regular smokers (i.e., they smoked regularly and had smoked more than 100 cigarettes). Data regarding initiation age and lifetime dosage of substances were collected.

Psychopathology. Total symptom counts from the K-SADS-PL were recorded for each type of psychiatric disorder. Symptom counts for depressive disorders and anxiety disorders (including post-traumatic stress disorder) were tallied to form a composite score for subdiagnostic internalizing pathology (range = 0 to 36). Symptom counts for conduct disorder (CD) and oppositional-defiant disorder (ODD) were tallied to form a composite variable representing subdiagnostic externalizing pathology (range = 0 to 12).

Previous studies have adopted similar means of assessing psychopathology in AUD samples. For instance, Fein and colleagues (2007) created composites of

subdiagnostic psychopathology similar to those used in the current study. Unlike the current study, however, the anxiety and mood disorders were analyzed as separate composites, and the subdiagnostic externalizing pathology composite comprised CD and antisocial personality disorder symptom counts. Similarly, Di Sclafani and colleagues (2008) tallied CD and antisocial personality disorder symptom counts, and mood and anxiety counts, to create composite scores for externalizing and internalizing pathology respectively.

This latter step was taken following research demonstrating that these childhood disorders are frequently precursors of adult externalizing disorders (viz., borderline and antisocial personality disorders), and that they are strongly related to greater SUD severity (e.g., Clark et al. 2005, Finn et al. 2005, 2009). ADHD symptoms were assessed separately, and were not included in the composite externalizing score, based on evidence suggesting that ADHD is inconsistently related to SUD severity (e.g., Clark et al. 2005) and that the diagnosis falls outside the classification of disruptive behavioral disorders categorized by social deviance (Kaplan and Sadock 1998).

We differentiated between the externalizing diathesis, which typically describes diagnosable externalizing pathology, and an externalizing propensity, which refers to a more subtle, subdiagnostic syndrome. Because counts on the externalizing symptom composite variable were non-normally distributed, we converted the measure into a categorical variable differentiating between higher and lower externalizing propensity within the AUD group, defined by a median split. The subsample with 2 or more disruptive externalizing symptoms (AUD with externalizing propensity) and those with fewer than 2 symptoms (AUD without externalizing propensity) constituted 47.1% and 52.9% of the AUD group, respectively.

Personality traits. Disinhibitory personality traits were measured using self-rated subscales from three major inventories. Specifically, impulsivity was measured using the Impulsivity-Venturesomeness Scales (Eysenck and Eysenck 1980). Alpha reliability coefficients for males on the Impulsivity and Venturesomeness subscales were 0.78 and 0.71 respectively, and 0.75 and 0.73 for females respectively, and the construct validity of both subscales were reported as acceptable (Eysenck and Eysenck 1980).

Novelty seeking was measured using the relevant subscale from Cloninger's (1987) Tridimensional Character Inventory. The Novelty Seeking subscale has been reported as reliable (0.79) (Gana and Trouillet 2003) and valid (Bagby et al. 1992).

Excitement seeking was measured by combining scores from the Disinhibition and Boredom Susceptibility subscales of Zuckerman and colleagues's (1978) Sensation Seeking Scale (SSS) (see Finn and Hall 2004). Items referring directly to alcohol and drug use were excluded from the subscale scores in order to avoid contamination of these measures with measures of substance use. Alpha coefficients measuring the internal consistency of the Disinhibition and Boredom Susceptibility subscales were 0.74 and 0.57 for males, and 0.76 and 0.56 for females, and the construct validity of both subscales was reported as good (Zuckerman et al. 1978). Finn and Hall (2004) demonstrated that the Disinhibition and Boredom Susceptibility subscales are indicators of the latent variable of excitement seeking.

Cognition. The Numbers Backwards subtest from the Children's Memory Scale (Cohen 1997) was used to measure working memory. This test, which is equivalent to other digit span tests, requires participants to recall the digit sequences in reverse order of presentation. Response inhibition was measured using the Stroop Color-

Word Test error score (Golden and Freshwater 2002). The Stroop Color-Word Test requires participants to read as many items as possible within a 45-second time limit. There are three separate tasks: 1) the Word page, where the participant reads the names of three colors printed in black ink; 2) the Color page, which involves naming the colors printed in colored “X’s”; and 3) the Color-Word page which requires reading the colors in which the words are printed, ignoring the printed words. The Color-Word task specifically measures the ability to selectively attend to one stimulus while guarding against interference against another (MacLeod 1991). The error scores therefore reflect the number of instances where participants are unable to inhibit the prepotent responses. A composite score for self-monitoring was derived from phonemic and semantic fluency error scores (Strauss et al. 2006), Auditory Verbal Learning Test total error score (Maj et al. 1993), rule violation scores from the Tower of London (Culbertson and Zillmer 2001), and error scores from the Children’s Color Trails Test (Llorente et al. 2003). Error scores on individual tests are used qualitatively in clinical practice to provide an indication of self-monitoring (Llorente et al. 2003, Mitrushina et al. 2005). We tallied the error scores as follows: repetitions, rule violations, and set loss errors in both phonemic and semantic fluency tests; repetitions and insertions in the Auditory Verbal Learning Test; rule violations on the Tower of London; near-misses, prompts, color sequence errors, and number sequence errors on the Children’s Color Trails Test.

Behavior. The bullying subscale from Reynolds’ (2003) Bully Victimization Scales for Schools measured the extent to which individuals perpetrated bullying behavior at school. Sexual risk-taking behavior was measured using a 12-item composite derived from the demographic questionnaire items that measured: causing, experiencing, or

terminating pregnancy, engaging in sexual intercourse without a condom, regular sexual intercourse, early sex, forced sex, sex while intoxicated, symptoms of sexually transmitted diseases, high-risk sexual partners (including multiple partners and partners 5 years older than the individual), anal sex, and sex with a homosexual or bisexual partner. School absenteeism was measured using school reports, which indicated how many days a participant had been absent during the preceding school year.

In the AUD group, a composite measure describing dangerous behaviors was derived from the K-SADS-PL Supplement 5 symptoms. *Dangerous behavior* was defined as number of behaviors that endangered participants' or others' lives (e.g., running across train tracks or committing illegal acts).

Academic achievement. Level of education was defined as number of years of schooling successfully completed. Academic results were obtained from school reports. Average percentages over four school terms (i.e., one school year) were calculated to assess educational achievement in first language and numeracy. Averages across all school subjects were tallied as an aggregate measure of academic achievement.

Statistical analysis. After appropriate cross-checking and cleaning of data, statistical analysis was performed using SPSS version 17.0 (SPSS 2008). Kolmogorov-Smirnov and Levene's tests were conducted to test for normality of data and homogeneity of variance, respectively. The first analytic step involved a set of between-group comparisons to confirm that (a) the control and AUD groups did not differ with regard to matching variables, and (b) the two groups differed significantly with regards to

group membership criteria (viz., alcohol dosage and diagnosis). Where assumptions for parametric tests were upheld, group means were compared using independent-samples *t*-tests. Mann-Whitney *U* tests were used to compare means for nonparametric data. The threshold for statistical significance was set at 0.05.

The test of our primary hypotheses involved repeated measures ANOVAs, with the matched pairs as the repeated measures, group as the within repeated measures factor and sex as the between pairs factor. The repeated measures design provides a powerful procedure to assess whether the AUD and control groups differed on measures of psychiatric symptoms, personality traits, cognitive functions, behavior, academic performance, and substance use. The test of our secondary hypotheses was set of a 2 (group: AUD with externalizing propensity vs AUD without externalizing propensity) x 2 (sex: male vs. female) factorial ANOVAs, with the measures of disinhibition and dysregulation as dependent variables, designed to assess whether (i) scores on those measures were increased in those with a higher number of externalizing symptoms compared to those with a lower number, and (ii) males showed more disinhibitory/dysregulatory tendencies than females.

Results

Confirmatory analyses

Matching criteria. The groups were adequately matched, with no statistically significant differences between control and AUD groups in age, sex, level of education, and socioeconomic status (see Table 1).

Alcohol use. The lifetime alcohol dosage (see Table 1) and alcohol use profile differed dramatically between control and AUD groups as 38.6% of participants in the

control group had never consumed alcohol while 61.4% were light drinkers, having consumed between 1 and 76 standard drinks in their lives. Most participants in the AUD group (97.1%) were diagnosed with alcohol dependence, with the remainder meeting criteria for alcohol abuse. The vast majority of participants in the AUD group (81.4%) only consumed alcohol on weekends, while others consumed alcohol on fewer than 15 days per month (14.3%), a few endorsed binge-drinking beyond the weekends, i.e. for more than 3 consecutive days (1.4%); and 2.9% drank on more than 15 days per month. Participants in the AUD group generally consumed more than one type of alcohol, with 38.4% using beer, wine, *and* liquor regularly, 38.5% used a mixture of two alcohol types (most popularly, beer and liquor) and 23.2% of the AUD group only used one type of alcohol. Both drinking style and preferences for alcohol types were consistent across males and females, and in AUD participants with lower and higher externalizing propensity.

Primary hypothesis: Analyses comparing control and AUD groups. See Table 2.

Other substance use. For both groups, the mean initiation age for nicotine and other drug use was in the 12th year. AUD participants smoked and experimented with cannabis significantly more than controls. Furthermore, more controls (58.5%) than AUD participants (20%) had never smoked a cigarette, and more controls (34.3%) than AUD participants (28.6%) were light smokers, as opposed to regular smokers. Very few controls (7.1%) were regular smokers, whereas more than half of the AUD participants (51.4%) were regular smokers who had exceeded a lifetime dosage of 100 cigarettes. Only two participants in the entire sample had experimented with illegal substances other than alcohol, nicotine, or cannabis. Both of these individuals were in the AUD group and both had inhaled methamphetamine 1-3 times.

Psychopathology. There were no between-group differences in internalizing psychiatric symptoms or ADHD. Participants in the AUD group endorsed more diagnostic symptoms of externalizing disorders (ODD and CD), and the effect size was large. Externalizing propensity severity was subtle, with participants from both groups endorsing very few symptoms (see Table 2).

Personality. AUD participants demonstrated stronger disinhibitory personality traits than controls across all measures. There were large effect sizes for between-group differences in impulsivity and excitement seeking.

Cognition. There were no group differences in working memory functioning, as measured by the CMS Numbers Backwards subtest. There were, however, between-group differences, associated with large effect sizes, on other executive functioning measures: AUD participants demonstrated more difficulties in inhibiting prepotent responses on the Stroop Color-Word Test, and made more self-monitoring errors as measured by the composite score including errors in phonemic and semantic fluency, the Auditory Verbal Learning Test, the Children's Color Trails Test, and rule violations in the Tower of London. An earlier in-depth report on cognitive function on a subset of these individuals has been published (Ferrett et al. 2010), and a more complete analysis of cognitive function on the completed study (to include 182 subjects) will be submitted for publication in the future.

Behavior. There were no between-group differences with regard to school absenteeism rates. The AUD participants, did, however, perpetrate significantly more acts of bullying and engaged in significantly more sexual risk-taking behavior.

Academic achievement. AUD participants fared worse than controls in their first language and aggregate performances, but no worse in numeracy, neither did they repeat more school grades.

Secondary hypotheses: Analyses comparing AUD groups with and without externalizing propensity, and males and females within the AUD group.

The data upon which the set of 2x2 factorial ANOVAs were based are shown in Table 3. The analyses showed that participants in the AUD with externalizing propensity group ($n = 33$) had their first drink, began drinking regularly, and first became intoxicated earlier than those in the AUD but without externalizing propensity group ($n = 37$) ($F(1, 66) = 7.82, p = .007, \omega^2 = .11$; $F(1, 66) = 7.82, p = .007, \omega^2 = .11$; and $F(1, 66) = 6.08, p = .016, \omega^2 = .08$, respectively). The duration and frequency of drinking were also greater in the AUD with externalizing propensity group ($F(1,66) = 5.17, p = .026, \omega^2 = .07$, and $F(1,66) = 8.92, p < .004, \omega^2 = .12$), but differences in average and maximum quantity and lifetime dosage of alcohol were non-significant. There were no significant main effects of sex or group x sex interaction effects on any of the measures of alcohol use, measures of other substance use, personality, cognition, behavior, or academic performance. There were, however, two significant main effects of sex: compared to girls with AUD ($n = 38$), boys with AUD ($n = 32$) perpetrated more bullying behavior ($F(1, 66) = 6.18, p = .015, \omega^2 = .09$) and had more difficulties with self-monitoring ($F(1, 66) = 4.51, p = .037, \omega^2 = .06$). The sex differences in bullying and self-monitoring were unique to the AUD group; sex differences within the control group were non-significant for bullying ($F(1,68) = 2.35, p = .130$) and self-monitoring ($F(1,68) = 0.02, p = .885$).

Discussion

A core finding of our study contrasts the AUD and control groups on subdiagnostic manifestations of internalizing vs. externalizing pathology. AUD and control groups differed in substance use, externalizing propensity, and measures of the disinhibitory syndrome (e.g., disinhibited personality traits, self-monitoring, response inhibition, bullying, and risk-taking), but did not demonstrate elevated symptom counts for internalizing disorders or for ADHD. We believe these results show that even after excluding all individuals with diagnosable internalizing or externalizing (excluding substance use) disorders, the externalizing propensity and the disinhibitory syndrome are still intimately tied to AUDs. ADHD and internalizing disorders, which fall outside the syndromes of disruptive behavior which define CD and ODD, are not as intimately associated with AUDs. This is contrary to previous findings in samples with comorbid psychopathology and polysubstance abuse (e.g., Clark et al. 2005) and to our hypotheses of higher internalizing symptoms in adolescents with “pure” AUDs. A recent study by Kendler and colleagues (2011), however, demonstrated that several externalizing disorders (including AUD, CD and antisocial personality disorder) share a common genetic etiology, and that this genetic predisposition is distinct from that of internalizing disorders. This finding may explain why the AUD group had comparatively higher symptom counts over a range of externalizing disorders, while this pattern did not hold for the internalizing disorders. We did confirm our hypothesis of higher symptom counts for externalizing disorders in our sample of adolescent “pure” AUD. Previous literature (e.g., Chen et al. 2007, Dawes et al. 2000) confirms a higher incidence of diagnosable externalizing disorders in AUD; our data suggest that after excluding individuals with an

externalizing disorder diagnosis, adolescents with an AUD still display more subdiagnostic externalizing symptoms than adolescents without an AUD.

In keeping with this result, the AUD participants in comparison to controls, demonstrated personality traits characterized by the disinhibitory syndrome (i.e., impulsivity, novelty seeking and excitement seeking). This finding replicates a large body of previous research on less “pure” AUD (e.g., Finn and Hall 2004, Justus et al. 2001, Martin et al. 2002). Also, as predicted, and in accordance with previous findings (e.g., Dolan et al. 2008, Finn et al. 2009), the AUD participants demonstrated poorer performance on some, but not all, measures of executive functioning. Specifically, AUD participants were less successful than controls at inhibiting prepotent responses and at self-monitoring. Unexpectedly, however, there was no between-group difference in working memory performance, which is a crucial resource for the modulation of impulse control and self-regulation. It may be that the digit-span backwards task used to measure working memory is not sensitive enough to pick up a deficit that does exist (Chanraud et al. 2010, Tapert et al. 2002), and recent literature suggests that other tasks (e.g., an n-back task) could be more sensitive to such deficits (Tapert et al. 2001, 2004).

In line with the previously established association between AUD and various forms of risk-taking behavior (Flisher et al. 2000, Tarter 2002), our AUD participants exhibited significantly more sexual risk-taking behavior than controls. They were also involved in more bullying behavior, which may be associated with the relatively higher conduct disorder symptom counts, demonstrating the tendency for socially deviant behavior (Kaltiala-Heino et al. 2000).

Based on previous studies conducted in both Cape Town (Flisher et al. 2003) and in other countries (Gerra et al. 2004, Kenny and Schreiner 2009), we predicted

that our AUD participants would display higher levels of school absenteeism than controls. This prediction was not confirmed. We suggest that because our AUD participants were predominantly weekend drinkers, alcohol use did not interfere with school attendance. AUD participants fared worse than controls in their first language, and this disadvantage was associated with lower academic aggregate achievement as in other studies (e.g., Gerra et al. 2004, Pendorf 1992).

Although the degree of externalizing propensity within the AUD group accounted for some differences in alcohol-related measures, it did not capture the potential heterogeneity of the disinhibitory syndrome within adolescents with AUD (Clark et al. 2006, Finn et al. 2002). We suggest that the homogeneity in this AUD sample is due to the stringent exclusionary criteria of adolescents with diagnosable externalizing pathology, resulting in a small number of externalizing symptom counts within our sample. As suggested in previous research (Finn et al. 2002) the participants with AUD with externalizing propensity initiated alcohol use, became intoxicated for the first time, and began drinking regularly at a younger age than those with AUD without externalizing propensity. Consequently, they had been drinking for a longer duration, but also drank more frequently than the AUD participants without externalizing propensity. They did not, however, have a higher lifetime dosage than the participants with AUD without externalizing propensity. Furthermore, the AUD participants with externalizing propensity began drinking regularly in their 11th year, a full year earlier than those without externalizing propensity. Since earlier onset age has been associated with alcohol related negative outcomes, lifetime disinhibitory problems and externalizing problems (Zernicke et al. 2010), our AUD group with externalizing propensity may be at risk for poorer prognoses. None of the disinhibitory/dysregulatory measures of the disinhibitory syndrome (including the

dangerous behavior composite) were increased in those with a higher number of externalizing symptoms compared to those with a lower number. We propose that, due to the exclusion of diagnosable externalizing pathology, the difference in degree of externalizing propensity between the AUD groups with and without externalizing propensity was too small to produce substantial differences in the disinhibitory syndrome between these groups.

Although some previous studies have shown that males exhibit more disinhibitory tendencies than females, in our data this trend applied only to bullying behavior and self-monitoring. Our finding is, however, consistent with recent studies (Kenny and Schreiner 2009) which suggest that sex differences relating to alcohol use may be diminishing over time.

Polysubstance use in our sample was restricted to nicotine and cannabis. In both the AUD and control groups, age of initiation of nicotine and cannabis use coincided with the initiation of alcohol use (at around 12 years of age). Nevertheless, those in the AUD group managed to accrue a lifetime nicotine dosage 15 times greater than that of controls, as well as a higher cannabis lifetime dosage. More than half the AUD participants smoked regularly, but cannabis use was minimal, typically averaging a lifetime dosage of four joints. Other drug use was negligible. This pattern is in accordance with recent (previous month) prevalence rates for adolescent substance use in Cape Town, which indicates that alcohol (31%), nicotine (27%), and cannabis (7%) are the most frequently used drugs (Flisher A. et al. 2003). The high rate of cigarette smoking in our sample is of concern, however, as nicotine has been established as a gateway drug in the Cape Town population. Data collected between 2004 and 2005 indicates that adolescents in the 8th-9th grade first begin smoking, and then progress to alcohol, cannabis, and inhalants (Patrick et al. 2009). Aside from

nicotine, the range and extent of other substance use in our sample was considerably lower than that reported in other studies (e.g., Gerra et al. 2004). In an American sample, 100% of participants with AUD reported having used drugs other than alcohol as follows: marijuana (94%), amphetamines (78%), cocaine (33%), hallucinogens (18%), and inhalants (6%) (Brown et al. 2000). Although previous studies of both foreign and local adolescents report sex differences in the frequency of other substance use (e.g., Gerra et al. 2004, Pendorf 1992), males and females in our sample had similar nicotine and cannabis use histories.

The reason for the comparatively lower level of polysubstance use in the Western Cape region of South Africa (in comparison to the USA) is unclear. Most South African studies on alcohol use have been epidemiological or descriptive by design and have not succeeded in addressing causal mechanisms. We may speculate, however, that the widespread use of alcohol as a drug of choice amongst the Coloured population may have historical roots. Previously, alcohol was used as a means of payment for wine farm labourers in the Western Cape. It is possible that alcohol use predominates because it seems to be more socially acceptable than other drugs, partially as a consequence of the intergenerational culture of alcohol as a socially acceptable agent. In addition, alcohol tends to be more accessible than other drugs within this community.

With regard to limitations of the current study, the cross-sectional design, although helpful in characterizing the externalizing propensity and the disinhibitory syndrome in our sample, does not have the capacity to determine whether these constitute long-term risk factors for chronic AUDs, or to draw causal inferences from the data. Longitudinal follow-up is required to document the trajectory of alcohol use and related factors to establish a risk profile over time. It would be helpful to ascertain

which elements of the externalizing propensity and the disinhibitory syndrome constitute risk factors for chronic and protracted AUD in populations with minimal comorbid psychiatric and polysubstance pathology. Another limitation is that we did not gather measures of family background; e.g., family history of alcohol use patterns, religion, or psychiatric problems.

Despite attempts to describe multidimensional aspects of functioning in adolescent AUD, biological and genetic factors were not investigated. It would be desirable to extend the scope of future studies of this cohort to investigate some of these salient risk factors which have been identified in other studies (e.g., Dawes et al. 2000, Finn et al. 2009, Schuckit 2009). The accumulation of a larger sample over time would allow for more sophisticated analytic models which could help us to understand relationships between multidimensional measures (e.g., Finn et al. 2009).

Two of the behavioral variables (i.e., dangerous behavior and sexual risk-taking behavior) were composite measures derived from diagnostic and demographic information. Item analyses would be necessary to establish item consistency.

The primary strength of this study is that it demonstrates that the externalizing propensity and the disinhibitory syndrome are useful constructs for multidimensional characterization of individuals with AUD in an early-onset adolescent sample. Our study makes a novel contribution to the literature by demonstrating that this characterization applies in the absence of substantial levels of psychiatric comorbidity and polysubstance use. Furthermore, we have shown that even when applying stringent exclusionary criteria for childhood externalizing disorders (ODD and CD), adolescent AUD is associated with higher symptoms of externalizing disorders.

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Table 1.*Confirmatory Analyses of Demographic and Alcohol Grouping Measures*

Variable	Control group (<i>n</i> = 70)		Alcohol Use Disorder group (<i>n</i> = 70)		<i>t/U</i>	<i>p</i>
	Range	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)		
Age	12.21-15.92	14.69 (0.80)	12.77-16.00	14.85 (0.74)	-1.19	.241
Education level ^a	6-10	7.71 (0.87)	6-9	7.79 (0.76)	2344.50	.643
Annual family income ^b	10959-97081	59910 (17495)	23044-96406	61032 (17733)	2294.50	.510
Alcohol lifetime dosage ^c	0-76	6.50 (13.3)	110-8624	1546.10 (1512.3)	0.00	<.001

^aYears of successfully completed education^bIn South African Rands (ZAR)^cTotal standard units

Table 2.*Descriptive Statistics and Comparisons of Means between Alcohol Use Disorder and Control Groups*

	Control group (<i>n</i> = 70)		Alcohol Use Disorder group (<i>n</i> = 70)		<i>F</i>	<i>p</i>	ω^2
	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range			
Nicotine							
Initiation age	12.66 (1.52)	6-15	12.49 (1.52)	8-15	6.25	.019*	0.19
Lifetime dosage ^a	100 (475)	0-3240	1553 (2935)	0-14328	13.36	.001**	0.33
Cannabis							
Initiation age	13.88 (0.64)	13-15	13.54 (1.17)	11-15	0.89	.440	0.31
Lifetime dosage ^b	0.13 (0.38)	0-2	4.15 (7.21)	0-30	0.69	.490	0.26
Psychiatric symptom counts							
Internalizing composite ^c	6.34 (7.30)	0-36	7.03 (7.62)	0-31	0.30	.587	0.01
ADHD	1.16 (2.02)	0-12	1.93 (3.46)	0-24	2.20	.140	0.03
Externalizing composite ^d	1.06 (1.85)	0-8	2.53 (3.51)	0-12	13.06	.001**	0.16
Personality							
Impulsivity subscale ^e	7.49 (3.71)	1-16	10.26 (3.02)	3-17	23.74	< .001***	0.26
Novelty seeking scale total ^f	55.80 (8.05)	36-73	59.53 (9.68)	36-85	5.79	.019*	0.08
Excitement seeking composite ^g	4.91 (2.69)	0-11	6.83 (2.58)	1-14	20.47	< .001***	0.23
Cognition							
SCWT Color-Word errors	1.29 (1.54)	0-6	2.96 (2.12)	0-10	32.47	< .001***	0.33
CMS Numbers Backward ^h	4.36 (1.55)	2-9	4.07 (1.34)	2-8	1.23	.270	0.02
Self-monitoring errors ⁱ	10.39 (6.01)	1-25	18.94 (8.97)	4-46	42.79	< .001***	0.39
Behavior							
Bullying ^j	4.89 (7.34)	0-39	11.94 (11.89)	0-51	19.42	< .001***	0.26
Sexual risk-taking	0.21 (0.64)	0-4	0.87 (1.81)	0-11	6.91	.011*	0.12
School absenteeism	9.07 (8.87)	0-44	11.78 (14.43)	0-76	1.98	.165	0.04
Academic performance ^k							
Grades repeated	0.13 (0.34)	0-1	0.24 (0.46)	0-2	0.89	.349	0.01
First language average %	51.84 (14.76)	16-84	46.80 (14.27)	12-78	7.18	.009**	0.11

	Control group (<i>n</i> = 70)		Alcohol Use Disorder group (<i>n</i> = 70)				
	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range	<i>F</i>	<i>p</i>	ω^2
Numeracy average %	41.93 (18.55)	12-87	37.78 (19.18)	0-78	2.99	.089	0.05
Aggregate ¹ %	48.29 (13.11)	16-76	44.52 (12.44)	13-70	5.63	.021*	0.08

Note. ADHD = attention-deficit/hyperactivity disorder; ODD = oppositional defiant disorder; CD = conduct disorder. SCWT = Stroop Color-Word Test; CMS = Children's Memory Scale.

^aTotal cigarettes smoked

^bTotal joints smoked

^cTotal symptoms of depressive and anxiety disorders

^dTotal symptoms of conduct disorder and oppositional defiant disorder

^eFrom the Impulsivity-Venturesomeness scale

^fFrom the Tridimensional Character Inventory

^gDisinhibition and Boredom Susceptibility subscales of the Sensation Seeking Scale

^hScaled scores

ⁱTotal of errors made on tests of phonemic and semantic fluency, and on the Auditory Verbal Learning Test and the Tower of London

^jFrom the Bully-Victimization Scale for Schools

^kAll numbers given are percentages

^lAnnual average across all school subjects

p* < .05. *p* < .01. ****p* < .001.

Table 3.*Descriptive Statistics for the AUD Group, Broken Down Separately by Externalizing Propensity and by Sex*

	Externalizing propensity						Sex					
	AUD without externalizing propensity (<i>n</i> = 37)		AUD with externalizing propensity (<i>n</i> = 33)		<i>F</i>	<i>p</i>	Female (<i>n</i> = 38)		Male (<i>n</i> = 32)		<i>F</i>	<i>p</i>
	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range			<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range		
Alcohol												
Initiation age	12.51 (1.43)	8-14	11.52 (1.90)	5-14	7.82	.007**	11.89 (1.66)	7-14	12.22 (1.81)	5-14	1.49	.226
Age of first intoxication	13.03 (1.14)	10-15	12.45 (1.12)	9-14	6.08	.016*	12.61 (1.15)	10-15	12.94 (1.16)	9-15	2.51	.118
Onset age of regular use	12.51 (1.43)	8-14	11.52 (1.90)	5-14	7.82	.007**	11.89 (1.66)	7-14	12.22 (1.81)	5-14	1.49	.226
Duration (months)	20.41 (10.48)	3-42	28.85 (20.48)	8-119	5.17	.026*	23.11 (8.33)	9-42	25.91 (22.65)	3-119	0.19	.669
Frequency ^a	4.84 (2.09)	2-8	7.45 (4.67)	2-25	8.92	.004**	5.97 (3.21)	2-16	6.19 (4.37)	2-25	0.09	.771
Average monthly quantity	62.45 (43.05)	5-184	73.23 (73.93)	7-392	0.45	.503	68.91 (67.32)	5-392	65.89 (49.44)	7-196	0.17	.690
Maximum dose	18.65 (7.96)	6-40	18.48 (7.76)	4-50	0.08	.772	18.00 (6.68)	6-40	19.25 (9.03)	4-50	0.42	.520
Lifetime dosage ^b	1359.78 (1332.61)	110-6384	1755.06 (1687.73)	160-8624	1.36	.247	1675.61 (1735.60)	110-8624	1392.37 (1204.25)	117-4680	1.02	.317
Nicotine												
Initiation age	12.56 (1.39)	10-15	12.41 (1.68)	8-15	0.10	.749	12.47 (1.23)	10-14	13.08 (1.24)	8-15	0.08	.777
Lifetime dosage ^c	1288.22 (2578.95)	0-13800	1850.00 (3306.10)	0-14328	1.00	.323	3480.53 (4070.04)	0-13800	1292.33 (1497.64)	0-14328	0.60	.443
Cannabis												
Initiation age	13.67 (1.28)	11-15	13.42 (1.07)	11-15	0.33	.572	13.41 (1.28)	11-15	13.58 (1.31)	11-15	0.59	.447
Lifetime dosage ^d	3.47 (6.32)	0-22	4.91 (8.14)	0-30	0.37	.550	8.56 (10.37)	0-3	8.17 (6.39)	0	0.01	.945

	Externalizing propensity						Sex					
	AUD without externalizing propensity (<i>n</i> = 37)		AUD with externalizing propensity (<i>n</i> = 33)		<i>F</i>	<i>p</i>	Female (<i>n</i> = 38)		Male (<i>n</i> = 32)		<i>F</i>	<i>p</i>
	<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range			<i>M</i> (<i>SD</i>)	Range	<i>M</i> (<i>SD</i>)	Range		
Personality												
Impulsivity ^e	10.54 (3.28)	3-17	9.94 (2.72)	5-17	0.89	.350	10.24 (3.32)	3-17	10.28 (2.67)	7-17	0.03	.872
Novelty Seeking Scale total ^f	59.35 (9.48)	36-84	59.73 (10.04)	37-85	0.01	.909	59.50 (9.98)	36-84	59.56 (9.46)	37-85	0.01	.985
Excitement seeking composite ^g	6.76 (2.80)	1-14	6.91 (2.35)	3-12	0.01	.983	6.37 (2.24)	1-12	7.38 (2.89)	2-14	2.57	.114
Cognition												
SCWT Color-Word errors	3.16 (2.09)	0-8	2.73 (2.17)	0-10	0.77	.383	2.89 (2.32)	0-10	3.03 (1.89)	0-6	0.18	.677
CMS Numbers Backward ^h	4.05 (1.29)	2-7	4.09 (1.42)	2-8	0.01	.978	4.03 (1.48)	2-8	4.13 (1.19)	3-7	0.07	.788
Self-monitoring errors ⁱ	19.41 (9.16)	6-46	18.42 (8.87)	4-39	0.60	.443	17.00 (7.93)	5-46	21.25 (9.69)	4-39	4.51	.037*
Behavior												
Bullying subscale ^j	10.35 (10.55)	0-40	13.73 (13.17)	0-51	0.50	.481	8.58 (9.01)	0-36	15.94 (13.70)	0-51	6.18	.015*
Sexual risk-taking Dangerous behavior	0.81 (1.63)	0-8	0.94 (2.02)	0-11	0.02	.962	0.58 (1.00)	0-5	1.22 (2.42)	0-11	2.06	.156
School absenteeism	2.14 (0.48)	2-4	2.36 (0.74)	2-4	2.16	.146	2.21 (0.58)	2-4	2.28 (0.68)	2-4	0.05	.824
School absenteeism	11.30 (15.03)	0-76	10.44 (13.38)	0-56	0.08	.774	10.64 (14.60)	0-76	11.26 (13.96)	0-56	0.04	.852
Academic performance ^k												
Grades repeated	0.18 (0.39)	0-1	0.22 (0.51)	0-2	0.32	.897	0.09 (0.29)	0-1	0.33 (0.56)	0-2	0.17	.665
First language average %	50.61 (14.82)	12-78	42.04 (12.51)	17-68	4.12	.047*	50.21 (11.49)	24-78	42.52 (16.51)	12-72	3.00	.089
Numeracy average %	42.91 (18.45)	7-76	32.04 (20.27)	0-78	4.19	.045*	39.30 (19.50)	6-76	36.44 (20.61)	0-78	0.02	.889
Aggregate ^l %	47.12 (11.62)	13-70	40.52 (12.53)	14-68	2.86	.097	47.33 (9.81)	30-70	40.26 (14.18)	13-67	3.52	.066

Note. Means are presented, with standard deviations in parentheses. SCWT = Stroop Color-Word Test; CMS = Children's Memory Scale.

^aDrinking days per month

^bTotal standard units of alcohol consumed

^cTotal cigarettes smoked

^dTotal joints smoked

^eTotal symptoms of depressive and anxiety disorders

^fFrom the Impulsivity-Venturesomeness scale

^gFrom the Tridimensional Character Inventory

^hDisinhibition and Boredom Susceptibility subscales of the Sensation Seeking Scale

ⁱScaled scores

^jTotal of errors made on tests of phonemic and semantic fluency, and on the Auditory Verbal Learning Test and the Tower of London

^kFrom the Bully-Victimization Scale for Schools

^lAside from the Grades repeated variable, all numbers given are percentages

^mAnnual average across all school subjects

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