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Taxometric Analysis of DSM-IV and DSM-5 Alcohol Use Disorders

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Abstract

Background—With preparations currently being made for the Diagnostic and Statistical Manual of Mental Disorders-5th Edition (DSM-5), one prominent issue to resolve is whether alcohol use disorders are better represented as discrete categorical entities or as a dimensional construct. The purpose of this study was to investigate the latent structure of DSM-Fourth Edition (DSM-IV) and proposed DSM-5 alcohol use disorders.

Methods—The study used the Wave 2 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) to conduct taxometric analyses of DSM-IV and DSM-5 alcohol use disorders defined by different thresholds to determine the taxonic or dimensional structure underlying the disorders.

Results—DSM-IV and DSM-5 alcohol abuse and dependence criteria with 3+ thresholds demonstrated a dimensional structure. Corresponding thresholds with 4+ criteria were clearly taxonic, as were thresholds defined by cut-offs of 5+ and 6+ criteria.

Conclusions—DSM-IV and DSM-5 alcohol use disorders demonstrated a hybrid taxonic-dimensional structure. That is, DSM-IV and DSM-5 alcohol use disorders may be taxonically

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Contributors

Mr. Kerridge wrote the first draft of the manuscript and assisted with the statistical analyses. Dr. Saha conducted statistical analyses. Drs. Gmel and Rehm commented on subsequent drafts and reviewed statistical analyses of the manuscript. Dr. Saha collected the data and administered the study.

Conflict of Interest

There are no conflicts of interest.

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distinct compared to no disorder if defined by a threshold of 4 or more criteria. However, there may be dimensional variation remaining among non-problematic to subclinical cases. A careful and systematic program of structural research using taxometric and psychometric procedures is warranted.

Keywords

Alcohol use disorder; taxometric analysis; latent structure; taxon-dimensional hybrid structure; structural analysis

1. INTRODUCTION

To date, numerous studies have used item response theory (IRT) and other methods to determine whether a dimensional latent structure underlies the Diagnostic and Statistical Manual of Mental Disorders-Fourth Revision (DSM-IV; American Psychiatric Association, 1992) alcohol abuse and dependence criteria (Borges et al., 2010; Hasin and Beseler, 2009; Hasin et al., 2006; Keyes et al., 2010; Proudfoot et al., 2006). These results have consistently demonstrated a good fit to the dimensional model that, in turn, have supported the DSM-Fifth Revision (DSM-5) Substance Use and Related Disorders Workgroup's proposal to combine DSM-IV diagnostic criteria for abuse and dependence into a single unitary diagnosis of alcohol use disorder.

The DSM-5 workgroup also proposed eliminating the legal problems criterion from the combined alcohol use disorder diagnosis along with adding a new criterion, alcohol craving. The impetus for recommending removal of the legal problems criteria was threefold. First, IRT analyses have shown that the legal problems criterion has a very high severity level, rendering its clinical utility questionable (Marin et al., 2006; Shmulewitz et al., 2010). Second, the criterion consistently generated low factor loadings and discrimination values relative to other DSM-IV abuse and dependence criteria (Keyes et al., 2011; Proudfoot et al., 2006). Third, prior IRT findings have noted superior aggregate information value of models that excluded the legal problems criterion compared to those that retained it (Saha et al., 2006). In a recent study (Keys et al., 2011), superior information value was also found for IRT models in which the craving criterion was added (and legal problems removed) relative to the model using DSM-IV abuse and dependence criteria (with the legal problems criterion and without the craving criterion).

Coinciding with the IRT literature on alcohol use disorders is a series of taxometric studies on alcohol use pathology. Unlike IRT methods that are premised on the existence of latent dimensions, taxometric analyses determine whether the underlying or latent construct of alcohol use disorders is taxonic (categorical) or dimensional (continuous). This small body of research has used statistical procedures and algorithms originally developed by Meehl and his colleagues (Meehl, 1995; Meehl and Yonce, 1994; 1996; Waller and Meehl, 1998). Among these studies were five conducted in federal prisons (Dana, 1990; Walters, 2008, 2009; Walters et al., 2009, 2010) and two that used data from nationally representative samples of the general population (Green et al., 2011; Slade et al., 2009). All of the studies conducted among prison inmates consistently supported a taxonic representation underlying

alcohol use pathology, with the exception of Walters et al. (2010) who identified a dimensional structure for men and a taxonic structure among women. These studies all shared the use of assessment instruments not explicitly developed to operationalize DSM-IV criteria for alcohol abuse and dependence and all but one (Walters et al., 2010) conceptually or empirically combined alcohol problems into three scales to serve as input into the taxometric analyses. Most of the studies were also conducted among males (Dana, 1990; Walters, 2008, 2009), further reducing the representativeness of inmate samples that are themselves not representative of the general population, and adversely impacting the manner in which the observed indicators of alcohol problems co-vary in the sample.

Sampling procedures in these studies also raise several issues. With exception of the Walters study (2009), which used consecutive sampling at admission, the remaining studies were based on archival data or conducted among samples of inmates selected on the basis of reporting problems with alcohol (Dana, 1990) or expressing interest in a comprehensive drug treatment program that would reduce the length of their sentencing. The absence of consecutive sampling at admission in the majority of these studies coupled with the assessment of alcohol problems for the time period of 12 months prior to incarceration was likely to increase recall bias. That is, for many inmates, there was likely many years between admission to the federal facility and the assessment period in which alcohol problems were measured. Further, the absence of probabilistic sampling of the inmate populations may have increased the likelihood of selection bias.

The two taxometric studies in this area conducted with nationally representative samples both used assessment instruments explicitly designed to directly measure alcohol abuse and dependence according to DSM-IV definitions (Green et al., 2011; Slade et al., 2009). Slade and his colleagues (2009) used the Australian National Survey of Mental Health and Wellbeing (NSMHWB) to conduct two separate taxometric analyses: one using DSM-IV alcohol abuse criteria and the other using dependence criteria. The results generally supported a dimensional structure for both abuse and dependence criteria. In the second study, Green et al. (2011), used the Wave 1 National Epidemiologic Survey on Alcohol and Related Conditions (Wave 1 NESARC; Grant et al., 2001) and found evidence of a taxonic structure. However, this study combined 47 alcohol and dependence symptom items (not criteria) that included several non-diagnostic measures of alcohol consumption (i.e., quantity, frequency and duration) into three empirically derived scales that served as input indicators to the taxometric analyses. While the Green et al. (2011) and Slade et al. (2009) studies addressed many of the methodological issues characteristic of inmate studies in this area, neither the use of empirically derived scales of alcohol problems nor the separate treatment of alcohol abuse and dependence criteria in these studies provided a direct examination of the latent structure of the proposed combined DSM-5 alcohol abuse and dependence criteria that additionally eliminated the legal problems criterion and added a craving criterion. It is also important to note that operationalizations of alcohol use problems used in studies conducted in inmate samples were not purposely designed to examine the latent structure of DSM-IV or the proposed DSM-5 definitions of alcohol use disorders at all.

Accordingly, the present study addressed whether the underlying latent structure of DSM-IV alcohol abuse and dependence criteria and proposed DSM-5 alcohol use disorder criteria were taxonic or dimensional using the Wave 2 (Grant et al., 2004), a large representative sample of the adult general U.S. population. This study will also assess the DSM-5 workgroup's preliminary proposal to include thresholds to define DSM-5 alcohol use disorder, a proposal that has not been psychometrically examined in the published literature. The workgroup proposed a threshold of 2+ criteria necessary to qualify for a diagnosis of DSM-5 alcohol use disorder with a 4+ criteria threshold indicating a severe disorder. Taxometric procedures will be applied to combined DSM-IV and proposed DSM-5 abuse and dependence criteria using three thresholds; 2+, 3+ and 4+ criteria. In the event that a cut-point was found that defined the alcohol use disorder taxon, additional taxometric analyses would be performed using higher level cut-points (e.g., 5+ criteria).

Taxometric procedures are best suited to directly address the structural questions of this study; that is, are DMS-IV and proposed DSM-5 alcohol use disorder criteria best represented by a taxonic or dimensional structure and should a taxonic structure be identified, what is the most efficient cut-point for sorting cases into taxon (disordered) and complementary (non-disordered) groups. Although other statistical models, such as cluster analysis and finite and factor mixture models (FFM), can also be used to differentiate taxon from continua, each has been shown to have difficulty in identifying the correct number of latent classes and once found difficulties arise in their interpretation (Bock, 1996; Grove, 1991; Everit, 1993; Lore, 1994; McLachlan and Bashford, 1988; McLachlan and Peel, 2001; Ruscio and Ruscio, 2004). To date, there exists no common acceptance of the best criteria that would resolve these issues (Nyland et al., 2008). Moreover, this study does not address the determination of the dimensionality vs. multidimensionality of the DSM constructs, a central focus of FMM. These other statistical approaches also do not provide for the identification of a cut-point with which cases can most efficiently be sorted into taxon and complement groups.

Of the few methods that test the taxonic versus dimensional structure of a construct, taxometric analysis does provide for setting a diagnostic threshold to match the boundary between taxon and complement groups at the latent level (Ruscio, 2009; Ruscio and Ruscio, 2002). Taxometric methods also have the strongest base of simulation studies supporting their ability to make this structural distinction (Ruscio and Ruscio, 2008; Ruscio et al., 2006) and uniquely provide for a test of the latent structure by evaluating the consistency of results across multiple nonredundant procedures in favor of traditional significance tests and goodness-of-fit indices alone (Meehl and Yonce, 1994; 1996; Ruscio et al., 2006; Ruscio and Ruscio, 2008). Taken together, the demonstrated utility of the taxometric method and the importance of the questions it addresses with regard to classification has been responsible for a notable rise in its application to all forms of psychopathology in recent years, including alcohol use disorders as described herein, major depressive disorder (Hankin et al., 2005; Ruscio et al., 2007; Slade and Andrews, 2005); anxiety disorders (Ruscio et al., 2002); eating disorders (Gleaves et al., 2000a; 2000b); psychotic and dissociative disorders (Waller et al., 1996; Waller and Ross, 1997) and personality disorders (Edens et al., 2009; Haslam, 2003; Haslam and King, 2002; Marcus et al., 2006).

This study will importantly contribute to our understanding of alcohol use disorders by providing structural knowledge that can inform classification, that is, could individuals with an alcohol use disorder be assigned to groups or located along a dimension and should a taxon structure exist, which is the most efficient cut-point to distinguish those with and without alcohol use disorders? Knowledge of the underlying structure of alcohol use disorders as taxonic or dimensional can also help constrain plausible theories of initiation and course, improve diagnosis, and refine efforts in prevention and treatment.

2. METHOD

2.1 Sample

The 2004–2005 Wave 2 NESARC (Grant et al., 2003) is the second wave of the NESARC. Wave 1 of the NESARC was conducted in 2001–2002 and is described in detail elsewhere (Grant et al., 2001, 2004). The Wave 1 NESARC surveyed a representative sample of the adult population in the United States, oversampling Blacks, Hispanics and young adults aged 18-to-24 years. The target population was the civilian population, 18 years and older, residing in households and group quarters. Face-to-face interviews were conducted with 43,093 respondents, yielding an overall response rate of 81.0%.

The Wave 2 NESARC was designed to include face-to-face interviews with all participants in the Wave 1 interview. Excluding respondents ineligible for the Wave 2 interview, the Wave 2 response rate was 86.7% reflecting 34,653 completed interviews. The cumulative response rate at Wave 2 was the product of Wave 2 and Wave 1 response rates, or 81.0%. Wave 2 NESARC data were weighted to reflect design characteristics of the NESARC and account for oversampling. Adjustment for nonresponse across sociodemographic characteristic in the presence of any lifetime Wave 1 NESARC substance use disorder or other psychiatric disorder was performed at the household and person levels. Weighted data were then adjusted to be representative of the civilian population of the United States on socioeconomic variables based on the 2010 census. For the purposes of this study, all analyses were conducted on the subgroup of the NESARC sample that drank at least 12 drinks of alcohol in the year preceding the Wave 2 interview (n=17,355). Selecting the past year assessment period was designed to reduce recall bias.

2.2 Measures

The Alcohol Use Disorder and Associated Disabilities Interview Schedule-DSM-IV (AUDADIS-IV: Grant et al., 2001) was designed to measure DSM-IV alcohol abuse and dependence criteria. The Wave 2 AUDADIS-IV version also included a symptom item operationalizing the craving criterion enabling examination of a complete set of proposed DSM-5 criteria. DSM alcohol abuse and dependence criteria were assessed by 37 symptom items that were combined to yield 12 dichotomous criteria items that measured either the 11 DSM-IV abuse and dependence criteria or the overlapping proposed 11 DSM-5 abuse and dependence criteria (where the legal problems criterion in DSM-IV was replaced by the craving criteria in DSM-5): (1) drinking in hazardous situations; (2) failure to fulfill major role obligations at work/school/home; (3) legal problems related to drinking, (4) social or interpersonal problems due to drinking; (5) tolerance; (6) withdrawal symptoms or

withdrawal relief/avoidance; (7) drinking larger amounts or for longer periods than intended; (8) persistent desire or unsuccessful efforts to cut down or control drinking; (9) great deal of time spent on activities to obtain alcohol to drink, or to recover from its effects; and (10) giving up or reducing important social, occupational or recreational activities in favor of drinking; (11) continued drinking despite knowledge of a physical or psychological problem caused or exacerbated by drinking; and (12) craving.

Reliability (Chatterji et al., 1997) and validity (Cottler et al., 1997) for AUDADIS-IV alcohol abuse and dependence criteria were fair to good, as assessed by test-retest and by clinical reappraisal studies conducted by psychiatrists using a semi-structured diagnostic interview. Intra-class correlations of alcohol abuse and dependence criteria were good (intra-class correlations = 0.71–0.75) as were the kappa values (k= 0.61–0.74) (Grant et al., 1995; 2003).

2.3 Statistical Analyses

2.3.1 Dichotomous indicators—The use of dichotomous (binary) indicators in taxonometric analyses was suggested by Meehl as early as 1965. Since then, some concern has been expressed in the literature (Miller, 1996) that the use of dichotomous input, under very rare circumstances, can result in false evidence of a latent taxon or alternatively the identification of a pseudo taxonic plot using the taxonic procedure referred to as maximum covariance (MAXCOV) or its multivariate extension, maximum eigenvalue (MAXEIG; Meehl, 1995a; 1995b). Meehl and Yonce (1996) questioned the theoretical basis for this concern and noted that dichotomous output indicators are formally identical to the preferred quantitative output because the General Covariance Mixture Theorem is distribution free, holding for any pair of real numbers, including those that take on only two values. This concern has also been rebutted by Monte Carlo work that shows that the MAXCOV and MAXEIG taxonic procedures can be used confidentially with dichotomous data with demonstrated validity and acceptably low levels of nuisance covariance (Ruscio and Ruscio, 2004a). Whether dichotomous measures produce pseudotaxons has to date not been empirically demonstrated and, in fact, a comprehensive review of taxometric studies conducted between 1990 and 2002 showed no tendency for MAXCOV or MAXEIG procedures to yield higher rates of taxonic findings (Haslam and Kim, 2002).

2.3.2 Indicator validity and nuisance covariance—Indicators selected for taxometric analysis must possess sufficiently high validity and be correlated at an acceptably low level within the taxon and complement groups. Indicator validity in taxometric analyses is expressed in terms of the difference between indicator variable means among individuals within taxon and complement groups, standardized by the pooled within group variance, a metric more commonly known as Cohen's d (Ruscio and Ruscio, 2004a). Indicators with a mean separation not much below 1.2 standard deviations should be effective in differentiating taxon and complement groups (Beachaine and Beauchaine, 2002; Meehl, 1995a). Potential nuisance covariance is assessed by examining the magnitude of the average within group (taxon, compliment) tetrachoric correlations among indicators. Nuisance covariance is generally attributable to one or more method factors (e.g., reporting or social response biases) to which the measures are sensitive. Monte Carlo studies suggest

that taxometric methods are robust to moderate levels of nuisance covariance on average within group (taxon and complement) correlations among indicators of < 0.30 (Meehl, 1995b). In contrast, indicator variables in the total sample should be more highly associated if indeed the indicators do represent multiple facets of the target construct (in this case, alcohol use disorder).

2.3.3. Selecting the base rate—In taxometric analyses, the size of the taxon must be sufficiently large to identify a taxon if indeed it does exist. Meehl's rule of thumb for the estimated taxon base rate (i.e., the proportion (p) of taxon members in a sample) is $p \geq 0.10$ (Meehl and Yonce, 1996a). However, recent studies have shown that the absolute number of taxon members may be more important than the estimated base rate (Ruscio, 2009; Ruscio and Ruscio, 2004b). These studies indicated that, at minimum, two criteria should be satisfied to establish taxon size, $n \geq 50$ and $p \geq 0.05$.

There are many ways to estimate the taxon base rate and selecting the best choice will depend on the research context. In the present study, in which the structure of alcohol use disorder is being tested, the taxon base rate is simply specified as the proportion of cases (i.e., prevalence) that meet criteria for an alcohol use disorder for each of the three diagnostic thresholds associated with DSM-IV and DSM-5 alcohol use disorders. Unlike the present study where base rates (prevalences) can be meaningfully specified *a priori* as input to the taxometric analyses, studies lacking meaningful base rates must rely on the results of preliminary taxometric analyses without comparison data and then use the mean of the base rate estimates in subsequent taxometric analyses to estimate latent parameters (i.e., size of the putative taxon, indicator validity, correlations) and to generate a population of categorical comparison data. Specifying *a priori* base rates representing meaningful thresholds for alcohol use disorders, as was done in this study; neither presupposes a taxonic structure nor predetermines structural results of taxometric procedures.

2.3.4 Taxometric analyses—Two taxometric procedures were conducted using Ruscio's TaxProg (2006) programs in the R statistical program language (Ihaka and Gentleman, 1996). Like all available taxometric programs, TaxProg does not accommodate the complex design effects of the NESARC. The first was the mean above minus below a cut (MAMBAC) procedure (Meehl and Yonce, 1994). The MAMBAC procedure was performed using all pairwise configurations of indicators (i.e., diagnostic criteria), with each indicator serving in turn as the input indicator with each other indicator serving as the output indicator. These input and output indicators are used to search for an optimal cut-off score that distinguishes taxon from complement groups with minimum false positives and negatives. The input indicator sorts cases along the score distribution while the output indicator is used to calculate mean differences for cases falling above and below the cut score on the score distribution. The mean differences are plotted along the y-axis of the MAMBAC graph, with the number of cases plotted along the x-axis. The cut score then moves along the input indicator by some number of cases until the final cut score is reached, yielding the MAMBAC curve that shows how the mean differences for cases above and below the cut varies with the location of the cut score. In the present study, we selected 50 cuts at equally-spaced intervals between cases, beginning and ending 25 cases from either

extreme (shown on the x-axis). This selection of cuts along the input indicator serves to reduce sampling error in calculating mean differences. This procedure was repeated for each input-output indicator pair, yielding 110 MAMBAC curves associated with 11 criteria (k(k −1)) that were averaged to present the MAMBAC curve. Generally, taxonic constructs produce peaked MAMBAC curves whereas dimensional structures appear concave or non-peaked (Meehl and Yonce, 1994). All MAMBAC procedures used 10 internal replications to smooth the shape of the MAMBAC curve (Ruscio and Ruscio, 2004a).

The second taxometric procedure implemented was MAXEIG, a multivariate extension of Meehl and Yonce's (1996) MAXCOV taxometric procedure. This non-redundant taxometric procedure served to evaluate the consistency of structural results. MAXEIG tests whether indicators of a construct covary because of a mixture of two underlying groups (taxonic structure) or loadings on a common latent factor (dimensional structure). The traditional MAXEIG procedure was used in which indicators served in all possible input-output-output triplets. MAXEIG examines the association between output indicators within subsamples of cases ordered along an input indicator that forms the x-axis of the MAXEIG graph. The first (largest) eigenvalue of the covariance matrix of the two output indicators is then calculated and plotted along the y-axis of the MAXEIG graph for each subsample. This procedure was repeated for each input-output-output triplet, yielding 495 (k(k−1)(k−2)/2) MAXEIG curves that are averaged for presentation purposes. Although there are several ways to divide cases into ordered subsamples along the input indicator, it is recommended that the windows approach be used (Ruscio and Ruscio, 2004). Thus, in the present study, cases were divided into 25 ordered fixed sized subsamples that overlapped 90.0% with adjacent subsamples (windows) as shown on the x-axis. Similar to MAMBAC, 10 replications were used to minimize the distorting effect on resultant curves resulting from subsample divisions occurring between cases possessing equal scores. For prototypical categorical data, the MAXEIG curve is expected to be peaked (Ruscio et al., 2008). A non-peaked MAXEIG curve suggests a dimensional construct (Waller and Meehl, 1998).

Since taxometric graphs may be influenced by a variety of factors (e.g., indicator skew), empirically-derived graphs may not always yield their prototypical shape, rendering interpretation difficult. For this reason, it is recommended to simulate via bootstrapping one or more sets of taxonic and dimensional comparison data using the same taxometric analyses used for the research data, in this case 100 simulated data sets for taxonic structure and 100 simulated data sets for dimensional structure. To the extent that the data resembles one type of simulated data or the other increases interpretability of the structural solution. Once the comparison data are generated and plotted, a Comparison Curve Fit Index (CCFI) is calculated to more objectively quantify the extent to which the taxometric graphs yielded by the research data were more similar to the taxometric graphs derived from the simulated taxonic or dimensional data. The CCFI is defined as the root mean squared error of approximation (RMSEA) of the fit between the average curve and simulated dimensional curve divided by the sum of the RMSEA of the fit between the average curve and simulated dimensional curve and the RMSEA of fit between the average curve and simulated taxonic curve (fit_{DIM} / fit_{DIM} + fit_{CAT}) (Ruscio and Ruscio, 2004a). A CCFI value of 0.50 supports equally good (or poor) fit between the data and simulated dimensional and taxonic models,

while values below 0.50 (to a minimum of 0.0) show support for a dimensional structure and values above 0.50 (to a maximum of 1.0) demonstrate support for taxonic structure.

Use of simulated data sets and calculation of the CCFI is especially helpful for distinguishing low base rate taxon (including those associated with alcohol use pathology) from positively skewed indicators of a latent dimension. This technique importantly holds indicator skew and other aspects of the empirical data (e.g., mean, standard deviation, indicator correlations) constant across data sets. Therefore, the only difference between the two simulated data sets is in their underlying structure (one latent dimension vs. two latent taxa; Ruscio et al., 2007). There is growing evidence (Ruscio, 2009; Ruscio and Marcus, 2007; Ruscio et al., 2007, 2010; Walters and Ruscio, 2009, 2010), including results from Monte Carlo simulations (Beach et al., 2005; Ruscio et al., 2010), that this technique can provide a valid method to differentiate between taxonic and dimensional data, especially under those circumstances in which taxon base rates is relatively low (<0.06). Therefore, the results of the comparisons with Monte Carlo simulation were presented in the present study.

3. RESULTS

3.1. Indicator validity, nuisance covariance, and a priori base rates

Taxometric analyses generally require each indicator's validity as measured by Cohen's d (effect size) to be not much below 1.2 standard deviation units separating taxon and complement groups. Five of the 11 criteria indicators associated with DSM-IV and DSM-5 classifications with 2+ thresholds failed to meet this standard (d = 0.493, 0.587, 0.621, 0.971 and 1.074). Because this data was not suitable for taxometric analysis it will not be discussed further. The majority of DSM-IV and DSM-5 abuse and dependence indicators associated with 3+ thresholds did meet validity standards. However, the number of lower d's for DSM-IV (0.893, 1.070, 1.13) and DSM-5 (1.005, 1.067) indicators were few and very near 1.2 standard deviations. As can be seen in Table 1, all DSM-IV and DSM-5 indicators with 4+ thresholds met the validity standard. Taxometric analyses also require nuisance covariance (inter-indicator correlations) to be moderate or high in the total sample but low within the taxon and compliment groups. The average and range of indicator correlations for the total sample, taxon group and complement group are shown in Table 1. Nuisance covariation was not an issue in the present study for any taxometric analysis: correlations were moderate in the total samples and very low in both taxon and complement groups regardless of which set of diagnostic criteria or threshold was assessed.

With regard to the taxometric analyses using DSM-IV alcohol abuse and dependence criteria, the *a priori* taxon base rates were 0.110 and 0.068 for the 3+ and 4+ thresholds. Corresponding base rates for DSM-5 criteria were similar, 0.117 and 0.073.

3.2 MAMBAC and MAXEIG

Analysis of fit between actual and simulated taxonic and dimensional curves in MAMBAC and MAXEIG (shown in Figures 1 and 2) yielded mean CCFI estimates of 0.338 and 0.332 for DSM-IV and DSM-5 criteria associated with 3+ thresholds, indicative of continuous structures (Table 1). However, DSM-IV and DSM-5 criteria associated with 4+ thresholds

yielded a much higher average CCFI values (0.763 and 0.735), reflecting taxonic structures, even by the most conservative dual threshold standard (CCFIs: < 0.4 = dimensional; > 0.60 = taxonic) (Walters and Russio, 2011). Consistent with these fit statistics, average MAMBAC and MAXEIG curves for DSM-IV and DSM-5 criteria with 3+ thresholds show a better fit to the dimensional data, while both criteria sets with 4+ thresholds support taxonic structures (Figures 1 and 2).

Given that a taxonic structure was identified for 4+ thresholds, we determined the latent structure of DSM-IV and DSM-5 criteria using 5+ and 6+ thresholds. Higher thresholds were associated with base rates too low (<0.014) to be suitable for taxometric analysis. Similar to the results for the 4+ thresholds, CFFIs associated with DSM-IV criteria with 5+ (mean CCFI=0.836) and 6+ thresholds (mean CCFI=0.711) and DSM-5 criteria with 5+ (mean CCFI=0.751) and 6+ (mean CCFI=0.779) thresholds supported taxonic structures. Indicator validity was also good for indicators associated with each of these models (>1.72) with low correlations within taxon and complement groups (<0.11) and greater correlations among indicators in the total samples (0.28–0.30).

4. DISCUSSION

This study found that when DSM-IV and DSM-5 proposed criteria for alcohol abuse and dependence with 3+ thresholds demonstrated taxometric characteristics of dimensional structure while the corresponding 4+ or greater threshold constructs were clearly taxonic. These findings remained the same regardless of whether the legal problems criterion was included among the DSM-IV criteria for alcohol use disorder or whether the cravings criterion was included among DSM-5 criteria. The dimensional findings associated with the DSM-IV and DSM-5 constructs with 3+ thresholds were consistent with prior IRT analyses of alcohol use disorder severity (Keys et al., 2011; Saha et al., 2007) while the results for the same constructs with 4+ or greater thresholds were consistent with most prior taxometric analyses in the area (Green 2011; Walters, 2008; Walters et al., 2009, 2010)

However, the mere existence of a taxon using 4+ or greater thresholds does not imply the absence of dimensional variation as evidenced by the dimensional structure of DSM-IV and DSM-5 constructs of alcohol use disorders using 3+ thresholds. As noted by Waller and Meehl (1998) there will usually be dimensional variation within the complement class, so that the taxonic vs. dimensional distinction might be better described by taxonic-dimensional vs. dimensional only. The latent structures indentified in this study could be referred to as hybrid, with one pure latent class (above the 4+ thresholds) where the complement group contains reliable variation of a single dimension. The content relevant dimensional variation among complement members superimposed on the taxonic structure could reflect nonproblematic to subclinical cases of alcohol problem severity. Therefore, alcohol use disorders may be taxonically distinct from those who do not have the disorder, with dimensional variation remaining among the non-problematic to subclinical cases in the complement group.

Another intriguing explanation of the differences in latent structure found between DSM-IV and DSM-5 alcohol use disorder indicators with 3+ and 4+ and greater thresholds, is that

certain features of alcohol use disorders, reflected in some of some of the core diagnostic criteria examined in this study, may be taxonic to the extent that there are qualitative differences between those who do and do not have DSM-IV or DSM-5 alcohol use disorder. Other features of alcohol use disorder, such as severity of alcohol use disorder symptomatology may, however, be more dimensional in nature. Differentiating alcohol use criteria that appear to define the taxonic structure of alcohol use disorder from those reflecting the dimensional nature of severity of alcohol use disorder symptomology will be critical for future research focusing on the underlying nature of the disorder.

That the latent structure of DSM-IV and DSM-5 alcohol use disorders may contain both taxonic and dimensional elements has major implications for assessment of this disorder. The possibility that alcohol use disorder is characterized by both the taxonic structure and a severity dimension, the presence/absence of disorder should be assessed along with a dimensional rating of severity. These results also suggest that a distinct category of alcohol use disorder exists only at thresholds greater than 4+ criteria. Below this threshold, we may speak of alcohol problems of varying severity. This puts into question a threshold of 2+ for the DSM-5 threshold for a clinically significant disorder, which clearly seems too low a threshold with respect to a distinct disorder category.

However, the results are in line with results of other epidemiological research, where the majority of people with alcohol use disorders in the general population were shown to have similar outcome characteristics in terms of mortality as the heavy drinking general population (Dawson, 2000; Fichter et al., 2011; Perälä et al., 2010), while only a subgroup of those with alcohol use disorders (who actually sought treatment) had much higher mortality rates (Campos et al., 2011; Gerdner and Berglund, 1997; Hayes et al., 2011; Rossow and Amundsen, 1997).

Although the results of this study may indicate a hybrid taxonic-dimensional structure underlying alcohol use disorder, with a distinct alcohol use disorder taxon associated with a 4+ or greater thresholds along with residual variation in the non-disordered to subclinical complement group, there may well be such variation within the taxon group. Although taxometric procedures only test the two-group latent class model, Ruscio and Ruscio (2004b) outline an iterative/procedure that can be used to begin to resolve complex latent structures like the one found in this study. For example, once the initial taxometric analysis indicates the possible existence of a taxon, subsequent taxometric analyses within the taxon class may reveal additional taxa. A series of taxometric analyses conducted within the taxon class may identify subtypes of alcohol use disorder, using additional indicators specific to the conjectured subtypes (e.g., age of onset, family history of alcohol use disorders). Given that taxonic structures were identified for alcohol use disorder associated with 4+, 5+, and 6+ thresholds, future analyses within the associated taxon groups to differentiate the existence of additional taxa or subtypes of alcohol use disorder are indicated. Follow-up exploratory or confirmatory factor analyses can also be conducted within the complement group to determine the existence of a unidimensional or multidimensional structure (e.g., non-problematic and preclinical cases). IRT analyses can also be used to determine critical properties of the indicators (e.g., information value, redundancy) of the latent dimension(s) and criterion items. These iterative procedures represent the next steps of a careful and

systematic program of structural research necessary to fully understand the latent nature of alcohol use disorders.

Undoubtedly, systematic taxometric inquiry does hold great promise in identifying the underlying latent structure of alcohol use disorder, a structure that will likely resemble a taxonic-dimensional hybrid. Only through identification of the critical features of alcohol use disorder that defines the putative taxon and those features characterizing dimensional clinical phenomena (e.g., severity, symptom manifestations reflecting differences in environmental or biological influences on vulnerability) will taxometric research achieve its full potential to elucidate etiology, facilitate accurate classification and inform prevention and treatment of alcohol use disorder in public health and clinical settings.

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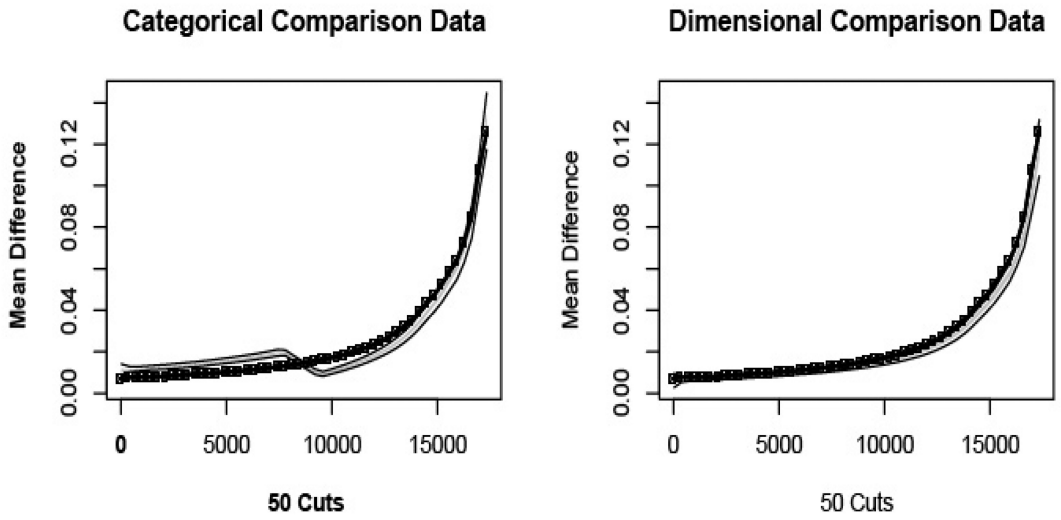
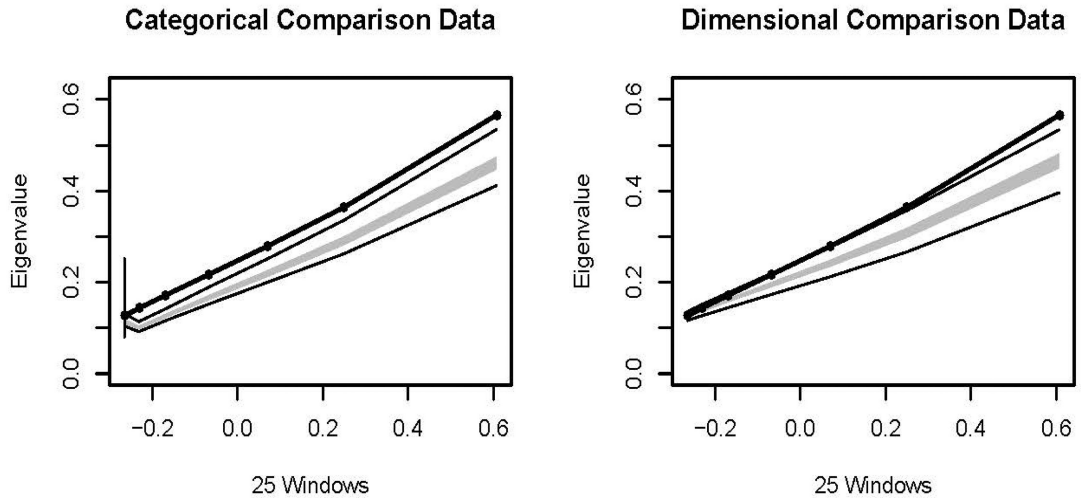
DSM-IV

MAMBAC

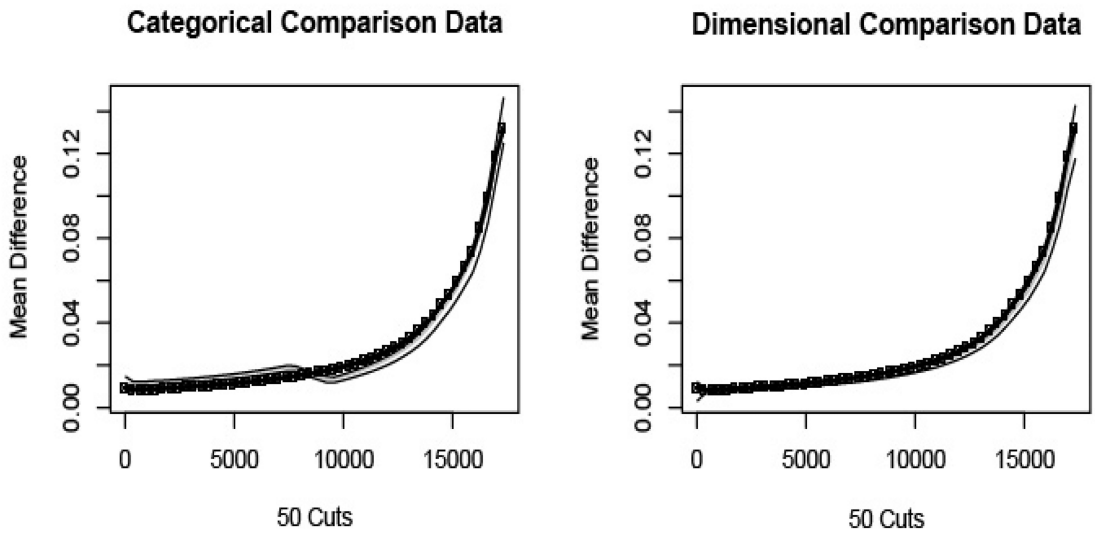


MAXEIG



DSM-5

MAMBAC



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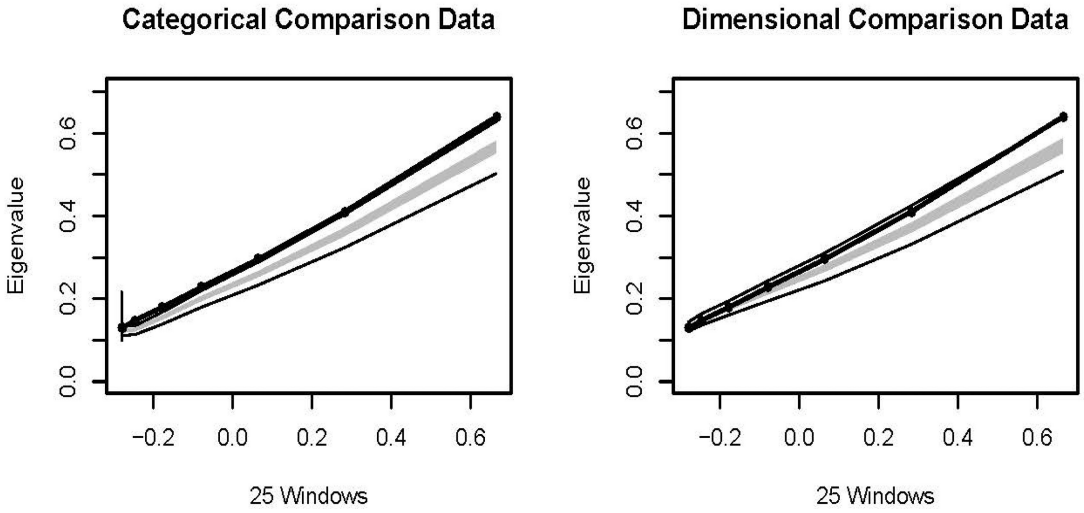
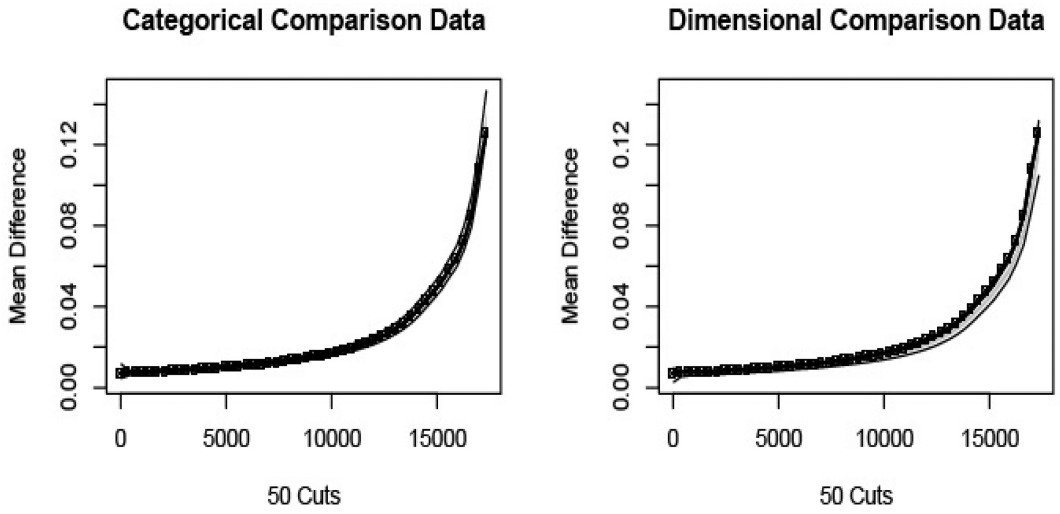


Figure 1.

DSM-IV and DSM-5 Diagnostic Criteria of Alcohol Abuse and Dependence with 3+ thresholds. Thick lines show the results from the empirical data in comparison with simulated taxonic and dimensional comparison data (thin lines represent one standard deviation above and below the mean)

DSM-IV

MAMBAC



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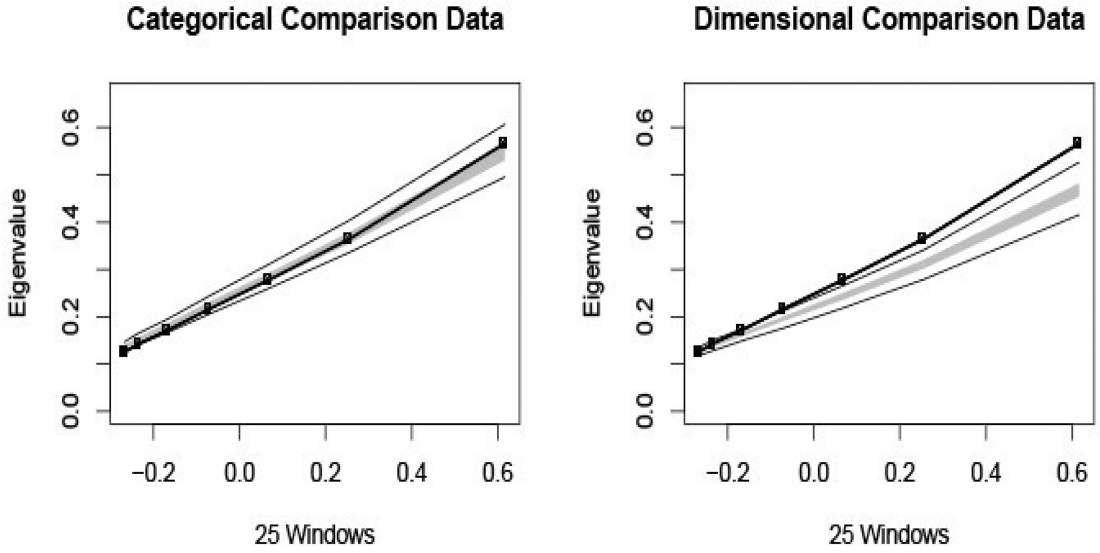
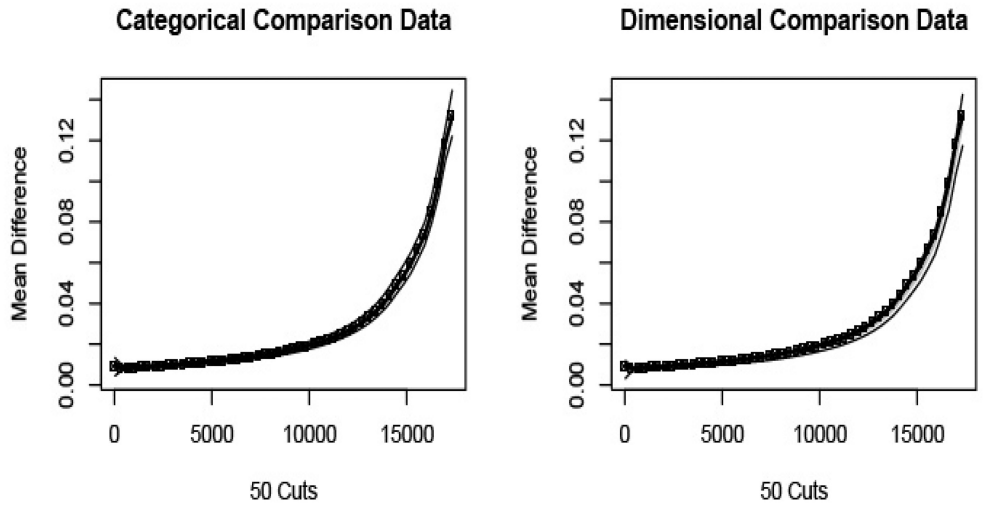


DSM-5

MAMBAC



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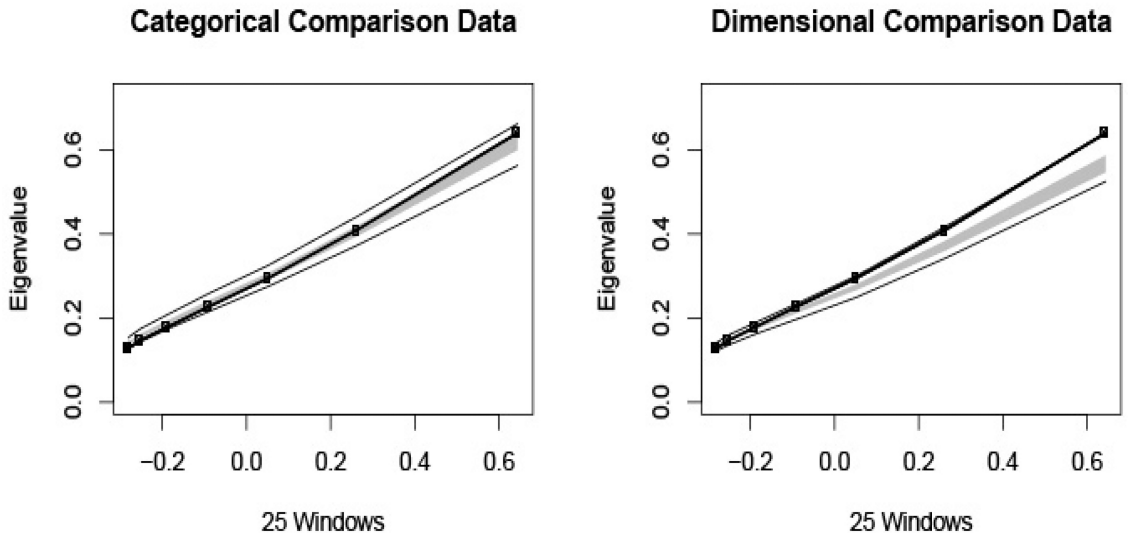

Figure 2.

DSM-IV and DSM-5 Diagnostic Criteria of Alcohol Abuse and Dependence with 4+ thresholds. Thick lines show the results from the empirical data in comparison with simulated taxonic and dimensional comparison data (thin lines represent one standard deviation above and below the mean)

Table 1

Taxometric Latent Parameter Estimates and Fit Statistics Associated with DSM-IV and DSM-5 Alcohol Abuse and Dependence Criteria with 3+ and 4+ Thresholds.

Model	Average Total Correlation Among Indicators (Range)	Average Nuisance Covariance (Range)		Cohen's *d* (Range)	Base Rate	CCFI		Mean CCFI
		Taxon	Complement			MAMBAC	MAXEIG	
DSM-IV, 3+ Threshold	0.27 (0.12–0.45)	0.09 (−0.08 – 0.38)	0.01 (−0.01 – 0.18)	1.695 (0.893–2.404)	0.110	0.423	0.253	0.338
DSM-5, 3+ Threshold	0.30 (0.16 – 0.45)	0.10 (−0.06 – 0.39)	0.01 (−0.01 – 0.18)	1.724 (1.005–2.302)	0.117	0.419	0.248	0.332
DSM-IV, 4+ Threshold	0.27 (0.12–0.45)	0.06 (−0.12 – 0.34)	0.04 (−0.01 – 0.22)	2.178 (1.412–3.543)	0.068	0.832	0.693	0.763
DSM-5, 4+ Threshold	0.30 (0.16 – 0.45)	0.08 (−0.03–0.35)	0.04 (−0.01 – 0.24)	2.198 (1.650–3.346)	0.073	0.868	0.601	0.735