The Role of Cannabis Use Within a Dimensional Approach to Cannabis Use Disorders

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Abstract

Context—Cannabis consumption is central to diagnosis of DSM-IV cannabis abuse and dependence; yet, most research on cannabis disorders has focused just on diagnosis or criteria. The present study examines the ability of a frequency and quantity measure of cannabis use as well as cannabis abuse and dependence criteria to discriminate between individuals across the cannabis use disorder continuum.

Method—A representative sample of USA adults in 2001–2002 (N=43,093) were queried about past year frequency of cannabis use and each DSM-IV cannabis abuse and dependence criterion. Factor analysis and item response theory (IRT) models were used to define the relationship between observed responses and the underlying unobserved latent trait (cannabis use disorder severity).

Results—Factor analyses demonstrated a good fit for a one factor model both with and without the cannabis use criterion and no differential criterion functioning was demonstrated across sex. The IRT model including the cannabis use criterion had discriminatory power comparable to the model without the cannabis use criterion and exceeded the informational value of the model without the cannabis use criterion in mild and moderate ranges of the severity continuum.

Discussion—Factor and IRT analyses disprove the validity of the DSM-IV abuse and dependence distinction: A single dimension represented the criteria rather than the two implied by the separate abuse/dependence categories. IRT models identified some dependence criteria to be among the mildest and some abuse criteria to be among the most severe —results inconsistent with the interpretation of DSM-IV cannabis abuse as a milder disorder or prodrome of cannabis dependence. The consumption criterion defined the mild end of the cannabis use disorder continuum and its excellent psychometric properties strongly supported its inclusion as a DSM -V criterion for cannabis use disorders. Additional work is needed to identify candidate consumption criteria across all drugs that apply to the milder end of the severity continuum while also improving overall model performance and clinical diagnostic utility.

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1. Introduction

In the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition (DSM-IV; American Psychiatric Association, 1994), cannabis abuse and dependence are defined as maladaptive patterns of cannabis use leading to clinically significant impairment or distress, as manifested by at least one of four abuse symptoms criteria or three of six dependence symptom criteria, respectively. As noted by Saha and his colleagues (2007), despite the central role of consumption in the DSM-IV classification of cannabis disorders, no specific pattern of cannabis use is defined nor do maladaptive patterns of cannabis use appear as diagnostic criteria for either disorder in the DSM-IV. For the most part, research on cannabis use disorders has ignored the actual use of the substance.

A further issue related to the DSM -IV classification of cannabis use disorders is whether abuse and dependence criteria are categorical conditions or may be better represented by a dimensional approach. Are abuse and dependence unique, distinct disorders? Or do the phenomenological presentations better fit continuous measures (i.e. dimensions)? This issue parallels recent calls to add a dimensional component to all psychiatric diagnoses (Krueger 2004; Krueger et al. 2005), and recently, researchers have answered this call by using item response theory (IRT). Published findings using IRT analyses have found strong evidence supporting a single latent dimension underlying DSM-IV alcohol abuse and dependence criteria and items (Krueger et al., 2004; Langenbucher et al., 2004; Proud foot et al., 2006; Kahler and Strong, 2006; Saha et al., 2006; 2007), and the less extensive IRT literature for DSM-IV cannabis use disorders (Teesson et al. 2002; Langenbucher et al. 2004; Lynskey and Agrawal, 2007; Martin et al., 2006; Gillespie et al. 2007) similarly found better fits for a model specifying a unidimensional latent trait of cannabis use disorder severity. These studies also identified few diagnostic criteria that discriminated at the milder levels of the cannabis use disorder severity continuum. These results highlight the critical need to develop better dimensional measures that discriminate across the entire spectrum of severity, including components that represent milder cases.

One limitation of IRT analyses con ducted to date on cannabis use disorders is the general unrepresentativeness of the research samples. The two exceptions to this rule are the study by Teesson and colleagues (2002) and the study by Lynskey and Agrawal (2007) using general population samples of adults age 18 and older. In another study, the sample consisted of adult male twins selected from the Virginia Twin Registry (Gillespie et al., 2007). The remaining two samples consisted of adolescent (Martin et al., 2006) and adult (Langenbucher et al., 2004) substance abuse inpatients and outpatients. The second limitation of these studies was the selection of the target sample of cannabis users to form the basis of the IRT analyses. In these studies, analyses were conducted among cannabis users narrowly defined as those individuals who reported using cannabis at least five times in the previous year (Teesson et al., 2002), at least once a month for six months (Martin et al., 2006) or who reported using cannabis at lest five times during their lifetime (Langenbucher et al., 2004). In the other IRT study (Gillespie et al., 2007), individuals who endorsed using a drug six or more times in their lifetime but not 11 times in one month may have only been asked symptom items related to cannabis abuse, whereas those endorsing use 11 times in one month were asked all cannabis abuse and dependence criteria symptom items. As a result of these limitations, variability in cannabis use was restricted in all studies, and the use of consumption as a screen for cannabis dependence in one study (Gillespie et

al., 2007) may have omitted numerous individual with dependence from the analysis. Third, except for the study by Teesson et al. (2002), previous studies conducted their psychometric analyses among lifetime cannabis users and examined lifetime endorsements of cannabis abuse and dependence criteria; lifetime measures are subject to recall bias.

To determine whether cannabis abuse and dependence measure a unitary dimension of cannabis use disorder, large representative samples of the general population are needed that do not restrict variability in cannabis use or dependence and that use current measures of cannabis use and disorder criteria to reduce substantially the risk of recall bias. Accordingly, the purpose of the present study was to determine whether the DSM-IV abuse and dependence criteria defined a cannabis use disorder continuum using a large (n=43,093) nationally representative sample of the U.S. population, the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). IRT methodology was used: (1) to examine the ability of each 12-month DSM-IV cannabis abuse and dependence criterion to discriminate between individuals across the cannabis use disorder continuum among respondents who had used cannabis during the year preceding the interview; and (2) to determine the differential severity of DSM-IV cannabis abuse and dependence criteria.

To our knowledge, no previous study has examined the role of cannabis use as a candidate criterion for cannabis use disorders, though pioneering research in this area has been conducted for alcohol consumption criteria (Li et al., 2007; Saha et al., 2007). In view of the important role played by cannabis use in DSM-IV definitions of cannabis abuse and dependence, and previous findings of the absence of criteria to represent the mild end of the cannabis use disorder continuum, a cannabis use quantity-frequency measure (i.e., consuming at least one joint per week in the year preceding the interview) was also examined to determine if it could serve as a potential candidate criterion to represent the milder end of the cannabis use disorder continuum. Identification of milder criteria is critical to etiologic research on cannabis use disorders through the development of dimensional measures that discriminate across the spectrum of severity. Accordingly, IRT models with and without the consumption criterion were compared with respect to model fit and information value. In addition, the relatively large sample size of the NESARC allowed for the examination of differential criterion function (DCF) versus invariance of the criteria across sex, an analysis infrequently conducted in past research due to small sample sizes.

2. Method

2.1. Sample

The 2001–2002 NESARC is a study of a representative sample of the USA conducted by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), described in detail else where (Grant et al. 2003; 2004). The NESARC target population was the civilian non-institutionalized population residing in households and group quarters, 18 years and older. Face-to-face interviews were conducted with 43,093 respondents, with a response rate of 81%. Blacks, Hispanics and young adults (ages 18 -24) were over sampled with data adjusted for over sampling and household-and person -level non-response. The weighted data were then adjusted to represent the U.S. civilian populations based on the 2000 census. The sample of this study included current cannabis users defined as those respondents who used any cannabis at all during the year preceding the NESARC interview (N = 1,603). Current, as opposed to lifetime, cannabis use and abuse and dependence criteria were used to minimize recall bias.

2.2 Cannabis use criterion

The frequency or volume criterion was constructed as a function of two variables measured in the NESARC. The first was a cannabis use frequency measure during the 12 months preceding the interview with the following response categories: every day; nearly every day; 3 to 4 times a week; 1to 2 times a week; 2 to 3 times a month; once a month; 7 to 11 times a year; 3 to 6 times a year; 2 times a year; and once a year.

The second quantity measure inquired directly about the number of joints usually smoked in a single day during the past 12 months. The quantity-frequency measure derived from these two variables and assessed in this study was smoking at least one joint per week, on average, in the last 12 months. All respondents who met this criterion were coded 1 or positive for this criterion, with the remaining respondents coded 2 or negative for this cannabis use criterion. Similar to all general population surveys, the distribution of cannabis use was relatively restricted, precluding the examination and comparison of a range of cannabis use measures differing in both frequency and quantity. For the purposes of this study, all statistical analyses were conducted on all respondents who had used cannabis during the year preceding the interview.

2.3. DSM-IV cannabis abuse and dependence

The NIAAA Alcohol Use Disorders and Associated Disabilities Interview Schedule-DSM-IV version (Grant et al., 2001) was designed to generate DSM-IV diagnoses of cannabis abuse and dependence. Following DSM-IV, cannabis abuse criteria included recurrent use resulting in one of the following during the 12 months prior to the interview: (1) use in hazardous situations; (2) failure to fulfill major role obligations at work/school/home; (3) legal problems related to use; or (4) social or interpersonal problems. DSM-IV dependence criteria included: (1) tolerance; (2) using larger amounts or for longer periods than intended; (3) persistent desire or unsuccessful efforts to cut down or control use; (4) a great deal of time spent in activities to obtain cannabis, or to recover from its effects; (5) giving up or reducing important social, occupational or recreational activities in favor of use; and (6) continued use despite knowledge of a physical of psychological problem caused or exacerbated by cannabis use. All abuse and dependence criteria were measured and coded as dichotomous (i.e., yes/no) variables.

As reported in detail elsewhere, the reliability and validity were good to excellent for cannabis use and cannabis use disorder diagnoses (Grant et al. 1995; 2003; 2004; Chatterji et al., 1997; Cottler et al., 1997; Pull et al., 1997; Ustun et al., 1997; Vrasti et al., 1997; Canino et al., 1999; Nelson et al., 1999; Compton et al., 2004). Reliability (Chatterji et el., 1997) and validity (Cottler et al., 1997) for cannabis abuse and dependence symptom criteria were fair to good as assessed in clinical reappraisal studies conducted by psychiatrists using a semi-structured diagnostic interview. Intraclass correlations (ICCs) of cannabis abuse and dependence criteria derived from a test-retest study of the general population (Grant et al., 1995) were excellent (ICCs=0.86–0.88) as was the kappa value (κ=0.78).

2.4. Statistical analysis

2.4.1 Factor analyses and unidimensionality—As a preliminary to the IRT analyses, factor analyses were conducted in a confirmatory factor analytic context using Mplus software (Muthén and Muthén, 2004) to test the IRT assumption of unidimensionality and to determine goodness of fit of a one-factor model. The parameters of the IRT model are most interpretable when the criteria reflect a single unitary dimension (Stout, 1987; Downing, 2003; Bolt et al., 2004; Krueger et al., 2004).

Factor analyses conducted within this confirmatory factor analytic framework produce goodness of fit statistics and chi-square statistics. The chi-square statistic is often used to assess model fit in these analyses. However, because the chi-square statistic is highly sensitive to large sample sizes, as in the case here, and may overstate the lack of fit of a structural model (Bollen, 1989), this test statistic was not used. Instead, a number of additional fit indices that have been developed to address the problem associated with the chi-square statistic were used. Hu and Bentler (1999) provided a test of the "rules of thumb" cutoffs for the most commonly used fit indices. They advocated a two-index strategy to assess the adequacy of fit of structural models. Hu and Bentler (1999) suggest a cutoff of 0.95 or above on either the Tucker Lewis Index (TLI; Tucker and Lewis, 1973) or the Comparative Fit Index (CFI; Bentler, 1990). A root mean squared error of approximation (RMSEA) "close to 0.06" also indicates good fit of a factor model.

2.4.2 IRT models—The two-parameter logistic model (Birnbaum, 1968; Lord and Novick, 1968), an extension of the Rasch or one-parameter logistic model (Rasch, 1960), was used to define the relationship between the observed responses to the criteria and the underlying unobserved latent trait or construct (cannabis use disorder severity). This Item Response Theory (IRT) model was generated using the marginal maximum likelihood estimates (Bock and Aitken, 1981; Harwell et al., 1988) of two parameters: the *b* or threshold parameter, and the *a* or discrimination parameter. The BILOG-MG statistical program was used for this purpose (Scientific Software International, 2003). The *a* parameter measures the ability of a criterion to discriminate people who are higher on the continuum from those who are lower on the continuum. This parameter describes how strongly the criterion is related to the underlying trait or construct. The larger the *a* parameter (i.e., the slope at its steepest point), the greater the discrimination of a criterion. The *b* or threshold parameter measures the severity of a criterion; criteria with high thresholds are endorsed less frequently and are therefore considered "more severe".

The *a* and *b* parameters were plotted graphically as criterion response curves (CRCs). In these plots the *b* parameter represents the criterion's location along the latent continuum (located on the horizontal axis). The *b* parameter (severity) is the point on the latent continuum where there is a 50% chance of the criterion being present. The *b* parameter shifts the CRC from left to right as the criterion becomes more severe. Criterion severity is an indication of the degree of criterion severity needed for a particular criterion to be present. The *a* or discrimination parameter indicates how steep the slope of the CRC is at its steepest point. Although not often done in prior research in this domain, the present study examined the question of whether the two-parameter IRT model indeed provided a better fit to the data than the one-parameter IRT model containing only the *b* parameter. This comparison was conducted for models with and without the cannabis use criterion, using the Bayesian information function (BIC) as the fit index.

2.4.3. Comparison of IRT models with and without the cannabis use criterion —The IRT models with and without the cannabis use criterion were examined with respect to information value. The aggregate criterion information function (ACIF) was estimated using BILOG-MG (Scientific Software International, 2003) for each model. The ACIF graphically depicts the information value of the criteria as a collective or in the aggregate. The ACIF is the reciprocal error variance in an efficient estimate of the latent trait and measures the contribution of each criterion to the reduction of error of measurement.

2.4.4. Differential criterion functioning—Criteria that demonstrate differential criterion functioning (DCF) need not reflect bias or variance across subgroups if the DCF occurs in opposing directions, e.g., with some criteria resulting in greater discrimination or severity among men and others demonstrating the opposite effect) (Cooke et al., 2001; Bolt

et al., 2004). Whether criteria demonstrating significant DCF do in fact reflect invariance across subgroups can be determined if the observed DCFs cancel out at the total test (scale) score level. To examine this, we plotted the expected raw scores by the severity of the cannabis use disorder continuum by age – plots referred to as the test response curves (TRCs). Due to sample size considerations, only TRCs by sex could be examined in this study. If the TRCs for subgroups (i.e., for men and women) do not substantially differ, we can conclude that any significant criterion-level DCFs that may be observed cancel out when considered at the total scale level, and that, for any latent trait value, men and women have identical expected raw scores. If, however, the TRCs do differ substantially between subgroups defined by sex, individual criteria demonstrating DCF are biased, lacking invariance across important subgroups of the population, and should be eliminated.

3. Results

3.1. Prevalence and factor analyses

The one-year prevalences of DSM-IV abuse and dependence criteria ranged from 2.4% for legal problems to 27.9% for hazardous use (Table 1). The rate of consuming at least one joint a week during the year preceding the NESARC interview was 45.0% among current cannabis users.

Consistent with the recommendations of Hu and Bentler (1999), the one-factor solution demonstrated a very good fit to the observed data underlying the DS M-IV cannabis abuse and dependence criteria both with and without the cannabis use criterion (CFA: 0.0967, 0.097; TLI: 0.980, 0.986; RMSEA: 0.038, 0.031) (Table 1).

3.2 Item response theory analyses

The two-parameter IRT models were found to provide a better fit for models with and without the cannabis use criterion (BIC= 10834.77 and 8966.20, respectively) relative to the one-parameter Rasch models (10849.32 and 8972.41, respectively). Therefore, further discussion is limited to the two-parameter IRT models, and Table 1 presents these IRT parameters. As shown in Table 1, the BIC was also lower for the model that excluded the cannabis use criterion (8966.20) compared with the model that included this criterion (10834. 77), indicating a slightly better fit for the model that did not include the cannabis use criterion.

The criterion response curves (CRCs) associated with each model (Figures 1 and 2) were quite similar in terms of the relative severity of DSM-IV cannabis abuse and dependence criteria, with the cannabis quantity-frequency use criterion falling along the least severe end of the cannabis use disorder continuum. In both models, severity was greatest for legal problems, activities given up and neglect of role criteria, lowest for hazardous use and quit/control, with the remaining abuse and dependence criteria representing intermediate levels of severity. There was less variability observed in discrimination, with discrimination values ranging from 1.60 to 1.83 for each of the two models.

3.3 Aggregate criterion information function

The ACIF curve is shown in Figure 3. Relative to the IRT model without the consumption criterion, the model with the cannabis use criterion demonstrates higher levels of information in the mild and moderate ranges of the severity continuum, while retaining similar information values as the model without the cannabis use criterion at the severe end of the continuum.

3.4 Differential criterion functioning

TRCs were essentially identical, i.e., overlapping, for each sex, for both IRT models. These findings indicate a general lack of evidence for DCF among subgroups defined by sex at the total scale score level.

4. Discussion

Both factor and IRT analyses indicated the utility of conceptualizing DSM-IV cannabis abuse and dependence criteria along a dimensional scale of severity. Regardless of whether the cannabis use criterion was entered into the model, factor analyses results indicated that a one-factor model provided a good fit to the data. IRT results showed that the diagnostic criteria for cannabis abuse and dependence (with or without the cannabis use criterion) can be effectively modeled along a unidimensional latent trait of cannabis use disorder severity, and that these results remained invariant across sex. These results are similar to those found for other studies examining cannabis use criteria using IRT analyses among adult (Teesson et al., 2002; Gillespie et al., 2006; Langenbucher et al., 2004; Lynskey and Agrawal, 2007) and adolescent samples (Martin et al., 2006).

The findings of the current study do not support the validity of the DSM-IV abuse and dependence distinction in two ways: First, a single dimension represented the criteria rather than the two implied by the separate abuse and dependence categories. Second, the CRCs identified some dependence criteria (e.g., quit/control, tolerance, physical/psychological problems) that were well represented among the mildest criteria, and some abuse criteria (e.g., legal problems, neglect of role) that tapped the more severe range of the continuum. These results are inconsistent with the common interpretation of DSM-IV cannabis abuse as a milder disorder or prodrome of cannabis dependence.

Taken together, the results suggest that cannabis use disorders should be diagnosed with a single criterion set consisting of both cannabis abuse and dependence diagnostic criteria. That dependence criteria are related to a single underlying dimension of cannabis use disorder severity is not surprising since the dependence criteria are expected to operationalize two closely related concepts: physical dependence (i.e., tolerance) and impaired control/compulsive use. However, three of the four cannabis abuse criteria also operationalize impaired control/compulsive use, that is, cannabis use despite social/ interpersonal problems or recurrent use resulting in neglect of role responsibilities or legal problems. In contrast, the fourth abuse criterion, recurrent cannabis use in situations likely to cause physical harm to the user, is not conceptually related to impaired control/compulsive use and appears best represented as a risk factor of potential harm and not a diagnostic criterion for cannabis use disorder. This study showed a strong relationship of this hazardous use criterion to the observed cannabis use disorder continuum, but the conceptual distinction indicates that further investigation is warranted.

The relative ordering of the severity of abuse and dependence criteria in the present study differs from the corresponding severity levels found in previous research. The most comparable study (in terms of sample and design) was the Australian general population study of Teesson and colleagues (2002). The results of the present study generally agree with this earlier study that hazardous use and quit/control were at the milder end of the continuum; while activities given up, legal problems and neglecting roles were at the severe end of the continuum. Considering the other IRT studies with unrepresentative and/or treated samples, consistent with prior results, neglect of role (Langbucher et al., 2004) and legal problems (Martin et al., 2006; Gillespie et al., 2007) were among the most severe criteria assessed. Larger/longer, tolerance, time spent and social/interpersonal problem criteria fell within the intermediate range of the cannabis use disorder continuum, results

also consistent with prior research (Langenbucher et al., 2004; Martin et al., 2006). In contrast, this study that found both quit/control and hazardous use criteria among the least severe criteria, while previous IRT analyses (Langenbucher et al., 2004; Martin et al., 2006) found these criteria to be among the most severe. Taken together, these results suggest that the ordering of cannabis use disorder criteria in terms of severity observed in this study may not be generalizable to adolescent samples or samples of individuals in treatment for cannabis use disorders; whereas, more consistency was found with the other general population sample.

As with prior re search in this area (Teesson et al., 2002; Langbucher et al., 2004; Lynskey and Agrawal, 2007; Martin et al., 2006; Gillespie et al., 2007), the present study found that DSM-IV criteria for cannabis use disorders tend to identify pathology at the moderate and more severe range of severity but do not provide indicators of the milder range. Ideally, diagnostic criteria for cannabis use disorder would show highly discriminating items with different thresholds arrayed more broadly across the severity continuum. The need for new symptom criteria to better define and measure the milder end of the cannabis use disorder continuum was addressed in this study by adding a cannabis use variable to the factor and IRT models. Analyses of abuse and dependence criteria with and without the consumption criterion produced models with good overall fit for a one-factor solution and the cannabis use criterion defined the mild end of the cannabis use disorder continuum in the IRT analysis. Further, the results of the IRT analyses showed that adding this cannabis use criterion did not substantially improve the fit of the original model that included only DSM-IV abuse and dependence criteria. However, the cannabis use criterion had an IRT discrimination parameter that was similar to all DSM-IV abuse and dependence criteria. More importantly, the aggregate criterion information curve associated with the model including the cannabis use criterion clearly demonstrated higher levels of information in the mild and moderate ranges of the severity continuum relative to the model without the cannabis use criterion, whereas both models retained similar information values at the severe end of the continuum. Taken together, these results strongly suggest the clinical and etiologic utility of the addition of a cannabis consumption criterion to the DSM-V.

Although the findings of this study strongly support the addition of one cannabis use criterion, i.e., consumption of at least one joint at least once a week during the past year, as a new DSM-V cannabis use disorder criterion, cannabis use can be measured in a variety of ways, by frequency only, by quantity only, or by quantity and frequency. The need for future research to conduct empirical tests of alternative definitions of cannabis use as candidate DSM-V criteria, which this study was unable to accomplish, is critical. Any alternative criterion, however, must demonstrate, at minimum, the informational and discriminatory power associated with consumption of at least one joint at least once a week during the past year, as well as the ability to tap the lower end of the severity continuum.

The need to increase the diagnostic utility of a classification of cannabis use disorders is as important as the development of dimensional measures that discriminate across the entire spectrum of cannabis use disorder severity. The introduction of a cannabis use criterion to DSM-V will necessarily be different from a consumption criterion proposed for alcohol and other drug use disorders. This added complexity can be addressed by examining the psychometric properties of alternative frequency-only measures with various cutoff points for each drug use disorder. The most psychometrically sound frequency of use criterion for each drug can then be incorporated within the DSM-V diagnostic criteria with the caveat stated in the manual that clinical judgment is required to ensure that the quantity of use is sufficiently high among those who met the frequency threshold. This proposed DSM-V structure would not completely address the difficulty of determining the quality of cannabis (i.e., its THC level) or of other drugs used, with the exception of possibly alcohol.

The current study extends prior work on IRT analyses to DSM-IV cannabis abuse and dependence and has important implications for the DSM-V. The results do not support the abuse and dependence distinction, nor the prodromal relationship of abuse to dependence. Our findings also indicate that a dimensional representation would provide a useful addition to the current diagnostic classification of cannabis use disorder. The results of these IRT analyses can also be used to create a continuous dimensional scale of cannabis use disorder by weighting each DSM-IV diagnostic criterion by its associated severity and/or discrimination parameters. These scales can be used to express the severity of cannabis use disorder in the general population, to assess outcome in clinical trials, or to measure changes in severity of cannabis use disorder in longitudinal studies. Future research is critically needed to identify psychometrically optimal consumption criteria for all drugs to be included in the DSM-V. This work promises to improve immensely the diagnostic utility of substance use disorders in the DSM-V, but additionally to provide for the development of psychometrically sound measures of severity of substance use disorders that discriminate across the entire range of their severity. This, in turn, will improve the assessment of stage of disease for any given individual, inform the development of improved treatment approaches for differing severity levels of substance dependence, and accelerate the important etiologic work that lies ahead.

Acknowledgments

References

American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 4. American Psychiatric Association; Washington, D.C: 1994.

Bentler PM. Comparative fit indexes in structural models. Psychol Bull. 1990; 107:203–246.

Birnbaum, A. Some latent trait models. In: Lord, FM.; Novick, MR., editors. Statistical Theory of Mental Test Scores. Addison-Wesley; Reading, MA: 1968. p. 397-472.

Bock RD, Aitkin M. Marginal maximum likelihood estimation of item parameters: application of an EM algorithm. Psychometrika. 1981; 46:443–445.

Bollen, KA. Structural Equations with Latent Variables. John Wiley & Sons, Inc; New York: 1989.

Bolt DM, Hare RD, Vitale JE, Newman JP. A multigroup item response theory analysis of the Psychopathy Checklist – Revised. Psychol Assess. 2004; 16:155–168. [PubMed: 15222812]

Chatterji S, Saunders JB, Vrasti R, Grant BF, Hasin D, Mager D. Reliability of the alcohol and drug modules of the Alcohol Use Disorder and Associated Disabilities Interview Schedule – Alcohol/ Drug – Revised (AUDADIS-ADR): an international comparison. Drug Alcohol Depend. 1997; 47:171–185. [PubMed: 9306043]

Compton WM, Grant BF, Colliver JD, Glantz MD, Stinson FS. Prevalence of marijuana use disorders in the United States: 1991–1992 and 2001–2002. JAMA. 2004; 291:2114–2121. [PubMed: 15126440]

Cottler LB, Grant BF, Blaine J, Mavreas V, Pull C, Hasin DS, Compton WM, Rubio-Stipec M, Mager D. Concordance of DSM-IV alcohol and drug use disorder criteria and diagnoses as measured by AUDADIS-ADR, CIDI and SCAN. Drug Alcohol Depend. 1997; 47:195–205. [PubMed: 9306045]

Downing M. Item response theory: applications of modern test theory in medical education. Med Educ. 2003; 37:739–745. [PubMed: 12945568]

Gillespie NA, Neale MC, Prescott CA, Aggen SH, Kendler KS. Factor and item- response analysis DSM-IV criteria for abuse of and dependence on cannabis, cocaine, hallucinogens, sedatives, stimulants and opioids. Addiction. 2007; 102:920–930. [PubMed: 17523987]

Grant, BF.; Dawson, DA.; Hasin, DS. The Alcohol Use Disorder and Associated Disabilities Interview Schedule – DSM-IV version. National Institute on Alcohol Abuse and Alcoholism; Bethesda, MD: 2001. Available at http://niaaa.census.gov/questionaire.html

Grant BF, Harford TC, Dawson DA, Chou SP, Pickering RP. The Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS): reliability of alcohol and drug modules in a general population sample. Drug Alcohol Depend. 1995; 39:37–44. [PubMed: 7587973]

Grant, BF.; Moore, TC.; Shepard, J.; Kaplan, K. Source and Accuracy Statement, Wave 1 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). National Institute on Alcohol Abuse and Alcoholism; Bethesda, MD: 2003.

Grant BF, Stinson FS, Dawson DA, Chou SP, Dufour MC, Compton WM, Pickering RP, Kaplan K. Prevalence and co-occurrence of substance use disorders and independent mood and anxiety disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Arch Gen Psychiatry. 2004; 61:807–816. [PubMed: 15289279]

Harwell MR, Baker FB, Zwarts M. Item parameter estimation via marginal maximum likelihood and an EM algorithm: a didactic. J Educ Stat. 1988; 13:243–271.

Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Structural Equation Modeling. 1999; 26:1–55.

Kahler CW, Strong DR. A Rasch model analysis of DSM-IV alcohol abuse and dependence items in the National Epidemiologic Survey on Alcohol and Related Conditions. Alcohol Clin Exp Res. 2006; 30:1165–1175. [PubMed: 16792564]

Krueger RF, Nicol PE, Hicks BM, Markon KE, Patrick CJ, Iacono WG, Mague M. Using latent trait modeling to conceptualize an alcohol problems continuum. Psychol Assess. 2004; 16:107–119. [PubMed: 15222807]

Krueger RF, Watson D, Barlow DH. Introduction to the special section: toward a dimensionally based taxonomy of psychopathology. J Abnorm Psychol. 2005; 114:491–493. [PubMed: 16351372]

Langenbucher JW, Labouvie E, Martin CS, Sanjuan PM, Bavly L, Kirisci L. An application of item response theory analysis to alcohol, cannabis, and cocaine criteria in DSM-IV. J Abnorm Psychol. 2004; 113:72–80. [PubMed: 14992659]

Li TK, Hewitt BG, Grant BF. Is there a future for quantifying drinking in the diagnosis, treatment, and prevention of alcohol use disorders? Alcohol Alcohol. 2007; 42:57–63. [PubMed: 17307789]

Lord, FM.; Novick, MR. Statistical Theory of Mental Test Scores. Addison-Wesley; Reading, MA: 1968.

Lynskey MT, Agrawal A. Psychometric properties of DSM assessment of illicit drug abuse and dependents: results from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). Psychol Med. 2007; 37:1345–1355. [PubMed: 17407621]

Martin CS, Chung T, Kirisci L, Langenbucher JW. Item response theory analysis of diagnostic criteria for alcohol and cannabis use disorders in adolescents: implications for DSM-V. J Abnorm Psychol. 2006; 115:807–814. [PubMed: 17100538]

Muthén, BO.; Muthén, LK. Mplus: Statistical Analysis with Latent Variables (Version 3.01). Muthén & Muthén, Inc; Los Angeles, CA: 2004.

Nelson CB, Rehm J, Üstün TB, Grant BF, Chatterji S. Factor structure for DSM-IV substance disorder criteria endorsed by cannabis, cocaine and opioid users: results from the World Health Organization Reliability and Validity Study. Addiction. 1999; 94:843–855. [PubMed: 10665074]

Proudfoot H, Baillie AJ, Teesson M. The structure of alcohol dependence in the community. Drug Alcohol Depend. 2006; 81:21–26. [PubMed: 16005578]

Pull CB, Saunders JB, Mavreas V, Cottler LB, Grant BF, Hasin DS, Blaine J, Mager D, Üstün BT. Concordance between ICD-10 alcohol and drug use disorder criteria and diagnoses as measured by the AUDADIS-ADR, CIDI and SCAN: results of a cross-national study. Drug Alcohol Depend. 1997; 47:207–216. [PubMed: 9306046]

Rasch, G. Probabilistic Models for Some Intelligence and Attainment Tests. Danish Institute for Educational Research; Copenhagen, Denmark: 1960.

Saha TD, Chou SP, Grant BF. Toward an alcohol use disorder continuum using item response theory: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Psychol Med. 2006; 36:931–941. [PubMed: 16563205]

Saha TD, Stinson FS, Grant BF. The role of alcohol consumption in future classifications of alcohol use disorders. Drug Alcohol Depend. 2007; 89:82–92. [PubMed: 17240085]

Du Toit, M., editor. Scientific Software International. Item Response Theory (IRT)from SSI. Scientific Software International; Lincolnwood, IL: 2003.

Stout W. A new item response theory modeling approach with application of unidimensional assessment and ability estimation. Psychometrika. 1987; 55:293–326.

Teeson M, Lynskey M, Manor B, Baillie A. The structure of cannabis dependence in the community. Drug and Alcohol Dependence. 2002; 68:255–262. [PubMed: 12393220]

Tucker LR, Lewis C. A reliability coefficient for maximum likelihood factor analysis. Psychometrika. 1973; 38:1–10.

Üstün B, Compton WM, Mager D, Babor T, Baiyewu O, Chatterji S, Cottler LB, Gogus A, Mavreas V, Peters L, Pull C, Saunders J, Smeets R, Stipec MR, Vrasti R, Hasin D, Room R, Van den Brink W, Regier D, Blaine J, Grant BF, Sartorius N. WHO study on the reliability and validity of the alcohol and drug use disorder instruments: overview of methods and results. Drug Alcohol Depend. 1997; 47:161–169. [PubMed: 9306042]

Vrasti R, Grant BF, Chatterji S, Üstün BT, Mager D, Olteanu I, Badoi M. The reliability of the Romanian version of the alcohol module of the WHO Alcohol Use Disorder and Associated Disabilities Interview Schedule – Alcohol/Drug – Revised (AUDADIS-ADR). Eur Addict Res. 1998; 4:144–149. [PubMed: 9852366]
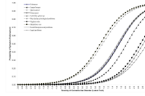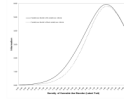
Figure 1.
Criterion response curves for DSM-IV cannabis abuse and dependence criteria.
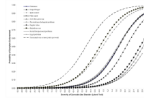
Figure 2.
Criterion response curves for DSM-IV cannabis abuse and dependence criteria and cannabis consumption criterion.

Figure 3.
Aggregate criteria information function for DSM-IV cannabis abuse and dependence criteria with and without the cannabis use criterion.

Table 1

Prevalence, factor loadings and criterion response parameters: DSM–IV cannabis abuse and dependence criteria and with and without the cannabis use criterion among past year cannabis users (N = 1,603)[*]

Past Year Cannabis Abuse (A), Dependence (D) and Consumption (C) Criteria	Prevalence (%)	Factor Loadings (One-Factor Model)		Model with Cannabis Use Criterion		Model without Cannabis Use Criterion	
		With Cannabis Use Criterion	Without Cannabis Use Criterion	Discrimination (*a*), Estimate *a* (S.E.)	Severity (*b*), Estimate *b* (S.E.)	Discrimination (*a*), Estimate *a* (S.E.)	Severity (*b*), Estimate *b* (S.E.)
Tolerance (D)	10.42	0.773	0.763	1.78 (0.08)	1.69 (0.07)	1.77 (0.08)	1.70 (0.07)
Larger/Longer (D)	6.92	0.806	0.797	1.83 (0.09)	2.05 (0.08)	1.83 (0.09)	2.05 (0.08)
Quit/Control (D)	26.08	0.666	0.680	1.60 (0.07)	0.96 (0.06)	1.66 (0.07)	0.94 (0.05)
Time spent (D)	11.04	0.789	0.771	1.83 (0.08)	1.70 (0.07)	1.79 (0.08)	1.71 (0.07)
Activities given up (D)	3.24	0.798	0.814	1.76 (0.08)	2.84 (0.13)	1.77 (0.08)	2.83 (0.13)
Physical/Psychological problems (D)	11.85	0.761	0.783	1.73 (0.08)	1.69 (0.07)	1.77 (0.08)	1.67 (0.07)
Neglect roles (A)	3.31	0.804	0.801	1.78 (0.09)	2.70 (0.12)	1.78 (0.08)	2.70 (0.12)
Hazardous use (A)	27.89	0.677	0.663	1.73 (0.07)	0.83 (0.05)	1.70 (0.07)	0.84 (0.05)
Legal problems (A)	2.43	0.358	0.352	1.62 (0.07)	3.02 (0.15)	1.62 (0.07)	3.01 (0.15)
Social/Interpersonal problems (A)	11.73	0.725	0.731	1.70 (0.07)	1.65 (0.07)	1.73 (0.08)	1.63 (0.07)
Consumed one or more joints per week (C)	45.04	0.665	-	1.70 (0.07)	0.18 (0.05)	-	-
Bayesian Information Criterion (BIC)				10834.77		8966.20	
Comparative Fit Index (CFI)		0.967	0.977				
Tucker Lewis Index (TLI)		0.980	0.986				
Root mean squared error of approximation (RMSEA)		0.038	0.031				

[*] Cannabis use volume measure was consuming at least one joint a week during the year preceding the NESARC interview.