Published in final edited form as:

Alcohol Clin Exp Res. 2019 March ; 43(3): 483–496. doi:10.1111/acer.13952.

Are Some AUD Criteria More (or Less) Externalizing than Others? Distinguishing Alcohol Use Symptomatology from General Externalizing Psychopathology

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Abstract

Background: The externalizing spectrum contains a range of disinhibition-related conditions, such as, conduct disorder, antisocial personality disorder, and substance use disorders. Comorbidity among externalizing disorders is commonly investigated at the syndromal and trait level precluding insight into the relationship of symptoms across externalizing disorders. It is unknown whether comorbidity across externalizing disorders holds constant across highly varied, individual alcohol use disorder (AUD) criteria. AUD criteria range from symptoms reflecting neuroadaptation (e.g., tolerance) to symptoms reflecting behavioral problems (e.g., social problems). The present study aimed to determine the degree to which individual AUD criteria are associated with symptomatology from other externalizing disorders. Characterization of the degree to which AUD criteria reflect neuroadaptation versus behavioral problems can be used to identify symptom profiles, which, in turn, can be used to inform diagnostic and treatment approaches.

Methods: Data from two large nationally-representative samples were used to examine associations between AUD criteria and externalizing behavior. Psychometric inquiries via multivariate and factor analytic approaches estimated relative and unique associations of externalizing behavior and AUD criteria endorsement, as compared to alcohol consumption.

Results: Our results indicate differential relations of externalizing behavior and AUD criteria endorsement. For example, social problems and role interference criteria were most strongly associated with externalizing behavior across analytic approaches, with general and unique associations with externalizing behavior. Additionally, tolerance was most weakly associated with externalizing behavior across approaches.

Conclusions: Results highlight potential etiological heterogeneity among AUD criteria that could guide future diagnostic refinements and aid in the identification of treatment targets.

Keywords

externalizing behavior; comorbidity; alcohol use disorder criteria

Introduction

The externalizing spectrum comprises psychological disorders related to impaired self-regulation and rule-breaking behavior. Disorders in this spectrum are characterized by impulsivity, high activity, and aggression (Krueger et al., 2001). Throughout the lifespan, externalizing disorders share an underlying disinhibitory process. In childhood, this disinhibitory process is exhibited in disorders like conduct disorder (CD), oppositional defiant disorder, and attention-deficit/hyperactivity disorder ([ADHD]; e.g., Farmer et al., 2009; Witkiewitz et al., 2013). In adulthood this process is expressed in antisocial personality disorder (ASPD) and substance use disorders (SUDs), both characterized by high disinhibition (Krueger, 1999a; Krueger et al., 2002). Externalizing disorders have high comorbidity with each other (e.g. Merikangas et al., 1998), and presence of one externalizing disorder increases risk for subsequent development of other externalizing disorders (Compton et al., 2005; Nock et al., 2006). These robust bivariate relationships exhibited across externalizing disorders have generated increased psychometric inquiries of shared factors to explain these strong associations.

Many shared features are rooted in personality traits. Personality traits characterized by disinhibition have been established as valid predictors for onset of psychological disorders (Krueger, 1999b; Krueger et al., 2001). Longitudinal studies examining relationships between childhood personality traits and subsequent SUDs provided early evidence for the externalizing spectrum. Cloninger and colleagues (1988) explored the relationship between novelty seeking, harm avoidance, and reward dependence in childhood and later AUD development. Higher degrees of these traits were related to increased risk for AUD suggesting existing externalizing personality traits contribute to later externalizing psychopathology development. Further, externalizing personality traits in adulthood confers risk for onset of SUDs more generally (Krueger et al., 1996; Krueger et al., 2007; Sher & Trull, 1994). These studies highlight shared personality features across externalizing disorders present throughout development.

Recently, shared influences underlying externalizing disorders and other psychopathology have been recovered in factor analytic studies. Factor analytic approaches estimate common risk factors underlying externalizing disorders, such as personality. Caspi and colleagues' (2014) bifactor and Kotov and colleagues' (2017) Hierarchical Taxonomy of Psychopathology (HiTOP) approaches examine symptom- and syndromal-level associations across mental disorders. Although these approaches extend beyond syndromal associations, they do not explicitly examine individual symptom associations across disorders. However, some evidence suggests SUD symptoms may vary in their association with an underlying externalizing process. Kendler and colleagues (2012) found three underlying genetic factors for the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV; American Psychiatric Association [APA], 1994) alcohol dependence symptoms. These

results raise the possibility of multiple genetically distinct risk factors for AUD (and possibly other SUDs) rather than a unitary risk factor. Further, some alcohol dependence genetic factors were ostensibly more related to the externalizing spectrum than others. For example, the loss of control and social dysfunction factor had the strongest association with cannabis dependence and CD symptom count, while the tolerance and excess drinking factor had the weakest association with cannabis dependence and CD symptoms. This suggests some criteria may have a stronger externalizing component than other criteria. Kendler and colleagues' (2012) study serves as an example of the shared latent trait underlying externalizing disorders and suggests this trait may not be generalizable to all AUD symptoms. Distinguishing AUD symptomatology based on an externalizing component, however, is not a recent development.

Historically, at least two distinct alcoholic subtypes have been proposed; one characterized by physiological dependence on alcohol, or neuroadaptation, and another characterized by poor self-control, or disinhibition. Although there are variations in the characteristics attributed to each subtype, a distinction between those with and without externalizing traits is made. For example, type A (Babor et al., 1992), type I (Cloninger, 1987), delta (Jellinek, 1960), reactive (Knight, 1937), primary (Winokur et al., 1971), and developmentally cumulative (Zucker, 1987) alcoholic-subtypes share common characteristics not commonly associated with externalizing traits, such as later drinking onset and alcoholism, high responsibility, and strong interpersonal relationships. Conversely, the complements to these subtypes (i.e., type B [Babor et al., 1992], type II [Cloninger, 1987], gamma [Jellinek, 1960], essential [Knight, 1937], sociopathic [Winokur et al., 1971], and antisocial [Zucker, 1987] alcoholic-subtypes), exhibit externalizing traits with characteristics such as earlier drinking onset and alcoholism, aggressiveness, frequent irresponsibility, and dysfunctional interpersonal relationships. This brings rise to the possibility that AUD (and perhaps other SUDs) criteria may be etiologically heterogeneous, such that certain AUD criteria may be more linked to an externalizing process than others. Extending findings from Kendler et al. (2012) and research in support of the externalizing spectrum, the current study focuses on symptoms of three externalizing disorders (i.e., AUD, CD, and ASPD) to determine which aspects of AUD symptomatology are most (and least) related to externalizing behaviors.

Current Study

Research has yet to systematically characterize the degree to which individual AUD criteria are associated with other externalizing spectrum indicators. Such characterization is potentially important in isolating symptoms more or less externalizing versus those more uniquely associated with alcohol use. In turn, different symptom profiles (not necessarily syndromal subtypes) might suggest different treatment targets. The present study examines the association of individual AUD criteria to externalizing behavior problems, especially those related to antisociality and impulsivity more generally. Externalizing behavior and alcohol consumption will likely be associated with each criterion, however, overall and relative association magnitudes may vary as a function of the nature of the criterion. Specifically, some AUD criteria ostensibly reflect neuroadaptations (e.g., tolerance, withdrawal) and some criteria appear to reflect poor self-control and/or reward seeking behavior (e.g., alcohol use in hazardous situations). It is hypothesized criteria seeming to

reflect impaired self-control will have higher associations with externalizing behavior whereas criteria more related to neuroadaptations will be less associated with externalizing behavior, and possibly more related to alcohol consumption (Figure 1).

Criteria within the “more” and “less” externalizing poles are considered prototypes of the poor self-regulation and physiological dependence distinction. Our model serves as a basic prototype of possible criteria orderings. We anticipate externalizing behavior and alcohol consumption associations with AUD criteria will be more complex, such that some criteria may be more purely related to consumption while other criteria may reflect dual-processes. To make matters more complex, it appears some neuroadaptations (e.g., incentive salience development; Robinson & Berridge, 1993) are associated with increases in impulsivity, at least in rodent models (Lovic et al., 2011). Given the complex processes underlying addiction, it is unlikely a given AUD criterion would be uniquely associated with either externalizing behavior or consumption. Thus, our a priori ordering represents our “best guess” of relative contributions, and items at the continuum poles are likely to be associated with both externalizing behavior and consumption.

Materials and Methods

Samples

NESARC.—The National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) is an epidemiological survey of U.S. persons 18 years and older conducted by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) in 2001–2002 (NESARC Wave 1; Grant et al., 2003) with a follow up in 2004–2005 (NESARC Wave 2; Grant & Kaplan, 2005). Participants who completed NESARC Wave 2, consumed at least one alcoholic beverage within the past year, and were at least 21 years old were included ($N=22,160$). Individuals at least 21 years old were selected because most individuals were at least 21 years old in NESARC Wave 2. Since the study compares two samples, the age minimum was set to 21 years-old to increase consistency across samples. Sample characteristics are presented in Table 1.

NESARC-III.—To assess the robustness and reliability of findings, analyses were replicated in an independent sample using data from NESARC-III (Grant et al., 2014). Participants who consumed at least one alcoholic beverage in the past year and were at least 21 years old were included in the replication sample ($N=24,773$). NESARC-III sample characteristics are presented in Table 1.

Measures

The Alcohol Use Disorder and Associated Disabilities Interview Schedule-Fourth Edition (AUDADIS-IV; Grant et al., 2001) and AUDADIS-5 (Grant et al., 2011) are structured interviews which assess AUD and comorbid psychological disorders for NESARC and NESARC-III, respectively. Items consistent across AUDADIS versions were used (see Appendix).

Externalizing behavior.—Externalizing behavior (hereafter referred to as EXT) was measured via ASPD, CD, and other impulsivity items. This operational definition excludes some common indicators of the externalizing spectrum, like ADHD and drug use disorders (DUDs), due to methodological and conceptual issues. ADHD was not included because it is unclear whether ADHD represents externalizing behavior without comorbid conduct problems (e.g., Abramowitz, Kosson, & Seidenberg, 2004; Loney, 1987; Loney et al., 1981; Mordre et al., 2011). Additionally, in the AUDADIS, childhood ADHD symptoms are based on retrospective self-report, which is associated with low recall accuracy and increased false positive rates (e.g., Mannuzza et al., 2002; Miller, Newcorn, & Halperin, 2010; Sibley et al., 2012). Further, ADHD, and other externalizing behavior indicators, like pathological gambling, were not assessed in both samples. Together, ASPD and CD represent the only externalizing disorders available in both AUDADIS versions aside from DUDs. Due to the high overlap across alcohol and DUDs, DUDs were also excluded in the EXT measure. Therefore, ASPD and CD symptoms primarily represented EXT¹. Impulsivity items were included to broaden EXT's scope, as impulsivity is a known characteristic associated with externalizing behavior (e.g., Krueger et al., 1996; Krueger et al., 2002). ASPD was measured using seven DSM-5 lifetime ASPD symptoms. CD was assessed with 14 of the 15 DSM-5 symptoms (the “has broken into someone else's house, building, or car” excluded because it is not included in the AUDADIS) that occurred prior to age 15. Impulsivity was measured using three items from the lifetime borderline personality disorder assessment in the AUDADIS. Impulsivity items assessed risky sexual behavior, gambling/over-spending, and engaging in activities in an impulsive way. An exploratory factor analysis (EFA) was conducted on ASPD, CD, and impulsivity items. Results indicated a one-factor solution best fit the data across samples (Supplementary Figure 1; Supplementary Tables 1–3)². Factor scores from a one-factor confirmatory factor analysis (CFA) were standardized and used in analyses (Table 1).

Alcohol consumption.—Alcohol consumption (hereafter referred to as CON) was measured via past-year drinking frequency, usual amount of alcohol consumed on drinking days, binge (4+/5+ drinks in single episode) frequency, intoxication frequency, exceeding daily drinking limits (NIAAA, 2004) frequency, and maximum number of drinks in a 24-hour period. Measures selected for inclusion have been shown to be related to genetic factors associated with heavy drinking behavior (Agrawal et al., 2009; Agrawal et al., 2011). Each consumption measure was standardized and an EFA was conducted on the standardized variables to determine the underlying factor structure. Results indicated a one-factor solution across samples (Supplementary Figure 3; Supplementary Tables 7 and 8)³. Factor scores from a one-factor CFA were re-standardized and included in analyses (Table 1).

¹Supplementary analyses were conducted in the NESARC sample in which EXT was measured using CD symptoms, ASPD symptoms, BPD impulsivity items, and *childhood ADHD symptoms* to determine whether inclusion of ADHD symptoms significantly changed results.

²Parallel analysis is not available for categorical data in Mplus. Thus, parallel analysis was not used to determine the factor structure for EXT. Instead, fit indices and a scree plot of eigenvalues were used to determine the best factor solution. EFAs were also conducted on the alternative EXT measure that included ADHD. Results from the EFA and CFA of the alternative EXT measure is available in Supplementary Figure 2 and Supplementary Tables 4–6.

³To determine the factor structure, we conducted two EFAs: one that accounted for complex survey methods and one that did not. We included an EFA that did not account for complex survey methods since Mplus cannot conduct parallel analyses with complex survey weights. In EFAs that accounted for complex survey techniques, we compared scree plots of eigenvalues. For the EFAs that did not

AUD criteria.—The following lifetime DSM-5 AUD (APA, 2013) criteria were used in the present study: (1) hazardous use – recurrent alcohol use in physically hazardous situations; (2) social problems –social/interpersonal problems caused or exacerbated by alcohol; (3) role interference –failure to fulfill major role obligations (e.g., work, home) because of alcohol use; (4) larger/longer – alcohol taken in larger amounts or over longer periods; (5) quit/cut down – persistent desire or unsuccessful efforts to cut down alcohol use; (6) time spent – substantial time spent in drinking activities (e.g., using or recovering from alcohol); (7) physical/psychological problems – physical or psychological problems due to alcohol use; (8) give up – important activities given up because of alcohol use; (9) craving – strong desire or urge to use alcohol; (10) tolerance – developing alcohol tolerance; (11) and withdrawal – having withdrawal symptoms or using alcohol to avoid withdrawal. Endorsement of one item within each criterion constituted positive endorsement, except for withdrawal. Endorsement of either two withdrawal items, or one relief/avoidance from withdrawal constituted positive endorsement. In the NESARC sample lifetime AUD criteria measures were based on endorsement at either Wave 1 or Wave 2 for all criteria excluding craving, which was not assessed in NESARC Wave 1. As such, craving’s assessment in NESARC was limited to the time between NESARC Wave 1 and Wave 2.

Analytic Strategy

Multigroup analyses were included to account for varying EXT and AUD comorbidity patterns of across developmental periods. The following age cohorts were used in all analyses: young (21–35), middle (36–55) and old (56+). We also included sex and race⁴ as exogenous covariates in all models. To assess whether criteria are more or less EXT, associations with EXT and CON were rank ordered based on the strength and direction of relationships with AUD criteria, with higher rankings indicating a stronger relationship. The study focus is on “top” rankings, which is defined as the three criteria most and least associated with EXT and CON (i.e., criteria ranked 1, 2, 3, 9, 10, and 11). In cases where estimates of the fourth and eighth ranked criteria were equal to third and ninth ranked criteria when rounded to the nearest hundredth, these criteria were included in the “top” rankings.

Path models.—Path models determined relative EXT and CON contributions across AUD criteria. In these models, EXT and CON predicted AUD criteria endorsement with sex and race included as covariates (Figure 2A)⁵.

Factor-controlled (FC) models.—Multiple Indicator Multiple Causes (MIMIC) models examined unique EXT and CON effects on criterion endorsement after consideration of indirect effects modeled through a latent AUD factor. Studies indicate AUD criteria form a

account for complex sampling, we conducted a parallel analysis to determine factor scores. All analyses suggested a single factor best captured the data.

⁴.Race was originally a 5-level variable that accounted for race and ethnicity and included the following categories: non-Hispanic White, non-Hispanic Black, non-Hispanic Native American/Alaskan Native, non-Hispanic Asian American/Pacific Islander, and Hispanic. However, this variable was collapsed into a dichotomous variable (1=non-White, 0=White) due to the low-prevalence rates of non-White participants in multigroup analyses.

⁵.Supplementary analyses also examined the independent associations of EXT and CON with AUD criteria. Results from these analyses are available in Supplementary Tables 9–10.

robust one-factor solution (e.g., Hasin et al., 2013; Langenbucher et al., 2004)⁶. We sought to leverage this well replicated finding by asking whether unique associations with EXT and CON were present above general associations with syndromal AUD. To do this, we modeled a latent AUD factor regressed on EXT and CON. The AUD factor was identified by constraining the criterion path with the largest factor loading to one (this was the give up criterion for all models). Paths from EXT and CON to AUD criteria were also modeled to assess unique effects. MIMIC models were specified as EXT and CON predicting a latent AUD factor and AUD criteria (Figure 2B)⁷.

To attain EXT and CON path estimates (as well as sex and race) to AUD criteria, a set of 11 submodels were estimated for each MIMIC model. For submodels to be statistically identified, paths were estimated for 10 of 11 AUD criteria, one criterion at a time. Paths were iteratively redacted from each submodel resulting in 10 sets of estimates (i.e., EXT, CON, sex, and race paths) for each criterion. Median estimates across submodel sets are reported as MIMIC model estimates.

Replicability/reproducibility analyses.—Product-moment and intra-class correlations (ICCs) estimated the consistency between regression coefficients and their rank orderings across samples and age cohorts. These analyses assessed the stability of EXT and CON associations with AUD criteria. Strong correlations suggest high replicability across samples. Previously established guidelines suggest ICCs can be interpreted as follows: below 0.40 is considered poor, between 0.40 and 0.59 is considered fair, between 0.60 and 0.74 is considered good, and above 0.75 is considered excellent (Cicchetti & Sparrow, 1981; Fleiss, 1981).

Results

Path Models

Estimates were significantly different across age cohorts in both samples. Results are presented in Table 2.

EXT associations.—EXT was most associated with social problems and role interference in all analyses. Across age, give up and time spent were included as “top” EXT criteria in either NESARC or NESARC-III. EXT was least associated with quit/cut down and tolerance across all analyses. Larger/longer was among the lowest ranked EXT criteria across age in NESARC-III, while craving was among the least EXT associated across age in NESARC and in the NESARC-III old cohort. Finally, hazardous use was among the least EXT in the NESARC-III middle cohort only.

⁶.We explored alternative models to determine whether a unitary factor best suited the data. In particular, a random intercept model, which allowed AUD criteria factor loadings to vary randomly, was considered. This model did not converge for either samples, suggesting AUD criteria may have a unitary structure. EFAs were also conducted to determine the underlying factor solution. Across samples, a one-factor solution best fit the data.

⁷.Supplementary analyses were included for factor-controlled models, such that EXT and CON associations with AUD criteria were also modeled independently. The results from these analyses are available in Supplementary Tables 11–13.

CON associations.—Larger/longer was among the “top” most CON associated criteria in all models. Tolerance and hazardous use were among the “top” most CON criteria across age cohorts in the NESARC and/or NESARC-III samples. The remaining “top” CON criteria had variable patterns and are as follows: (1) physical/psychological problems in NESARC-III young and old cohorts; (2) craving in NESARC middle and old cohorts; and (3) quit/cut down in the NESARC-III middle cohort and NESARC old cohort. Regarding least CON associated criteria, give up and role interference were consistently among the least CON associated criteria in all analyses. Additionally, social problems was among the least CON criteria across age cohorts in NESARC. The remaining least CON associated criteria are as follows: (1) quit/cut down in the NESARC-III young cohort; (2) withdrawal in the NESARC-III middle cohort; and (3) time spent in the NESARC-III old cohort.

FC Models

Since paths were not consistently significant within submodel sets, a binomial test of significance was used to determine median residual regression coefficients' reliability. In the binomial test, a two-tailed probability was set at $p=0.025$ ($\alpha=0.05$) for 10 trials (i.e., 10 estimates for each criterion). After taking into account multiple test occasions by 10 separate criteria, the probability of observing four or more significant paths out of 10 was less than 0.0001. Therefore, median residual estimates with four or more (out of 10) significant paths within submodel sets are considered “significant.” In both samples median fit statistics across models suggest good fit. NESARC had the following fit statistics: $\chi^2=622.31$, $p<0.05$, $df=150$, Root Mean Square Error of Approximation (RMSEA)=0.021, Comparative Fit Index (CFI)=0.995, and Tucker Lewis Index (TLI)=0.990. NESARC-III's fit statistics were as follows: $\chi^2=674.83$, $p<0.05$, $df=150$, RMSEA=0.021, CFI=0.997, and TLI=0.993.

All paths were ranked based on median estimates, however, only “significant” path rankings are discussed below. Positive “significant” paths from EXT and CON suggest these constructs may uniquely increase the likelihood of AUD criterion endorsement. Negative “significant” (and “non-significant”) paths may suggest decreased likelihood of AUD criteria endorsement, or suppression effects. Suppression effects may be likely to arise given the number of paths estimated in FC models and variable correlations among EXT, CON, and AUD (Table 1). Redaction of highly correlated AUD criteria in FC submodels could result in a suppression effect of EXT and CON paths to AUD criteria. Table 3 displays median factor loadings and regression coefficients for FC models⁸. Estimates were significantly different among age cohorts in both samples.

EXT associations.—EXT positively predicted AUD in all analyses. Social problems and hazardous use were among the strongest “significant” positive EXT paths in all analyses. Role interference was among the strongest “significant” positive paths in all analyses except the NESARC middle cohort. Quit/cut down was consistently among the greatest negative “significant” EXT paths in all analyses. Similarly, larger/longer was among the least “significant” EXT paths for each age cohort in either NESARC or NESARC-III. Remaining

⁸. Across FC models, there were standardized AUD factor loadings greater than 1. When AUD factor loadings were greater than 1, the corresponding EXT and/or CON criterion-path estimates were negative and did not have negative residual variances. This suggests the standardized factor loadings greater than 1 were likely due to a suppression effect.

criteria were not among the largest negative “significant” EXT paths across cohorts. Tolerance was among the least EXT paths for young and middle cohorts in NESARC and/or NESARC-III, while craving was among the greatest “significant” negative EXT paths for the old cohort across samples. Lastly, give up was among the largest “significant” negative EXT paths in the NESARC-III young cohort only.

CON associations.—CON positively predicted AUD in all analyses. Tolerance was among the “top” positive “significant” CON paths in all analyses. Larger/longer and hazardous use were among the top CON associations across age cohorts in NESARC and/or NESARC-III samples. The remaining “top” positive CON associations were as follows: (1) craving in the NESARC middle and old cohorts; (2) physical/psychological problems in the NESARC-III young cohort; and (3) quit/cut down in the NESARC old cohort. Meanwhile, role interference and give up were consistently among the strongest negative “significant” CON paths in all analyses. Social problems was among the top negative CON paths across age cohorts in the NESARC sample only. The other “top” ranked negative CON paths were variable across age cohorts or samples. They are as follows: (1) time spent in the NESARC-III middle and old cohorts; (2) quit/cut down in the NESARC-III young cohort; and (3) physical/psychological problems in the NESARC-III middle cohort.

Replicability/Reproducibility Analyses

Correlations examined estimates’ and ranking orderings’ consistency across samples and within age cohorts (Table 4). EXT and CON path and FC model regression coefficients and rankings were generally highly correlated across samples, suggesting good stability across samples. Additionally, ICCs assessed parameter estimates reliability across age cohorts (Table 5). Across models, ICCs for EXT and CON coefficients and rankings were typically within the good to excellent range, except in path models. Specifically, CON coefficients from the path models were within the poor range when examining age cohort consistency overall (i.e., across samples) and within the NESARC-III sample. This is likely driven by greater variability in CON path estimates across age cohorts in NESARC-III. Overall, results suggest moderate-high replicability across samples and age cohorts, with greater replicability for FC models.

Discussion

The present study aimed to systematically characterize the degree to which individual DSM-5 AUD criteria (APA, 2013) are associated with EXT to better understand robust relations reported at the syndromal level. Results indicate modest and variable associations between EXT and AUD criteria. It was hypothesized criteria ostensibly reflecting impaired self-control (e.g., hazardous use and social problems) would have relatively stronger associations with EXT, whereas criteria seeming to reflect neuroadaptations resulting from chronic alcohol use (e.g., withdrawal and tolerance) would have weaker associations with EXT. Our results provide some evidence for our a priori theoretical AUD criteria ordering. For instance, social problems and role interference criteria were most strongly associated with EXT across path models and generally exhibited “significant” positive associations with EXT in FC models. These results seemingly fit with our criteria theoretical ordering

(Figure 1). Similarly, tolerance was consistently most weakly associated with EXT in path models and had strong “significant” negative associations with EXT in most FC models. These results indicate the presence of “more” and “less” externalizing AUD criteria.

“More” Externalizing AUD Criteria

Social problems and role interference were hypothesized to be more externalizing criteria because of similarities with historical externalizing alcoholic subtypes (e.g., Knight, 1937, Zucker, 1987). Based on our results, it appears both criteria are more strongly associated with externalizing characteristics than other AUD symptomatology. These associations could be due to conceptual overlap across disorders (e.g., shared irresponsibility characteristics), or increased vulnerability to pharmacological effects of alcohol by more externalizing individuals. McDougall (1929) reported observing cases in which extroverted individuals were “very susceptible to the influence of alcohol,” such that disinhibition increased at low consumption levels. Similarly, Cleckley’s (1955) criteria for psychopathy included “fantastic and uninviting behavior with drink and sometimes without,” noting psychopaths as more likely to engage in socially unacceptable behavior with or without consumption. Our findings could be due to increased social deviance at lower consumption levels for more externalizing individuals, increasing the likelihood for social-behavioral criteria (e.g., social problems) endorsement. Results are also consistent with Kendler and colleagues (2012), as the loss of control and social dysfunction genetic risk factor most associated with EXT characteristics included the role interference criterion. In our results, role interference’s association with externalizing could be related to a shared externalizing component underlying CD, ASPD, and more externalizing AUD symptomatology more generally.

Conversely, hazardous use’s associations with EXT was more mixed. Hazardous use was theorized to be more externalizing than other AUD symptomatology because of the reckless behavior embedded in the criterion. Hazardous use was not consistently among the strongest associations with EXT relative to other AUD criteria in path models; however hazardous use had strong “significant” unique associations with EXT in most FC models. This may be explained, in part, by hazardous use’s restricted conceptualization. Although hazardous use can include a range of reckless behavior, it is commonly characterized by drinking and driving (Martin, Sher, & Chung, 2011). Indeed, in the AUDADIS (Grant et al., 2001; Grant et al., 2011) two of the three items assessing hazardous use involve drinking and driving. Hazardous use’s associations with EXT may be driven by drinking and driving behavior’s association with EXT and CON (i.e., stronger associations with CON due to drinking and driving operationalization), rather than other hazardous use behaviors. Hazardous use’s association with EXT may be better elucidated by assessing more reckless behaviors. Additionally, hazardous use as a criterion may reflect two distinct processes: (1) general heedlessness, and (2) a manifestation of compulsive use. Disambiguating the meaning of hazardous use for a given individual would require more extensive assessment than the mere phenotypic aspects of the behavior.

“Less” Externalizing AUD Criteria

Tolerance was initially theorized to be less externalizing than other AUD criteria because it was presumed to be an indicator of neuroadaptations from prolonged alcohol use.

Tolerance is characterized by a physiological change resulting in the need for increased alcohol consumption to achieve desired effects. Tolerance appears to be less related to EXT and strongly related to CON with relatively robust unique CON associations. Craving was also theorized as an indicator of neuroadaptation due to increased drug cue sensitization (Robinson & Berridge, 1993). Results provide some evidence in support of this hypothesis, though findings were not as robust as tolerance. Specifically, craving was among the least EXT criteria in a majority of path models, with some negative “significant” EXT associations in FC models. Coinciding with our hypothesis, tolerance and craving may be less externalizing and a better alcohol neuroadaptation indicator than other AUD symptomatology.

Likewise, withdrawal was hypothesized to be less externalizing because it was presumed to be an indicator of physiological changes resulting from chronic alcohol exposure. Contrary to our hypothesis, withdrawal appears to have a stronger EXT-related component than theorized. Though withdrawal generally had small negative associations with EXT in FC models, withdrawal generally had midlevel rank orderings for EXT (and CON) in path models. This may be explained, in part, by the AUDADIS’ (Grant et al., 2001; Grant et al., 2011) withdrawal measure. Studies note the AUDADIS may confound hangover and withdrawal effects (Boness, Lane, & Sher, 2016; Martin et al., 2018). The AUDADIS’ withdrawal (which confounds traditional withdrawal symptoms with possible hangover because the stem includes “the morning after drinking”) could reflect binge drinking episodes leading to hangover, rather than withdrawal. Additionally, changes to the withdrawal definition in the DSM may also explain findings. The tremors specifier (i.e., tremors requirement for alcohol withdrawal diagnosis) was removed in DSM-IV (APA, 1994). Removal of the tremors specifier for withdrawal has been associated with decreased alcohol dependence chronicity odds, suggesting lower predictive utility of DSM-5 withdrawal (Hasin et al., 2000). Consequently, withdrawal’s current operationalization may not be the best indicator of physiological dependence on alcohol.

AUD Criteria “In the Middle”

For some AUD criteria hypothesized to be “in the middle,” unanticipated EXT associations were present. Quit/cut down and larger/longer criteria were theorized to be “in the middle,” such that there is no clear distinction between an externalizing or alcohol-related component; however, these criteria may be less “in the middle” and less related to EXT. Like tolerance, quit/cut down and larger/longer were consistently less associated with EXT in path models, and had strong unique “significant” negative associations with EXT in FC models. Overall, results suggest these criteria may be less likely to be contaminated by EXT therefore potentially serving as direct indicators of physiological dependence relative to other AUD symptomatology.

In sum, there was a consistent pattern of AUD criteria “most” and “least” associated with EXT across age cohorts and samples, with some variation in age cohorts. The variation across age cohorts did not typically have an age-specific pattern, suggesting EXT associations are mostly consistent across developmental periods. Together, findings provide evidence for variable associations between EXT and AUD symptomatology.

Implications

The possibility that some criteria may be less alcohol related has been raised (Martin et al., 2014) and is partially supported in these results. Although consumption is a robust criterion predictor, our results note an additional externalizing process underlying some criteria endorsement. This externalizing process, as measured by CD, ASPD, and impulsivity items, appears to have a greater influence on criteria more related to poor self-regulation (e.g., role interference) and less influence on criteria related to neuroadaptations (e.g., tolerance). Criteria more contaminated by an externalizing process may be weaker indicators of maladaptive drinking patterns than those less contaminated by EXT. Further investigation into externalizing criteria could have important diagnostic refinement implications. Our analyses do not provide evidence to support the removal of more externalizing criteria, however, diagnostic measures may want to differentiate criteria related to alcohol-related processes and externalizing processes to better assess atypical functioning.

In a recent review, Litten and colleagues (2015) noted a need for a systematic approach to studying AUD based on the Research Domain Criteria initiative (RDoC; Insel et al., 2010). RDoC is a framework to study psychopathology which integrates several domains (from neurobiology to observed behaviors) to understand underlying dimensions of functioning in normal and atypical behavior (Cuthbert & Insel, 2013). By understanding domains underlying AUD, the extent to which such specific domains overlap with other diagnostic categories can be better understood. Treatments targeting underlying constructs rather than diagnostic categories are likely to be more personalized and therefore more effective than current clinical treatments (Litten et al., 2015). Results from the present study could indicate externalizing mechanisms related to specific AUD symptomatology that would inform diagnostic, treatment, and prevention practices.

Associations between EXT and some criteria may have additional treatment implications. By identifying more externalizing criteria treatment targets can be personalized for individuals with certain AUD symptom patterns. In recent years, researchers have focused on identifying AUD subgroups with shared pathophysiology who may be more likely to respond to certain medications to improve medication efficacy (e.g., Johnson, 2010). This approach can be applied to both pharmacological and psychological AUD treatments. For example, an individual endorsing solely social-behavioral AUD symptomatology may benefit from treatment targeting poor self-regulation and consumption reduction because it addresses multiple areas of problematic functioning. A social-behavioral symptom profile may also suggest the use of medications targeting subjective craving responses (e.g. acamprosate) since externalizing individuals are more likely to have greater sensitivity to subjective craving responses. More generally, our results are consistent with recent calls to examine comorbidity at the symptom-level as is increasingly being done in network approaches to psychopathology (Borsboom & Cramer, 2013).

Limitations & Future Directions

The current study has several notable strengths, including the use of two large, nationally-representative samples. However, some limitations should be noted. First, the study used retrospective externalizing behavior self-reports. Common self-report biases (e.g., social

desirability, recall bias) may have affected the recall accuracy of more deviant externalizing behaviors. Additionally, CD symptoms were assessed prior to age 15 with two items assessed prior to age 13, which may influence accuracy recall in the samples. CD and ASPD criteria also had very low base rates across samples and a measure with better “low end” resolution might have yielded more sensitive analyses. Our analytic approach also relied on cross-sectional correlational analyses, precluding insight into causal mechanisms, growth progressions, or reciprocal processes (i.e., feedback loops) between externalizing and AUD symptom endorsement. Further, our analytic approach did not incorporate AUD criteria interrelatedness beyond consideration of a single latent AUD variable. Some AUD criteria are highly correlated in the AUDADIS, with criteria like give up and role interference correlated above 0.8 (Table 1), which may have altered associations between them and EXT. These high correlations may also drive suppression effects in FC models, given the complex specification involved in these models.

Finally, EXT was measured within a diagnostic framework. EXT was constrained to behaviors associated within CD, ASPD, and impulsivity assessed within a diagnostic instrument. General personality traits associated with EXT were not assessed. Personality has been associated with externalizing psychopathology, including AUD (e.g., Sher & Trull, 1994). Assessment of personality traits in conjunction with diagnostic externalizing behaviors and AUD symptomatology could expand upon the results in the present study. Additionally, inclusion of other externalizing psychopathology would greatly enhance our EXT measure. Given that other disinhibitory disorders, like ADHD, pathological gambling, and DUDs, were not included in the EXT measure, the scope of the relationship between AUD criteria and other EXT disorders was somewhat limited⁹.

Research using prospective EXT assessments, alternative modeling of EXT and AUD, and genetically informative designs across clinical and general populations is needed. Using prospective EXT assessments would allow for a more accurate account of externalizing behaviors. Additionally, it could help to resolve method effects minimizing retrospective biases in the assessments. In conjunction with prospective EXT measure, future research could incorporate an RDoC approach, including objective (e.g., cognitive measures) and subjective EXT assessment and addiction/alcohol-related processes. Moreover, research investigating the relationship of DUDs with EXT would further our understanding of (1) whether the AUD's associations with EXT are distinct, and (2) whether SUD symptoms are differentially related to the EXT based on the substance class. If there are in fact differential relationships across AUD and DUDs with EXT, this could suggest different externalizing processes underlying SUDs.

Additionally, AUD (and SUDs more generally) are also related to internalizing disorders like anxiety and depression (e.g., Burns & Teesson, 2002; Grant & Harford, 1995; Hussong et al., 2011). The internalizing pathway to AUD may explain some unanticipated associations, such as the relationship of EXT and CON with withdrawal. Moreover, some of the unique

⁹Supplementary analyses compared EXT path model and FC results to an alternative EXT measure (which included childhood ADHD symptoms) in the NESARC sample. Within these models, EXT tended to have a stronger relationship with AUD criteria, however, it did not dramatically change rankings (See Supplementary Tables 14–15).

associations from FC models, specifically negative EXT paths, could be related to AUD criteria's associations with the internalizing spectrum. Future research investigating AUD criteria's associations with internalizing disorders, independently and jointly, could better elucidate these complex relationships.

The present study suggests variable associations of EXT and AUD symptomatology beyond syndromal associations. To further our understanding of AUD and its comorbidity with other externalizing disorders, research should extend beyond syndromal associations and consider comorbidity at the symptom level to better identify key clinical concerns and promising targets for treatment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements:

The authors have no financial relationships relevant to this article to disclose.

Funding Source: This work was supported by grants from the National Institute on Alcohol Abuse and Alcoholism grants T32-AA013526, R01-AA024133, and K05-AA017242 to Kenneth J. Sher. The funding agency and data providers had no role in the design, conduct, collection, management, analysis, or interpretation of data, or the preparation, review, or approval of this paper.

References

- Abramowitz CS, Kosson DS, Seidenberg M (2004) The relationship between childhood attention deficit hyperactivity disorder and conduct problems and adult psychopathy in male inmates. *Personality and Individual Differences* 36(5):1031–47.
- Agrawal A, Grant JD, Littlefield A, Waldron M, Pergadia ML, Lynskey MT, Madden PA, Todorov A, Trull T, Bucholz KK, Todd RD (2009) Developing a quantitative measure of alcohol consumption for genomic studies on prospective cohorts. *Journal of Studies on Alcohol and Drugs* 70(2):157–68. [PubMed: 19261227]
- Agrawal A, Lynskey MT, Todorov AA, Schrage AJ, Littlefield AK, Grant JD, Zhu Q, Nelson EC, Madden PA, Bucholz KK, Sher KJ (2011) A candidate gene association study of alcohol consumption in young women. *Alcoholism: Clinical and Experimental Research* 35(3):550–8.
- American Psychiatric Association (1994) *Diagnostic and statistical manual of mental disorders*. 4th ed American Psychiatric Publishing, Washington, DC.
- American Psychiatric Association (2013) *Diagnostic and statistical manual of mental disorders*. 5th ed American Psychiatric Publishing, Washington, DC.
- Babor TF, Hofmann M, DelBoca FK, Hesselbrock V, Meyer RE, Dolinsky ZS, Rounsaville B (1992) Types of alcoholics, I: Evidence for an empirically derived typology based on indicators of vulnerability and severity. *Archives of General Psychiatry* 49:599–608. [PubMed: 1637250]
- Boness CL, Lane SP, Sher KJ (2016) Assessment of withdrawal and hangover is confounded in the alcohol use disorder and associated disabilities interview schedule: withdrawal prevalence is likely inflated. *Alcoholism: Clinical and Experimental Research* 40:1691–1699.
- Borsboom D, Cramer AO (2013) Network analysis: an integrative approach to the structure of psychopathology. *Annual Review of Clinical Psychology* 9:91–121.
- Burns L, Teesson M (2002) Alcohol use disorders comorbid with anxiety, depression and drug use disorders: Findings from the Australian National Survey of Mental Health and Well Being. *Drug and Alcohol Dependence* 68(3):299–307. [PubMed: 12393224]
- Caspi A, Houts RM, Belsky DW, Goldman-Mellor SJ, Harrington H, Israel S, Meier MH, Ramrakha S, Shalev I, Poulton R, Moffitt TE (2014) The p factor: one general psychopathology factor in the

structure of psychiatric disorders?. *Clinical Psychological Science* 2:119–137. [PubMed: 25360393]

- Cicchetti DV, & Sparrow SA (1981). Developing criteria for establishing interrater reliability of specific items: applications to assessment of adaptive behavior. *American Journal of Mental Deficiency*, 86, 127–137. [PubMed: 7315877]
- Cleckley H (1955) *Fantastic and uninviting behavior with drink and sometimes without*, in *The Mask of Sanity: An Attempt to Clarify Some Issues About the So-called Psychopathic Personality* 3rd ed (Cleckley H ed), pp. 406–410. C V Mosby Co, St Louis, MO.
- Cloninger CR (1987) Neurogenetic adaptive mechanisms in alcoholisms. *Science* 236:410–416. [PubMed: 2882604]
- Cloninger CR, Sigvardsson S, Bohman M (1988) Childhood personality predicts alcohol abuse in young adults. *Alcoholism: Clinical and Experimental Research* 12:494–505.
- Compton WM, Conway KP, Stinson FS, Colliver JD, Grant BF (2005) Prevalence, correlates, and comorbidity of DSM-IV antisocial personality syndromes and alcohol and specific drug use disorders in the United States: results from the national epidemiologic survey on alcohol and related conditions. *Journal of Clinical Psychiatry* 66:677–685. [PubMed: 15960559]
- Cuthbert BN, Insel TR (2013) Toward the future of psychiatric diagnosis: the seven pillars of RDoC. *BMC Medicine* 11:126. [PubMed: 23672542]
- Farmer RF, Seeley JR, Kosty DB, Lewinsohn PM (2009) Refinements in the hierarchical structure of externalizing psychiatric disorders: Patterns of lifetime liability from mid-adolescence through early adulthood. *Journal of Abnormal Psychology* 118:699. [PubMed: 19899840]
- Fleiss JL (1981). *Statistical methods for rates and proportions* (2nd ed). New York: Wiley
- Franken IHA. (2002) Behavioral approach system (BAS) sensitivity predicts alcohol craving. *Personality and Individual Differences* 32:349–355.
- Grant BF, Chu A, Sigman R, Amsbary M, Kali J, Sugawara Y, Jiao R, Ren W, Goldstein R (2014) Source and Accuracy Statement: National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III). National Institute on Alcohol Abuse and Alcoholism, Rockville, MD.
- Grant BF, Dawson DA, Hasin DS (2001) The Alcohol Use Disorder and Associated Disabilities Interview Schedule-Fourth Edition Version (AUDADIS-IV). National Institute on Alcohol Abuse and Alcoholism, Bethesda, MD.
- Grant BF, Kaplan KD (2005) Source and Accuracy Statement for the 2004–2005 Wave 2 National Epidemiologic Survey on Alcohol and Related Conditions. National Institute on Alcohol Abuse and Alcoholism, Bethesda, MD.
- Grant BF, Goldstein RB, Smith SM, Jung J, Zhang H, Chou SP, Saha TD, Ruan WJ, Huang B, Smith SM, Zhang H, Jung J, Pickering RP, Aivadyan C, Greenstein E, Hasin DS (2011) The Alcohol Use Disorder and Associated Disabilities Interview Schedule, Fifth Edition Version (AUDADIS-5). National Institute on Alcohol Abuse and Alcoholism, Rockville, MD.
- Grant BF, Harford TC (1995) Comorbidity between DSM-IV alcohol use disorders and major depression: results of a national survey. *Drug and Alcohol Dependence* 39(3):197–206. [PubMed: 8556968]
- Grant BF, Moore TC, Shepard J, Kaplan K (2003) Source and Accuracy Statement: Wave 1 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). National Institute on Alcohol Abuse and Alcoholism, Bethesda, MD.
- Haeny AM, Littlefield AK, Sher KJ (2014) Repeated diagnoses of lifetime alcohol use disorders in a prospective study: Insights into the extent and nature of the reliability and validity problem. *Alcoholism: Clinical and Experimental Research* 38(2):489–500.
- Haeny AM, Littlefield AK, Sher KJ (2016) Limitations of lifetime alcohol use disorder assessments: A criterion-validation study. *Addictive Behaviors* 59:95–9. [PubMed: 27082748]
- Hasin DS, O'Brien CP, Aurriacombe M, Borges G, Bucholz K, Budney A, Compton WM, Crowley T, Ling W, Petry NM, Schuckit M, Grant BF (2013) DSM-5 criteria for substance use disorders: recommendations and rationale. *The American Journal of Psychiatry* 170:834–851. [PubMed: 23903334]

- Hasin DS, Paykin A, Meydan J, Grant BF (2000) Withdrawal and tolerance: prognostic significance in DSM-IV alcohol dependence. *Journal of Studies on Alcohol* 61:431–438. [PubMed: 10807215]
- Hussong AM, Jones DJ, Stein GL, Baucom DH, Boeding S (2011) An internalizing pathway to alcohol use and disorder. *Psychology of Addictive Behaviors* 25(3):390–404. [PubMed: 21823762]
- Insel T, Cuthbert B, Garvey M, Heinssen R, Pine DS, Quinn K, Sanislow C, Wang P (2010) Research domain criteria (RDoC): toward a new classification framework for research on mental disorder. *American Journal of Psychiatry* 167:748–751.
- Jellinek EM (1960) Alcoholism, a genus, and some of its species. *The Journal of the Canadian Medical Association* 83:1341–1345.
- Johnson BA (2010) Medication treatment of different types of alcoholism. *American Journal of Psychiatry* 167:630–639. [PubMed: 20516163]
- Kendler KS, Aggen SH, Prescott CA, Crabbe J, Neale MC (2012) Evidence for multiple genetic factors underlying the DSM-IV criteria for alcohol dependence. *Molecular Psychiatry* 17:1306–1315. [PubMed: 22105626]
- Knight RP (1937) The dynamics and treatment of chronic alcohol addiction. *Bulletin of the Menninger Clinic* 1:233–250.
- Kotov R, Krueger RF, Watson D, Achenbach TM, Althoff RR, Bagby RM, Brown TA, Carpenter WT, Caspi A, Clark LA, Eaton NR (2017) The Hierarchical Taxonomy of Psychopathology (HiTOP): A dimensional alternative to traditional nosologies. *Journal of Abnormal Psychology* 126:454. [PubMed: 28333488]
- Krueger RF (1999a) The structure of common mental disorders. *Archives of General Psychiatry* 56:921–926. [PubMed: 10530634]
- Krueger RF (1999b) Personality traits in late adolescence predict mental disorders in early adulthood: A prospective-epidemiological study. *Journal of Personality* 67:39–65. [PubMed: 10030020]
- Krueger RF, Caspi A, Moffitt TE, Silva PA, McGee R (1996) Personality traits are differentially linked to mental disorders: a multitrait-multidiagnosis study of an adolescent birth cohort. *Journal of Abnormal Psychology* 105:299–312. [PubMed: 8772001]
- Krueger RF, Markon KE, Patrick CJ, Benning SD, Kramer MD (2007) Linking antisocial behavior, substance use, and personality: an integrative quantitative model of the adult externalizing spectrum. *Journal of Abnormal Psychology* 116:645–666. [PubMed: 18020714]
- Krueger RF, Markon KE, Patrick CJ, Iacono WG (2005) Externalizing psychopathology in adulthood: A dimensional-spectrum conceptualization and its implications for DSM-V. *Journal of Abnormal Psychology* 114:537–550. [PubMed: 16351376]
- Krueger RF, McGue M, Iacono WG (2001) The higher-order structure of common DSM mental disorders: Internalization, externalization, and their connections to personality. *Personality and Individual Differences* 30:1245–1259.
- Langenbucher JW, Labouvie E, Martin CS, Sanjuan PM, Bavly L, Kirisci L, Chung T (2004) An application of item response theory analysis to alcohol, cannabis, and cocaine criteria in DSM-IV. *Journal of Abnormal Psychology* 113:72–80. [PubMed: 14992659]
- Litten RA, Ryan ML, Falk DE, Reilly M, Fertig JB, Koob GF (2015) Heterogeneity of alcohol use disorder: understanding mechanisms to advance personalized treatment. *Alcoholism: Clinical and Experimental Research* 39:579–584.
- Loney J (1987) Hyperactivity and aggression in the diagnosis of attention deficit disorder, in *Advances in clinical child psychology*, Vol. 10 (Lahey BB, Kazdin AE eds), pp. 99–135. Plenum Press, New York.
- Loney J, Kramer J, Milich R (1981) The hyperactive child grows up: Predictors of symptoms, delinquency, and achievement at follow-up, in *Psychosocial aspects of drug treatment for hyperactivity*, (Gadow KD, Loney J eds). Westview Press, Boulder, CO.
- Lovic V, Saunders BT, Yager LM, Robinson TE (2011) Rats prone to attribute incentive salience to reward cues are also prone to impulsive action. *Behavioural Brain Research* 223:255–261. [PubMed: 21507334]
- Mannuzza S, Klein RG, Klein DF, Bessler A, ShROUT P (2002) Accuracy of adult recall of childhood attention deficit hyperactivity disorder. *American Journal of Psychiatry* 159(11):1882–8. [PubMed: 12411223]

- Martin CS, Langenbucher JW, Chung T, Sher KJ (2014) Truth or consequences in the diagnosis of substance use disorders. *Addiction* 109:1773–1778. [PubMed: 24913314]
- Martin CS, Sher KJ, Chung T (2011) Hazardous use should not be a diagnostic criterion for substance use disorders in DSM-5. *Journal of Studies on Alcohol and Drugs* 72:685–686. [PubMed: 21683051]
- Martin CS, Vergés A, Langenbucher JW, Littlefield A, Chung T, Clark DB, Sher KJ (2018) Algorithm Analysis of the DSM-5 Alcohol Withdrawal Symptom. *Alcoholism: Clinical and Experimental Research* 42(6):1073–1083.
- McDougall W (1929) The chemical theory of temperament applied to introversion and extroversion. *The Journal of Abnormal and Social Psychology* 24:293–309.
- Merikangas KR, Mehta RL, Molnar BE, Walters EE, Swendsen JD, Aguilar-Gaziola S, Bijl R, Borges G, Caraveo-Anduaga JJ, Dewit DJ, Kolody B, Vega WA, Wittchen HU, Kessler RC (1998) Comorbidity of substance use disorders with mood and anxiety disorders: results of the International Consortium in Psychiatric Epidemiology. *Addictive behaviors* 23:893–907. [PubMed: 9801724]
- Miller CJ, Newcorn JH, Halperin JM (2010) Fading memories: retrospective recall inaccuracies in ADHD. *Journal of Attention Disorders* 14(1):7–14. [PubMed: 19794136]
- Moffitt TE, Caspi A, Taylor A, Kokaua J, Milne BJ, Polanczyk G, Poulton R (2010) How common are common mental disorders? Evidence that lifetime prevalence rates are doubled by prospective versus retrospective ascertainment. *Psychological Medicine* 40(6):899–909. [PubMed: 19719899]
- Mordre M, Groholt B, Kjelsberg E, Sandstad B, Myhre AM (2011) The impact of ADHD and conduct disorder in childhood on adult delinquency: A 30 years follow-up study using official crime records. *BMC Psychiatry* 11(1):57. [PubMed: 21481227]
- National Institute on Alcohol Abuse and Alcoholism (2004) NESARC Data Notes. National Institute on Alcohol Abuse and Alcoholism, Bethesda, MD.
- Nock MK, Kazdin AE, Hiripi E, Kessler RC (2006) Prevalence, subtypes, and correlates of DSM-IV conduct disorder in the National Comorbidity Survey Replication. *Psychological Medicine* 36:699–710. [PubMed: 16438742]
- Robbins TW, Gillan CM, Smith DG, de Wit S, Ersche KD (2012) Neurocognitive endophenotypes of impulsivity and compulsivity: towards dimensional psychiatry. *Trends in cognitive sciences* 16:81–91. [PubMed: 22155014]
- Robinson TE, Berridge KC (1993) The neural basis of drug craving: An incentive-sensitization theory of addiction. *Brain Research Reviews* 18:247–291. [PubMed: 8401595]
- Sher KJ, Trull TJ (1994) Personality and disinhibitory psychopathology: Alcoholism and antisocial personality disorder. *Journal of Abnormal Psychology* 103:92–102. [PubMed: 8040486]
- Shrout PE, Fleiss JL (1979) Intraclass correlations: uses in assessing rater reliability. *Psychological Bulletin* 86:420–428. [PubMed: 18839484]
- Sibley MH, Pelham WE, Jr, Molina BS, Gnagy EM, Waxmonsky JG, Waschbusch DA, Derefinko KJ, Wymbs BT, Garefino AC, Babinski DE, Kuriyan AB (2012) When diagnosing ADHD in young adults emphasize informant reports, DSM items, and impairment. *Journal of Consulting and Clinical Psychology* 80(6):1052. [PubMed: 22774792]
- Winokur G, Rimmer J, Reich T (1971) Alcoholism IV: is there more than one type of alcoholism? *The British Journal of Psychiatry* 118:525–531. [PubMed: 5580368]
- Witkiewitz K, King K, McMahon RJ, Wu J, Luk J, Bierman KL, Coie JD, Dodge KA, Greenberg MT, Lochman JE, Pinderhughes EE, Conduct Problems Prevention Research Group (2013) Evidence for a multi-dimensional latent structural model of externalizing disorders. *Journal of Abnormal Child Psychology* 41:223–237. [PubMed: 22936218]
- Wood PK, Jackson KM (2013) Escaping the snare of chronological growth and launching a free curve alternative: general deviance as latent growth model. *Development and Psychopathology* 25:739–754. [PubMed: 23880389]
- Zucker RA (1987) The four alcoholisms: A developmental account of the etiologic process, in *Alcohol and Addictive Behavior, Nebraska Symposium on Motivation*, 1986, Vol. 34 (Rivers PC ed), pp. 27–83. University of Nebraska Press: Lincoln, NE.

Zucker RA, Ellis DA, Bingham CR, Fitzgerald HE (1996) The development of alcoholic subtypes: Risk variation among alcoholic families during the early childhood years. *Alcohol Health & Research World* 20:46–55.

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Figure 2.

Multigroup path and factor-controlled models. *Figure 2A*: Path model; *Figure 2B*: Factor-controlled model. Multigroup analyses were based on the following age cohorts: young (ages 21 – 35); middle (ages 36 – 55); and old (ages 56 and above). Sex and the race paths are not pictured. Correlations between alcohol use disorder (AUD) criteria are also not pictured. For clarity, dashed lines represents criterion-level paths after accounting for associations with externalizing behaviour and alcohol consumption at the latent AUD-level. Criteria listed in figure are as follows: hazardous use – recurrent alcohol use in physically hazardous situations; social problems –social/interpersonal problems caused or exacerbated by alcohol; role interference –failure to fulfill major role obligations (e.g. work, home) because of alcohol use; larger/longer – alcohol taken in larger amounts or over longer periods; quit/cut down – persistent desire or unsuccessful efforts to cut down alcohol use; time spent – substantial time spent in drinking activities (e.g., using or recovering from alcohol); physical/psych. problems – physical or psychological problems due to alcohol use; give up – important activities given up because of alcohol use; craving – strong desire or urge to use alcohol; tolerance – developing alcohol tolerance; withdrawal – having withdrawal symptoms or using alcohol to avoid withdrawal.

Descriptive Characteristics of Externalizing Behavior, Alcohol Consumption, Alcohol Use Disorder Criteria, and Covariates

Table 1.

Variable	Mean/Percent (SE)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	N	NIII																		
1. Sex	47.94 (0.19)	49.18 (0.37)		0.01	0.01	-0.02	-0.01	-0.31 [*]	-0.20 [*]	-0.33 [*]	-0.32 [*]	-0.16 [*]	-0.20 [*]	-0.26 [*]	-0.20 [*]	-0.19 [*]	-0.18 [*]	-0.17 [*]	-0.30 [*]	-0.15 [*]
2. Young	31.97 (0.19)	32.10 (0.50)	0.04 [*]		-1.00	-0.95	0.20	0.22 [*]	0.09 [*]	-0.06 [*]	0.09 [*]	0.07 [*]	0.12 [*]	0.07 [*]	0.15 [*]	0.17 [*]	0.04 [*]	0.16 [*]	0.16 [*]	0.15 [*]
3. Middle	42.61 (0.19)	39.37 (0.43)	-0.01	-1.00 [*]		-0.96	0.06	0.00	0.04 [*]	0.09 [*]	0.06 [*]	0.07 [*]	0.05 [*]	0.05 [*]	0.05 [*]	0.03 [*]	0.10 [*]	0.03 [*]	0.04 [*]	0.04 [*]
4. Old	25.43 (0.18)	28.52 (0.53)	-0.03 [*]	-0.93 [*]	-0.98 [*]		-0.32	-0.36 [*]	-0.16 [*]	-0.04 [*]	-0.20 [*]	-0.19 [*]	-0.20 [*]	-0.15 [*]	-0.26 [*]	-0.26 [*]	-0.19 [*]	-0.24 [*]	-0.24 [*]	-0.23 [*]
5. Race	25.00 (0.23)	30.88 (0.72)	-0.01	0.17 [*]	0.04 [*]	-0.25 [*]		0.03 [*]	0.00	-0.29 [*]	-0.04 [*]	-0.05 [*]	-0.19 [*]	-0.01	-0.12 [*]	-0.09 [*]	0.01 [*]	-0.10 [*]	-0.07 [*]	-0.09 [*]
6. CON	0.04 (0.00)	-0.03 (0.01)	-0.37 [*]	0.24 [*]	-0.02 [*]	-0.35 [*]	0.01		0.29 [*]	0.44 [*]	0.46 [*]	0.33 [*]	0.46 [*]	0.42 [*]	0.44 [*]	0.47 [*]	0.36 [*]	0.45 [*]	0.55 [*]	0.40 [*]
7. EXT	0.01 (0.00)	-0.02 (0.01)	-0.22 [*]	0.22 [*]	0.01 [*]	-0.28 [*]	0.01	0.31 [*]		0.43 [*]	0.51 [*]	0.46 [*]	0.40 [*]	0.36 [*]	0.45 [*]	0.45 [*]	0.42 [*]	0.42 [*]	0.41 [*]	0.39 [*]
8. Hazardous Use	47.28 (0.24)	44.77 (0.57)	-0.29 [*]	0.02 [*]	0.11 [*]	-0.15 [*]	-0.18 [*]	0.43 [*]	0.47 [*]		0.71 [*]	0.61 [*]	0.69 [*]	0.58 [*]	0.67 [*]	0.66 [*]	0.57 [*]	0.61 [*]	0.64 [*]	0.61 [*]
9. Social Problems	16.73 (0.17)	18.41 (0.37)	-0.28 [*]	0.14 [*]	0.05 [*]	-0.24 [*]	-0.14 [*]	0.36 [*]	0.50 [*]	0.71 [*]		0.76 [*]	0.66 [*]	0.64 [*]	0.73 [*]	0.75 [*]	0.74 [*]	0.68 [*]	0.69 [*]	0.64 [*]
10. Role Interference	5.47 (0.10)	6.87 (0.22)	-0.12 [*]	0.16 [*]	0.00	-0.21 [*]	-0.02	0.31 [*]	0.49 [*]	0.58 [*]	0.75 [*]		0.67 [*]	0.65 [*]	0.76 [*]	0.77 [*]	0.83 [*]	0.72 [*]	0.65 [*]	0.67 [*]
11. Larger/Longer	42.42 (0.23)	41.82 (0.61)	-0.20 [*]	0.20 [*]	0.04 [*]	-0.27 [*]	-0.10 [*]	0.48 [*]	0.44 [*]	0.66 [*]	0.65 [*]	0.66 [*]		0.70 [*]	0.77 [*]	0.73 [*]	0.66 [*]	0.71 [*]	0.74 [*]	0.71 [*]
12. Quit/Cut Down	34.29 (0.17)	32.69 (0.47)	-0.28 [*]	0.10 [*]	0.06 [*]	-0.18 [*]	0.10 [*]	0.43 [*]	0.36 [*]	0.54 [*]	0.58 [*]	0.67 [*]	0.65 [*]		0.69 [*]	0.69 [*]	0.69 [*]	0.66 [*]	0.70 [*]	0.62 [*]
13. Time Spent	17.20 (0.17)	21.97 (0.40)	-0.23 [*]	0.20 [*]	0.01	-0.26 [*]	-0.06 [*]	0.40 [*]	0.50 [*]	0.64 [*]	0.71 [*]	0.75 [*]	0.73 [*]	0.67 [*]		0.79 [*]	0.77 [*]	0.76 [*]	0.76 [*]	0.71 [*]
14. Phys./Psych.	16.53 (0.15)	21.01 (0.43)	-0.21 [*]	0.22 [*]	-0.02 [*]	-0.23 [*]	-0.01	0.44 [*]	0.48 [*]	0.60 [*]	0.72 [*]	0.77 [*]	0.69 [*]	0.68 [*]	0.77 [*]		0.81 [*]	0.75 [*]	0.73 [*]	0.73 [*]
15. Give Up	4.22 (0.08)	5.38 (0.21)	-0.19 [*]	0.12 [*]	0.02 [*]	-0.18 [*]	0.05 [*]	0.32 [*]	0.46 [*]	0.57 [*]	0.76 [*]	0.83 [*]	0.65 [*]	0.67 [*]	0.78 [*]	0.79 [*]		0.73 [*]	0.69 [*]	0.70 [*]
16. Craving	5.08 (0.10)	18.86 (0.39)	-0.18 [*]	0.19 [*]	0.00	-0.25 [*]	0.02	0.42 [*]	0.37 [*]	0.46 [*]	0.57 [*]	0.58 [*]	0.55 [*]	0.58 [*]	0.61 [*]	0.66 [*]	0.62 [*]		0.70 [*]	0.68 [*]
17. Tolerance	36.30 (0.21)	35.21 (0.48)	-0.27 [*]	0.27 [*]	-0.02 [*]	-0.28 [*]	0.03 [*]	0.50 [*]	0.41 [*]	0.57 [*]	0.61 [*]	0.61 [*]	0.65 [*]	0.64 [*]	0.69 [*]	0.66 [*]	0.62 [*]	0.53 [*]		0.66 [*]
18. Withdrawal	26.07 (0.18)	27.86 (0.49)	-0.15 [*]	0.21 [*]	0.05 [*]	-0.31 [*]	-0.05 [*]	0.38 [*]	0.43 [*]	0.61 [*]	0.62 [*]	0.67 [*]	0.67 [*]	0.57 [*]	0.67 [*]	0.70 [*]	0.68 [*]	0.55 [*]	0.59 [*]	

Note. Sex: 0=female, 1=male. Young = participants ages 21–35, 0=no, 1 =yes. Middle = participants ages 36 – 55, 0=no, 1=yes. Old=participants ages 56 and above, 0=no, 1 =yes. Race: 0=White (non-Hispanic), 1=Non-White (non-Hispanic). CON = standardized alcohol consumption factor score. EXT = standardized externalizing behavior factor score. Phys./Psych = physical/psychological problems. N=NESARC; NIII= NESARC-III. Weighted means and standard deviations provided for continuous variables. Weighted percentages and standard errors provided for categorical variables. Below diagonal = NESARC correlations; Above diagonal = NESARC-III correlations. Correlations among two binary variables are tetrachoric correlations, remaining correlations are Pearson product-moment correlations.

* p<0.05.

Table 2.

Path Model Estimates

Criterion	Young Cohort (ages 25–35)						Middle Cohort (ages 36–55)						Old Cohort (ages 56 and above)					
	<i>b</i>	<i>SE</i>	<i>Rk</i>	<i>b</i>	<i>SE</i>	<i>Rk</i>	<i>b</i>	<i>SE</i>	<i>Rk</i>	<i>b</i>	<i>SE</i>	<i>Rk</i>	<i>b</i>	<i>SE</i>	<i>Rk</i>	<i>b</i>	<i>SE</i>	<i>Rk</i>
Hazardous Use																		
NESARC	0.33 [*]	0.02	6	0.35 [*]	0.02	3	0.42 [*]	0.01	5	0.32 [*]	0.01	5	0.35 [*]	0.02	5	0.24 [*]	0.02	6
NESARC-III	0.33 [*]	0.01	4	0.35 [*]	0.01	4	0.29 [*]	0.01	8	0.44 [*]	0.01	4	0.30 [*]	0.01	6	0.28 [*]	0.01	2
Social Problems																		
NESARC	0.39 [*]	0.02	2	0.22 [*]	0.02	9	0.44 [*]	0.02	3	0.19 [*]	0.02	11	0.38 [*]	0.02	1	0.13 [*]	0.02	9
NESARC-III	0.40 [*]	0.01	1	0.34 [*]	0.01	6	0.40 [*]	0.01	2	0.40 [*]	0.01	7	0.36 [*]	0.02	2	0.22 [*]	0.01	7
Role Interference																		
NESARC	0.48 [*]	0.03	1	0.15 [*]	0.03	11	0.45 [*]	0.02	1	0.22 [*]	0.02	10	0.38 [*]	0.03	2	0.13 [*]	0.02	10
NESARC-III	0.40 [*]	0.02	2	0.22 [*]	0.02	11	0.40 [*]	0.02	1	0.30 [*]	0.02	11	0.36 [*]	0.02	1	0.19 [*]	0.02	9
Larger/Longer																		
NESARC	0.28 [*]	0.02	8	0.38 [*]	0.01	2	0.34 [*]	0.01	8	0.38 [*]	0.01	1	0.28 [*]	0.02	8	0.29 [*]	0.01	3
NESARC-III	0.27 [*]	0.02	9	0.38 [*]	0.01	3	0.29 [*]	0.01	9	0.47 [*]	0.01	2	0.27 [*]	0.02	9	0.27 [*]	0.01	4
Quit/Cut Down																		
NESARC	0.26 [*]	0.02	10	0.29 [*]	0.02	7	0.27 [*]	0.02	11	0.35 [*]	0.01	4	0.21 [*]	0.02	10	0.33 [*]	0.02	1
NESARC-III	0.24 [*]	0.02	10	0.30 [*]	0.01	9	0.25 [*]	0.01	11	0.44 [*]	0.01	3	0.23 [*]	0.02	11	0.26 [*]	0.01	6
Time Spent																		
NESARC	0.39 [*]	0.02	3	0.31 [*]	0.02	6	0.43 [*]	0.01	4	0.24 [*]	0.02	8	0.37 [*]	0.02	3	0.15 [*]	0.02	8
NESARC-III	0.31 [*]	0.02	6	0.33 [*]	0.01	8	0.37 [*]	0.01	3	0.39 [*]	0.01	8	0.32 [*]	0.02	4	0.18 [*]	0.02	10
Phys./Psych.																		
NESARC	0.36 [*]	0.02	5	0.31 [*]	0.02	5	0.40 [*]	0.02	6	0.29 [*]	0.02	6	0.35 [*]	0.02	4	0.25 [*]	0.02	5
NESARC-III	0.31 [*]	0.01	5	0.40 [*]	0.01	2	0.34 [*]	0.02	5	0.43 [*]	0.01	6	0.32 [*]	0.02	5	0.27 [*]	0.02	3
Give Up																		
NESARC	0.38 [*]	0.03	4	0.20 [*]	0.03	10	0.44 [*]	0.02	2	0.22 [*]	0.02	9	0.32 [*]	0.04	7	0.09 [*]	0.02	11
NESARC-III	0.34 [*]	0.02	3	0.23 [*]	0.02	10	0.36 [*]	0.02	4	0.34 [*]	0.01	10	0.33 [*]	0.03	3	0.18 [*]	0.02	11

Criterion	Young Cohort (ages 25–35)						Middle Cohort (ages 36–55)						Old Cohort (ages 56 and above)					
	<i>b</i>	<i>SE</i>	Rk	<i>b</i>	<i>SE</i>	Rk	<i>b</i>	<i>SE</i>	Rk	<i>b</i>	<i>SE</i>	Rk	<i>b</i>	<i>SE</i>	Rk	<i>b</i>	<i>SE</i>	Rk
Craving																		
NESARC	0.26 [*]	0.03	9	0.32 [*]	0.02	4	0.28 [*]	0.02	10	0.36 [*]	0.02	3	0.19 [*]	0.04	11	0.32 [*]	0.02	2
NESARC-III	0.30 [*]	0.02	7	0.34 [*]	0.01	5	0.33 [*]	0.02	6	0.44 [*]	0.01	5	0.27 [*]	0.02	8	0.26 [*]	0.01	5
Tolerance																		
NESARC	0.24 [*]	0.02	11	0.44 [*]	0.02	1	0.28 [*]	0.02	9	0.37 [*]	0.02	2	0.25 [*]	0.02	9	0.28 [*]	0.02	4
NESARC-III	0.24 [*]	0.01	11	0.49 [*]	0.01	1	0.27 [*]	0.01	10	0.49 [*]	0.01	1	0.26 [*]	0.02	10	0.29 [*]	0.01	1
Withdrawal																		
NESARC	0.31 [*]	0.02	7	0.27 [*]	0.02	8	0.36 [*]	0.01	7	0.26 [*]	0.02	7	0.32 [*]	0.02	6	0.17 [*]	0.01	7
NESARC-III	0.28 [*]	0.02	8	0.33 [*]	0.01	7	0.30 [*]	0.02	7	0.38 [*]	0.01	9	0.29 [*]	0.02	7	0.21 [*]	0.01	8

Note. EXT = standardized externalizing behavior factor score. CON = standardized alcohol consumption factor score. Rk = rank ordering of regression coefficient from largest (1) to smallest (11). Phys./Psych. = physical/psychological problems. Sex and race were included as covariates.

* $p < 0.05$.

Table 3.

Factor-Controlled Model Median Factor Loadings and Path Coefficients

Variable	Young Cohort (ages 25–35)										Middle Cohort (ages 36–55)										Old Cohort (ages 56 and above)									
	AUD			EXT			CON			AUD			EXT			CON			AUD			EXT			CON					
	Mdn λ	Range		Mdn b	Range		Rk	Mdn b	Range	Rk	Mdn λ	Range		Mdn b	Range	Rk	Mdn λ	Range		Mdn b	Range	Rk	Mdn λ	Range		Mdn b	Range	Rk		
Hazardous Use	N	0.63 [*]	0.54 – 0.80	0.07 [*]	0.02 – 0.014		3	0.08 [*]	–0.11 – 0.25	3	0.64 [*]	0.59 – 0.82	0.13 [*]	0.07 – 0.21		1	0.08 [*]	–0.11 – 0.19	5	0.74 [*]	0.71 – 0.83	0.10 [*]	0.01 – 0.19	2	0.01 [*]	–0.14 – 0.19		5		
	NIII	0.73 [*]	0.63 – 0.89	0.10 [*]	–0.02 – 0.15		2	0.04 [*]	–0.14 – 0.21	4	0.74 [*]	0.69 – 0.93	0.05 [*]	–0.07 – 0.16		3	0.11 [*]	–0.01 – 0.22	2	0.73 [*]	0.70 – 0.88	0.07 [*]	–0.05 – 0.14	2	0.07 [*]	0.00 – 0.15		2		
Social Problems	N	0.80 [*]	0.68 – 1.01	0.08 [*]	–0.03 – 0.15		2	–0.10 [*]	–0.34 – 0.11	9	0.82 [*]	0.76 – 1.06	0.10 [*]	–0.09 – 0.18		2	–0.14 [*]	–0.25 – 0.10	9	0.86 [*]	0.82 – 0.96	0.10 [*]	–0.02 – 0.21	1	–0.13 [*]	–0.31 – 0.09		9		
	NIII	0.67 [*]	0.59 – 0.82	0.12 [*]	0.02 – 0.19		1	–0.02 [*]	–0.21 – 0.16	8	0.64 [*]	0.60 – 0.80	0.12 [*]	–0.03 – 0.18		1	0.02 [*]	–0.13 – 0.20	6	0.69 [*]	0.66 – 0.83	0.12 [*]	0.06 – 0.17	1	–0.01 [*]	–0.08 – 0.10		6		
Role Interference	N	0.96 [*]	0.82 – 1.22	0.09 [*]	–0.03 – 0.18		1	–0.27 [*]	–0.54 – 0.03	11	0.97 [*]	0.90 – 1.26	0.02 [*]	–0.19 – 0.13		5	–0.19 [*]	–0.31 – 0.01	11	0.88 [*]	0.84 – 0.98	0.08 [*]	–0.04 – 0.19	3	–0.14 [*]	–0.33 – 0.05		10		
	NIII	0.95 [*]	0.83 – 1.16	0.05 [*]	–0.11 – 0.13		3	–0.24 [*]	–0.49 – 0.01	10	0.92 [*]	0.85 – 1.15	0.08 [*]	–0.20 – 0.13		2	–0.16 [*]	–0.33 – 0.16	11	0.89 [*]	0.85 – 1.07	0.06 [*]	–0.10 – 0.11	3	–0.10 [*]	–0.19 – 0.01		10		
Larger/Longer	N	0.80 [*]	0.68 – 1.01	–0.05 [*]	–0.14 – 0.04		10	0.11 [*]	–0.25 – 0.32	2	0.79 [*]	0.73 – 1.03	–0.02	–0.18 – 0.08		8	0.12 [*]	–0.03 – 0.22	3	0.82 [*]	0.79 – 0.92	–0.04 [*]	–0.14 – 0.08	9	0.10 [*]	–0.13 – 0.23		4		
	NIII	0.84 [*]	0.73 – 1.02	–0.05 [*]	–0.19 – 0.02		10	0.04 [*]	–0.18 – 0.25	3	0.81 [*]	0.75 – 1.01	–0.05 [*]	–0.19 – 0.02		10	0.08 [*]	–0.07 – 0.22	3	0.82 [*]	0.79 – 0.99	–0.03	–0.16 – 0.03	10	0.04 [*]	–0.06 – 0.13		3		
Quit/Cut Down	N	0.84 ^{**}	0.71 – 1.06	–0.10 [*]	–0.19 – 0.04		11	–0.02 [*]	–0.26 – 0.21	7	0.79 [*]	0.73 – 1.02	–0.10 [*]	–0.26 – 0.05		11	0.10 [*]	–0.06 – 0.20	4	0.77 [*]	0.73 – 0.86	–0.11 [*]	–0.20 – 0.04	11	0.15 [*]	–0.06 – 0.27		2		
	NIII	0.81 [*]	0.71 – 0.99	–0.07 [*]	–0.21 – 0.02		11	–0.05 [*]	–0.26 – 0.16	9	0.79 [*]	0.74 – 0.99	–0.07 [*]	–0.21 – 0.02		11	0.04 [*]	–0.11 – 0.17	5	0.81 [*]	0.77 – 0.97	–0.06 [*]	–0.19 – 0.03	11	0.03 [*]	–0.06 – 0.12		4		
Time Spent	N	0.86 [*]	0.74 – 1.09	0.04 [*]	–0.07 – 0.13		4	0.01 [*]	–0.25 – 0.24	5	0.89 [*]	0.83 – 1.15	0.02 [*]	–0.16 – 0.13		4	–0.11 [*]	–0.22 – 0.07	7	0.89 [*]	0.85 – 1.00	0.03 [*]	–0.09 – 0.14	4	–0.12 [*]	–0.31 – 0.08		8		
	NIII	0.88 [*]	0.76 – 1.07	0.01 [*]	–0.15 – 0.08		5	–0.02 [*]	–0.24 – 0.21	7	0.87 [*]	0.81 – 1.10	0.03 [*]	–0.13 – 0.10		4	–0.04 [*]	–0.18 – 0.15	8	0.89 [*]	0.85 – 1.07	0.00 ^d	–0.15 – 0.06	6	–0.09 [*]	–0.18 – 0.02		9		
Phys./Psych.	N	0.89 [*]	0.75 – 1.12	0.01 [*]	–0.09 – 0.11		5	–0.05 [*]	–0.27 – 0.23	8	0.90 [*]	0.84 – 1.17	–0.01	–0.20 – 0.09		7	–0.13 [*]	–0.20 – 0.10	8	0.90 [*]	0.86 – 1.00	0.00 ^e	–0.11 – 0.12	6	–0.07 [*]	–0.22 – 0.17		6		
	NIII	1.02 [*]	0.89 – 1.24	0.04 [*]	–0.10 – 0.11		4	0.06 [*]	–0.27 – 0.26	2	0.99 [*]	0.92 – 1.24	0.01 [*]	–0.15 – 0.09		5	–0.04 [*]	–0.18 – 0.15	9	0.95 [*]	0.91 – 1.14	0.02	–0.13 – 0.07	4	–0.03 [*]	–0.10 – 0.10		7		
Give Up	N	1.04 [*]	0.89 – 1.32	–0.03 [*]	–0.16 – 0.07		8	–0.24 [*]	–0.55 – 0.04	10	0.98 [*]	0.91 – 1.26	0.03 [*]	–0.18 – 0.14		3	–0.16 [*]	–0.30 – 0.02	10	0.93 [*]	0.89 – 1.05	–0.03	–0.16 – 0.08	8	–0.21 [*]	–0.41 – 0.05		11		
	NIII	0.81 [*]	0.70 – 0.98	–0.04 [*]	–0.21 – 0.05		9	–0.25 [*]	–0.53 – 0.05	11	0.90 [*]	0.84 – 1.12	0.01 [*]	–0.17 – 0.09		6	–0.16 [*]	–0.32 – 0.04	10	0.90 [*]	0.86 – 1.08	0.01	–0.15 – 0.07	5	–0.12 [*]	–0.21 – 0.03		11		
Craving																														

Variable	Young Cohort (ages 25–35)						Middle Cohort (ages 36–55)						Old Cohort (ages 56 and above)							
	AUD		EXT		CON		AUD		EXT		CON		AUD		EXT		CON			
	<i>Mdn λ</i>	Range	<i>Mdn b</i>	Range	Rk	<i>Mdn b</i>	<i>Mdn λ</i>	Range	<i>Mdn b</i>	Range	Rk	<i>Mdn b</i>	<i>Mdn λ</i>	Range	<i>Mdn b</i>	Range	Rk	<i>Mdn b</i>	Range	Rk
N	0.68 [*]	0.58–0.86	–0.02	–0.09–0.06	7	0.06 [*]	0.67 [*]	0.62–0.87	–0.03	–0.16–0.06	9	0.14 [*]	0.64 [*]	0.61–0.71	–0.07	–0.15–0.02	10	0.17 [*]	0.05–0.27	1
NIII	0.81 [*]	0.70–0.98	0.00 ^a	–0.14–0.07	6	0.01 [*]	0.83 [*]	0.77–1.04	–0.01 [*]	–0.16–0.04	7	0.04 [*]	0.83 [*]	0.80–1.00	–0.01 [*]	–0.15–0.05	7	0.02 [*]	–0.07–0.11	5
Tolerance																				
N	0.72 [*]	0.61–0.91	–0.04 [*]	–0.12–0.05	9	0.22 [*]	0.72 [*]	0.66–0.93	–0.05 [*]	–0.19–0.04	10	0.14 [*]	0.69 [*]	0.66–0.77	–0.02 [*]	–0.10–0.08	7	0.13 [*]	–0.06–0.24	3
NIII	0.75 [*]	0.65–0.91	–0.03 [*]	–0.15–0.04	8	0.20 [*]	0.75 [*]	0.70–0.94	–0.04 [*]	–0.17–0.03	8	0.14 [*]	0.75 [*]	0.72–0.90	–0.02	–0.14–0.03	8	0.08 [*]	0.00 ⁱ –0.17	1
Withdrawal																				
N	0.78 [*]	0.66–0.99	0.00 ^b	–0.09–0.09	6	0.01 [*]	0.78 [*]	0.72–1.01	0.01 [*]	–0.16–0.10	6	–0.03 [*]	0.83 [*]	0.79–0.92	0.01	–0.10–0.12	5	–0.08 [*]	–0.25–0.11	7
NIII	0.77 [*]	0.67–0.94	0.00 ^c	–0.13–0.07	7	0.01 [*]	0.82 [*]	0.76–1.02	–0.04 [*]	–0.17–0.02	9	–0.02 [*]	0.83 [*]	0.79–0.99	–0.02	–0.16–0.04	9	–0.04 [*]	–0.12–0.06	8
AUD																				
N			0.42 [*]	0.32–0.53		0.39 [*]			0.46 [*]	0.33–0.53		0.35 [*]			0.38 [*]	0.23–0.47		0.27 [*]	0.08–0.49	
NIII			0.37 [*]	0.29–0.48		0.42 [*]			0.38 [*]	0.31–0.50		0.36 [*]			0.37 [*]	0.29–0.45		0.31 [*]	0.20–0.38	

Note. *Mdn λ* = Median factor loading for factor-controlled model. *Mdn b* = Median path coefficient from factor-controlled model subset. Range = Minimum and maximum path coefficients across factor-controlled model subsets. AUD = alcohol use disorder. EXT = standardized externalizing behavior factor score. CON = standardized alcohol consumption factor score. N=NESARC. NIII=NESARC-III. Phys./Psych.= physical/psychological problems. *Rk* =rank ordering of residual regression coefficient from largest (1) to smallest (11). 0.00^a=–0.001; 0.00^b=0.003; 0.00^c=–0.004; 0.00^d=–0.003; 0.00^e=–0.004. Sex and race were included as covariates.

* Four or more significant paths within subset.

Table 4.
Correlations of Path and Factor-Controlled Model Path Coefficients and Ranking Orderings between Samples.

	Full Sample	Young	Middle	Old
<i>Path Models</i>				
EXT coefficients	0.84 *	0.89 *	0.75 *	0.87 *
EXT rank orders	0.86 *	0.90 *	0.85 *	0.85 *
CON coefficients	0.77 *	0.88 *	0.82 *	0.87 *
CON rank orders	0.80 *	0.86 *	0.86 *	0.66 *
<i>Factor-Controlled Models</i>				
EXT coefficients	0.85 *	0.90 *	0.80 *	0.87 *
EXT rank orders	0.84 *	0.95 *	0.78 *	0.80 *
CON coefficients	0.85 *	0.92 *	0.85 *	0.83 *
CON rank orders	0.81 *	0.75 *	0.88 *	0.79 *

Note. Full Sample = all participants; Young = participants ages 21–35; Middle = participants ages 36–55; Old = participants 56 and older. EXT = standardized externalizing behavior factor score. CON = standardized alcohol consumption factor score.

* $p < 0.05$

Table 5.

Intra-class Correlations of Path and Factor-Controlled Model Path Coefficients and Ranking Orderings across Age Cohorts.

	Across Samples	NESARC	NESARC-III
<i>Path Models</i>			
EXT coefficients	0.67	0.74	0.84
EXT rank orders	0.89	0.90	0.92
CON coefficients	0.31	0.63	0.24
CON rank orders	0.80	0.83	0.83
<i>Factor-Controlled Models</i>			
EXT coefficients	0.88	0.88	0.92
EXT rank orders	0.86	0.83	0.93
CON coefficients	0.79	0.86	0.77
CON rank orders	0.80	0.86	0.83

Notes. EXT = standardized externalizing behavior factor score. CON = standardized alcohol consumption factor score.