PERFORMANCE OF A CRAVING CRITERION IN DSM ALCOHOL USE DISORDERS

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ABSTRACT

Objective: Adding a craving criterion, presently in ICD-10 diagnosis of alcohol dependence, has been under consideration as one possible improvement to the DSM-IV, and recently proposed for inclusion by the DSM Substance Related Disorders Work Group in the 5th revision (DSM-V) of diagnostic criteria for alcohol use disorders. To inform cross-cultural applicability of this modification, performance of a craving criterion is examined in Emergency Departments (EDs) in four countries manifesting distinctly different culturally-based drinking patterns (Mexico, Poland, Argentina, U.S.). **Method:** Exploratory Factor Analysis (EFA) and Item Response Theory (IRT) were used to examine psychometric properties and individual item characteristics of the 11 DSM-IV abuse and dependence criteria with and without craving for each country separately. Differential Item Functioning (DIF) analysis was performed to examine differences in the difficulty of endorsement (severity) and discrimination of craving across countries. **Results:** EFA found craving fit well within a one dimensional solution, and factor loadings were high across all countries. Results from IRT analyses indicated that both discrimination and difficulty estimates for the craving item were located in the middle of the corresponding discrimination and difficulty ranges for the other 11 items for each country, but did not substantially increase the efficiency (or information) of the overall diagnostic scheme. Across the four countries, no DIF was found for difficulty but significant DIF was found for discrimination (similar to other DSM-IV criteria). **Conclusions:** Findings suggest that while craving performed similarly across EDs in the four countries, it does not add much in identification of individuals with alcohol use disorders.

INTRODUCTION

Work is currently underway by the Diagnostic and Statistical Manual of Mental and Behavior Disorders (DSM) (American Psychiatric Association, 2000) Substance Related Disorders Work Group to inform the 5th revision (DSM-V) of the diagnostic criteria for alcohol use disorders, with a look to improving the validity and utility of diagnosis (Helzer et al., 2007; Saha et al., 2006). This work has entailed analysis which has examined the inclusion of alcohol dependence and abuse into a single diagnostic category with a quantity/frequency measure (5+ drinks on an occasion for men and 4+ for women at least weekly) to tap the lower end of the severity spectrum (Saha et al., 2007), as well as a consideration of the inclusion/exclusion of specific criteria. Of particular interest in this regard is the potential for a closer alignment of the DSM diagnostic classification with that of the International Classification of Disease (ICD-10) (World Health Organization, 1990b).

While there is substantial overlap of DSM and ICD diagnostic schemes, which have generally shown good agreement, the ICD-10 criteria have been found to caste a wider net than DSM criteria for identifying alcohol dependence in the general population but not necessarily in clinical populations (Rapaport et al., 1993; Rounsaville et al., 1993), and to have a slightly higher reliability (Hasin et al., 2006; Rounsaville, 2002). The primary difference between the two sets of diagnostic criteria is that the ICD contains a criterion on alcohol craving (a strong desire or sense of compulsion to take the substance), which may account, in part, for observed differences. Craving, a self reported characteristic of a state that may promote and maintain substance dependence, serving as a cue immediately prior to self-administration, is particularly appealing to be considered in the formulation of DSM-V due to a possible neurological or genetic basis

(Martin et al., 2006). While human brain imaging studies have documented a biological cue-induced craving response among alcohol dependent individuals (Weiss, 2005) and craving has been used as an outcome measure in studies of alcohol treatment (O'Brien, 2005), its definition is somewhat controversial, it may be multidimensional in nature, and uncertainty remains as to whether it represents a physiological or behavioral state (O,Brien et al., 1998).

Much of the work to date on reformulation of the DSM-V has focused on analysis of data from the U.S. general population, including analysis of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) (Grant et al., 2004; Saha et al., 2006; Saha et al., 2007; Keyes et al., 2009) and the National Longitudinal Alcohol Epidemiologic Survey (NLAES) which also measured craving (Keyes et al., in press). Analysis using item response theory (IRT) was conducted to evaluate the psychometric properties of DSM abuse and dependence criteria when the NLAES alcohol craving item, "In your entire life did you ever want a drink so badly that you couldn't think of anything else?' (and if yes, the respondent was asked if that had happened in the last 12 months) was introduced as a criterion. The craving item was found to demonstrate relatively high discrimination and produced a model which captured individuals on the more severe end of the alcohol use disorder spectrum. While the addition of the item produced an overall better-fitting IRT model than when this criterion was not included, the authors concluded that craving did not identify individuals who would not have already been identified based on DSM-IV abuse and dependence criteria, and therefore was redundant with existing criteria (Keyes et al., in press). Additionally, the DSM-V Work Group conducted analysis to examine craving on data from the high risk family study of the Collaborative Studies on the Genetics of Alcoholism (COGA) (Bucholz & Agrawal, 2009). As in the NLAES analysis,

IRT results indicated good fit. Craving demonstrated good discrimination and appeared to be among the more severe items in the adult sample, and the authors concluded that craving appears to warrant serious consideration as an addition to the DSM-V. The DSM-V Work Group subsequently proposed craving as a candidate for inclusion in the revised DSM-V as stipulated in the provisional criteria recently made public http://www.dsm5.org/ProposedRevisions/Pages/Substance-RelatedDisorders.aspx, accessed April 1st, 2010).

While this research based on analyses in the general population is important, two limitations exist, which suggests that additional research is required for adequately informing the formulation of DSM-V. First, these results need to be replicated using different datasets, especially those across various types of clinical practice in which patients under consultation tend to have more symptoms and more severe symptoms than general population samples. Secondly, it is not clear what the impact may be of altering diagnostic criteria of the DSM-V alcohol use disorder diagnostic scheme across countries and cultures.

Given these concerns in adding a quantity/frequency criterion (which has a large variation in prevalence across cultures, and which may not necessarily be in the same direction as variation in alcohol abuse and dependence) to the DSM-IV abuse and dependence criteria as noted above, Borges and colleagues (Borges et al., 2010) replicated analysis based on the NESARC data (Saha et al., 2006) in emergency department (ED) populations in four countries manifesting distinctly different culturally-based drinking styles: Mexico, Poland, Argentina and the U.S. Mexico typifies a fiesta-drinking style (infrequent but heavy drinking), Poland typifies much of the central and eastern European heavy drinking of spirits, Argentina typifies the Mediterranean drinking style (highly

integrated but low quantities of alcohol, primarily wine), while the drinking style in the U.S. sample (Santa Clara, CA) varies across the three main ethnic groups of whites, blacks and Hispanics.

Findings based on these four ED samples were in concordance with general population findings of an unidimensional continuum of alcohol use disorders in each site; however, cross-country variation in the difficulty of endorsing the heavy drinking criterion of 5+ drinks weekly/monthly for males/females was evident, and cross-cultural variation in differential item functioning, although observed among several of the DSM-IV criteria, was largest for this heavy drinking measure (Borges et al., 2010). While any modifications to the existing DSM diagnostic criteria must undergo scrutiny to understand the consequences of proposed changes, these findings underscore the importance of sensitivity analyses across countries and cultures.

Although both behavioral (O'Brien et al., 1998) and pharmacological (O'Brien, 2005) underpinnings give support to the possible inclusion of craving as a criterion in the reformulation of DSM alcohol use disorders, and craving may underlie symptoms reflecting an individual's loss of control over drinking, such as unsuccessful efforts to cut down (O'Brien, 2005), a new criterion should only be added if it can be shown to improve diagnosis in terms of reliability/validity and/or case finding (Keyes et al., in press).

Building on this prior research in the general population for reformulation of DSM diagnostic criteria, performance of a craving criterion is examined in seven ED sites in the four countries analyzed above, to inform the cross-cultural applicability of proposed modifications to the DSM diagnostic criteria and consequences in a cross-cultural context. Exploratory Factor Analysis (EFA) and Item Response Theory (IRT) were used to examine psychometric properties and individual item characteristics, in terms of difficulty and discrimination, of the 11 DSM-IV abuse

and dependence criteria with and without craving for each country separately. Differential Item Functioning (DIF). analysis was also performed to examine differences in the difficulty of endorsement (severity) as well as discrimination of craving across countries.

METHODS

Samples and Data Sets

The sample consists of seven ED sites in four countries, compiled as part of the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP) (Cherpitel et al., 2003), and includes 5,195 ED patients from one site in Santa Clara, CA (1995-96; n=1,429), three sites in Pachuca, Mexico (1996-97; n=1,417), one site in Mar del Plata, Argentina (2001; n=978), and one site each in Warsaw and Sosnowiec, Poland (2002-03; n=1,501). Data at each site were collected using a similar methodology and instrumentation (Cherpitel, 1989) in which a probability sampling design was implemented so that each shift was equally represented for each day of the week during the period data were collected in each ED. Across all studies, samples of injured and non-injured patients 18 years and older were selected from ED admission forms, which included walk-in patients as well as those arriving by ambulance, and reflected consecutive arrival at the ED. Once selected for the study, and as soon as possible after ED admission, patients were approached with an informed consent to participate, and were then breathalyzed and administered a questionnaire of about 25 minutes in length by trained interviewers while the patient was in the waiting room or treatment area and/or following treatment. Patients who were too severely injured or ill to be interviewed in the ED and who were subsequently hospitalized were interviewed later after their condition had stabilized.

Measures

Diagnostic criteria for alcohol dependence and abuse/harmful drinking was obtained from an adaptation of the Alcohol Section of the Composite International Diagnostic Interview (CIDI) Core (World Health Organization, 1990a) for a diagnosis of both DSM-IV and ICD-10 alcohol dependence and alcohol abuse/harmful drinking for the past 12 months. The CIDI diagnostic interview was developed as a joint project by the World Health Organization and the U.S. Alcohol, Drug Abuse and Mental Health Administration, and has been tested in 19 countries. The alcohol section of the CIDI has been found to perform well, is easy to use, and is acceptable to subjects in almost all cultures (Wittchen et al., 1991). DSM-IV criteria for alcohol dependence included the following seven domains: tolerance, withdrawal, drinking more than intended, unsuccessful efforts to control, giving up pleasures or interests to drink, spending a great deal of time in drinking activities, and continued use despite physical or psychological problems, while alcohol abuse criteria included consequences related to role performance, hazardous use (injury), legal problems and social problems. The ICD-10 alcohol dependence criteria included the same domains as DSM-IV with the addition of a craving criterion: "Feel such strong desire to drink that couldn't resist it or think of anything else" (also taken from the Alcohol Section of the CIDI core (World Health Organization, 1990a)).

Data Analysis

Only current drinkers who reported drinking during the last 12 months were included in the analysis of alcohol use disorder (AUD) in the past 12 months. Exploratory factor analysis (EFA) was performed to examine dimensionality of the 11 existing DSM-IV AUD criteria, with and without craving, across the four countries. Both one and two factor models were estimated using Mplus 5.1

(Muthén and Muthén, 2008) (Table 3). Dimensionality was examined by factor loadings, eigenvalues and 2-factor model factor correlation after oblique rotation, and model fit was assessed using standard measures such as the CFI (Comparative Fit Index), RMSEA (Root Mean Squared Error of Approximation), and SRMR (Standardized Root Mean Square Residual).

When unidimensionality was confirmed, a 2-parameter logistic IRT model was built which estimated the difficulty of endorsing a criterion at a given latent AUD level (severity or difficulty) and the ability of a criterion to discriminate respondents from lower to high levels of the latent AUD continuum (discrimination). The specific Item Response Theory model estimated here is a 2-parameter model (Muthén et al., 1991), which places a probabilistic structure on the set of observed DSM items x_j, namely $P(x_j = 1|s,a_j,b_j) = \exp(a_j\ (s - b_j))/(1+ \exp(a_j\ (s - b_j))$ where s is the latent severity variable, and a_j and b_j are called, respectively, the discrimination and difficulty parameters for variable j. The difficulty parameter generally corresponds to the rate of endorsement of the item whereas the discrimination parameter indicates the degree to which variance in the item aligns with that of the underlying severity factor.

In Mplus, Confirmatory Factor Analysis (CFA) models were fitted and the model parameter estimates rescaled to IRT metric to derive the estimates of difficulty and discrimination. Also obtained from the logistic IRT model were the maximum likelihood estimates of variances of respondent's underlying AUD continuum level, depending on the parameter estimates of the criteria in the IRT model. The reciprocal of the variance at a given AUD continuum level is thus a measure of the information one has as to a respondent's unknown AUD severity level. The aggregate information curve was generated to visually represent the total amount of information provided by all criteria. The 2-parametric IRT model was fitted for the four countries separately.

Finally, differential item function (DIF) (Saha et al., 2006) was performed to test whether, at a given level of latent AUD continuum, the difficulty and discrimination vary significantly across the four countries. PARSCALE (du Toit, 2009) was used for its capability to evaluate DIF on both difficulty and discrimination.

RESULTS

Table 1 shows the past 12 months prevalence rates of DSM-IV AUD and dependence with and without the addition of the craving criterion. While the prevalence of current alcohol use disorders among drinkers varied greatly across countries, ranging from 31% in the U.S. to 14% in Poland, prevalence was minimally increased by the addition of a craving criterion, ranging from a .9% increase in the U.S. to no increase in Mexico. Similarly, little change was found in the prevalence for dependence, alone, when craving was added.

[Table 1 about here]

Table 2 shows the proportion of drinkers endorsing each of the 11 existing DSM-IV criteria, as well as craving, among those meeting criteria for AUDs. The prevalence of the craving criterion also varied greatly across countries, ranging from 44% in the U.S. to 22.5% in Poland, and was located in the middle of the corresponding prevalence range for the other 11 items for each country, similar to rates of tolerance and withdrawal. Rates of craving were somewhat similar to those of tolerance and withdrawal and did not represent the lowest or highest of rates across the other DSM items.

[Table 2 about here]

Results from EFA are shown in Table 3. Across the four countries, both 1-factor and 2-factor

models exhibited acceptable model fit (CF and TLI > 0.95, RMSEA < 0.05), with and without craving, although slightly better fit was seen for the 2-factor model. For the U.S. three abuse criteria were heavily loaded on the second factor in the 2-factor model without craving, and did not change when craving was added, with a high correlation between the two factors (r=0.87). For Mexico one dependence criterion and the same three abuse criteria were also heavily loaded on the second factor, without craving (r= 0.89 between the two factors), but with the addition of craving only legal problems continued to load on the second factor. For both Argentina and Poland a single factor was prominently observed, with and without the craving criterion (although legal problem was cross loaded between the first and second factor in Poland, regardless of craving). For the four countries, with and without craving, the first eigenvalue was much larger than the second, which was never larger than one. Taken together these findings show that across the four countries, unidimensionality (with and without craving) is a reasonable assumption with one latent AUD continuum.

[Table 3 about here]

Table 4 shows the discrimination and difficulty estimates from the 2-parameter logistic IRT models as well as the model fit index for the four countries, with and without craving. Adding craving did not substantially change the parameter estimates of the 11 existing DSM-IV criteria. The difficulty estimates for the craving criterion were located in the middle of the corresponding difficulty ranges compared with the other 11 criteria for each country, and discrimination estimates also fell into the middle range. A formal DIF test (not shown) across country showed no significant difference in difficulty for craving (Chi2=2.2, df=3), in contrast to such criteria as withdrawal (chi2=29.5, df=3), quit/control (chi2=22.7, df=3) and neglect role (chi2=23.8, df=3). While a significant cross-country difference in discrimination was observed for craving (chi2=30.7, df=3),

similar differences were found for all but two of the 12 test criteria, with quit/control exhibiting the largest DIF on discrimination (chi2=78.9, df=3).

[Table 4 about here]

Figure 1 plots the aggregate information curve for each country for the 11 DSM-IV existing criteria and for the 12 criteria including craving. While adding craving provides slightly more information, as reflected by a higher information curve peak, adding craving did not capture a substantially larger or different range of the underlying AUD continuum.

[Figure 1 about here]

DISCUSSION

The prevalence of current alcohol use disorders among drinkers varied greatly across ED samples in these four countries, from 31% in the U.S. to 14% in Poland; however, prevalence was minimally increased by the addition of a craving criterion, ranging from a .9% increase in the U.S. to no increase in Mexico. Among those meeting criteria for AUDs, the prevalence of craving was located in the middle of the corresponding prevalence range for the other 11 items for each country, similar to rates of tolerance and withdrawal, and ranged from 44% in the U.S. to 23% in Poland.

EFA found craving fit well within a one dimensional solution, and factor loadings were high across all countries. Results from IRT analyses indicated that both the discrimination and the difficulty estimates for the craving criterion were located in the middle of the corresponding discrimination and difficulty ranges for the other 11 items for each country, but did not substantially increase the efficiency (or information) of the overall diagnostic scheme. Across the four countries, no DIF was found for difficulty but significant DIF was found for discrimination (similar to other

DSM-IV criteria).

The operational definition of craving used in the ERCAAP studies was similar, but not identical, to that used in NLAES ("In your entire life, did you ever want a drink so badly that you couldn't think of anything else?"), and similar findings here to those from NLAES (Keyes et al., in press) strengthen the generalizability of findings from the general population. Because of the rarity of endorsing craving (1.3%) in NLAES and the lack of additional cases identified, the authors suggest that a craving criterion is largely redundant in the context of the existing DSM-IV criteria, and raises doubts about the utility of adding a craving criterion. Our findings support this conclusion, especially given that IRT analysis of the ERCAAP did data not find an increase in the total information provided when craving was added (as also found in the NLAES data). It should be noted that the craving criterion used in this study may represent a more severe form of craving (and in this regard may not encompass the broad range of craving, which may account for its relative lack of providing additional information. It is also important to note, that our conclusion is based on the empirical findings reported here, and there may be other bases for considering the addition of a new criterion to an AUD diagnosis. For example, a criterion that may be more fundamental to the neurophysiology of addiction (although this has been a subject of debate in relation to craving) and which may reflect pathophysiology, treatment or outcomes, could have added value in an AUD diagnosis in relation to clinical decisions regarding treatment of dependence. Additionally, since craving is relatively rare among those not meeting existing criteria for alcohol dependence, if not included as a diagnostic criterion, it would be useful, clinically, to be described in the accompanying narrative for the disorder.

Prior research related to the current nosological classifications for alcohol dependence

(Room et al., 1996; Üstün et al., 1997) has warned that not all criteria are similarly understood across different societies. Considerable cross-country variation in these same samples was reported earlier in the difficulty of endorsing a heavy drinking criterion (5+ weekly/monthly for men/women) when added to DSM-IV criteria for AUD (Borges et al., in press), with similar variation also reported among several other DSM-IV criteria (but to a smaller extent than that exhibited by the heavy drinking criterion). While cultural factors may influence interpretation of or willingness to endorse specific dependence criteria (possibly reflected in the varying rates of prevalences of AUD, regardless of craving, found here), variation in endorsement of the craving item across countries was not found in these clinical samples of ED patients (previously characterized as heavy chronic and acute drinkers (Cherpitel, 2007)) from four countries demonstrating heterogeneous per capita consumption, drinking patterns and drinking cultures. Homogeneity of results here within the cross-national nature of the samples widens the applicability of these findings.

Some limitations apply to this study. The present paper was restricted to an examination of the performance and utility of adding a craving criterion to the existing DSM diagnostic classification scheme, with an eye to bringing it in closer alignment with that of the ICD. Within this context we have not examined other DSM AUD criteria, and if scrutinized to this same level, it is possible that similar differences may be found.

While our aim was to determine cross-cultural differences in the performance of a craving criterion added to the proposed DSM-V AUD nomenclature in a clinical sample of heavier drinkers, the four countries examined here, although exhibiting distinctly different drinking cultures and associated drinking patterns, are clearly not representative of all drinking cultures and certainly not

all encompassing. Additionally, the ED samples analyzed here, while representative of patients treated in the particular ED facility, may not be representative of other ED facilities in the region or country nor of their respective general population. It is also important to note that the type of ED and system of emergency services delivery also varied across countries, which likely impacted which individuals were available for inclusion in the sample in each of the countries. These differences across EDs and countries, coupled with possible variation in interpretation of items, may have resulted in some of the cross-cultural differences reported here, for example the large variation in prevalence of AUD found across the four country samples.

Nevertheless, findings here based on epidemiologic research in clinical populations where alcohol use disorders are likely more prevalent than in the general population, as well as in countries with distinctly different drinking cultures and styles, inform the cross-cultural applicability of proposed modifications to the DSM diagnostic criteria in relation to adding a craving criterion. Taken together, these findings suggest that while craving performed similarly across countries, in the context of the analysis conducted here, and does not appear to be a culturally-sensitive criterion, it does not increase the identification of individuals with alcohol use disorders and may not be a useful addition to proposed DSM-V AUD nomenclature in this regard.

REFERENCES

Table 1. Comparing of past 12 months prevalence rates of DSM-IV AUD and dependence with craving added among current drinkers

	Santa Clara CA, US	**Pachuca, Mexico**	**Mar Del Plata, Argentina**	**Warsaw & Sosnowiec, Poland**
DSM-IV AUD (1+ out of 4 abuse criteria or 3+ out of 7 dependence criteria)	31.0%	21.2%	17.4%	13.8%
AUD adding craving (1+ out of 4 abuse criteria or 3+ out of 8 dependence criteria)	31.9%	21.2%	17.5%	14.0%
DSM-IV dependence (3+ out of 7 dependence criteria)	19.8%	12.6%	8.8%	5.7%
Dependence adding craving (3+ out of 8 dependence criteria)	20.8%	13.0%	9.2%	6.5%

Table 2. Proportion of DSM-IV dependence (D) and abuse (A) criteria and craving among those reporting positive AUD in the past 12 months

	Santa Clara CA, US	**Pachuca, Mexico**	**Mar Del Plata, Argentina**	**Warsaw & Sosnowiec, Poland**
D1 Tolerance	46.7%	27.6%	31.3%	23.2%
D2 Withdrawal	57.6%	58.6%	33.9%	53.6%
D3 Larger/Longer	63.9%	62.9%	57.4%	45.7%
D4 Quit/Control	51.7%	41.4%	35.7%	21.2%
D5 Time Spent	52.2%	39.7%	53.0%	20.5%
D6 Activities Given Up	40.6%	30.2%	28.7%	16.6%
D7 Physical /Psychological Problems	64.0%	48.3%	54.8%	47.0%
A1 Neglect Roles	51.5%	74.1%	53.0%	50.3%
A2 Hazardous Use	35.9%	22.4%	43.5%	35.1%
A3 Legal Problems	30.8%	8.6%	10.4%	15.2%
A4 Social /Interpersonal Problems	64.0%	36.2%	40.9%	51.7%
Craving	44.2%	27.6%	30.4%	22.5%

Table 3. Exploratory factor Analyses of alcohol use disorder by Emergency Room Collaborative Alcohol Analysis Project (ERCAAP) sites

	Base Model (DSM-IV 11 criteria)			**Model with Craving (DSM-IV 11 criteria + craving)**		
Santa Clara, US	One factor	Two factors		One factor	Two factors	
Tolerance (D)	0.888	**0.971**	-0.084	0.892	**0.980**	-0.094
Withdrawal (D)	0.911	**0.911**	0.005	0.912	**0.912**	0.004
Larger/Longer (D)	0.906	**0.932**	-0.024	0.904	**0.915**	-0.008
Quit/Control (D)	0.953	**0.942**	0.016	0.951	**0.916**	0.042
Time spent (D)	0.967	**0.942**	0.032	0.970	**0.957**	0.018
Activities given up (D)	0.958	**0.966**	-0.005	0.959	**0.959**	0.003
Phys/psych problems (D)	0.890	**0.634**	0.286	0.890	**0.638**	0.282
Neglect roles (A)	0.810	0.189	**0.676**	0.808	0.190	**0.675**
Hazardous use (A)	0.795	**0.589**	0.231	0.800	**0.622**	0.200
Legal problems (A)	0.881	-0.006	**0.958**	0.875	-0.006	**0.956**
Social/Interpersonal problems (A)	0.885	0.216	**0.730**	0.881	0.198	**0.748**
Craving	-	-	-	0.938	**0.982**	-0.046
Factor correlation	-	0.867		-	0.868	
Eigenvalue	8.955	9.473		9.821	10.356	
Comparative Fit Index (CFI)	0.998	1.000		0.999	1.000	
Tucker Lewis Index (TLI)	0.998	1.000		0.998	1.000	
Root mean squared error of approximation RMSEA	0.039	0.000		0.037	0.000	
Pachuca, Mexico	One factor	Two factors		One factor	Two factors	
Tolerance (D)	0.888	**0.743**	0.163	0.895	**0.806**	0.150
Withdrawal (D)	0.788	**0.850**	-0.049	0.785	**0.808**	-0.028
Larger/Longer (D)	0.963	**0.987**	-0.004	0.961	**0.896**	0.112
Quit/Control (D)	0.790	0.023	**0.797**	0.788	**0.796**	-0.002
Time spent (D)	0.924	**0.562**	0.387	0.920	**0.824**	0.162
Activities given up (D)	0.877	0.452	0.451	0.873	**0.939**	-0.092
Phys/psych problems (D)	0.873	**0.833**	0.056	0.872	**0.930**	-0.079
Neglect roles (A)	0.901	0.174	**0.763**	0.899	**0.805**	0.157
Hazardous use (A)	0.726	0.386	0.360	0.720	**0.781**	-0.088
Legal problems (A)	0.796	0.002	**0.820**	0.851	0.002	**1.270**
Social/Interpersonal problems (A)	0.857	-0.062	**0.953**	0.858	**0.706**	0.243
Craving	-	-	-	0.866	**0.636**	0.349
Factor correlation	-	0.892		-	0.546	
Eigenvalue	8.189	8.905		8.939	9.735	
Comparative Fit Index (CFI)	1.000	1.000		0.999	1.000	
Tucker Lewis Index (TLI)	1.000	1.000		0.999	1.000	
Root mean squared error of approximation RMSEA	0.010	0.000		0.019	0.000	

Table 3. Continued

	Base Model (DSM-IV 11 criteria)			Model with Craving (DSM-IV 11 criteria + craving)		
Mar Del Plata, Argentina	One factor	Two factors		One factor	Two factors	
Tolerance (D)	0.808	**0.809**	0.009	0.803	**0.804**	-0.027
Withdrawal (D)	0.778	**0.783**	0.243	0.783	**0.772**	0.298
Larger/Longer (D)	0.879	**0.872**	-0.169	0.888	**0.892**	-0.156
Quit/Control (D)	0.842	**0.846**	0.018	0.841	**0.834**	0.182
Time spent (D)	0.943	**0.937**	-0.274	0.939	**0.945**	-0.170
Activities given up (D)	0.978	**0.975**	-0.060	0.981	**0.981**	-0.004
Phys/psych problems (D)	0.921	**0.926**	0.089	0.923	**0.920**	0.092
Neglect roles (A)	0.821	**0.815**	-0.180	0.817	**0.826**	-0.256
Hazardous use (A)	0.818	**0.820**	0.086	0.812	**0.807**	0.118
Legal problems (A)	0.931	**0.931**	-0.035	0.926	**0.930**	-0.110
Social/Interpersonal problems (A)	0.881	**0.888**	0.217	0.881	**0.875**	0.172
Craving	-	-	-	0.876	**0.875**	0.025
Factor correlation	-	-0.006		-	0.032	
Eigenvalue	8.563	9.134		9.308	9.887	
Comparative Fit Index (CFI)	0.999	1.000		0.999	0.999	
Tucker Lewis Index (TLI)	0.999	1.000		0.999	0.999	
Root mean squared error of approximation RMSEA	0.021	0.011		0.020	0.016	
Warsaw & Sosnowiec, Poland	One factor	Two factors		One factor	Two factors	
Tolerance (D)	0.746	**0.821**	-0.219	0.746	**0.805**	-0.213
Withdrawal (D)	0.824	**0.840**	-0.026	0.823	**0.839**	-0.040
Larger/Longer (D)	0.788	**0.902**	-0.304	0.781	**0.882**	-0.333
Quit/Control (D)	0.847	**0.850**	0.010	0.842	**0.848**	-0.002
Time spent (D)	0.913	**0.917**	0.017	0.927	**0.929**	0.024
Activities given up (D)	0.868	**0.907**	-0.089	0.873	**0.903**	-0.083
Phys/psych problems (D)	0.830	**0.790**	0.133	0.831	**0.802**	0.126
Neglect roles (A)	0.791	**0.768**	0.086	0.784	**0.775**	0.059
Hazardous use (A)	0.755	**0.763**	-0.003	0.752	**0.763**	-0.019
Legal problems (A)	0.953	0.659	0.678	0.953	0.722	0.633
Social/Interpersonal problems (A)	0.944	**0.816**	0.286	0.944	**0.840**	0.278
Craving	-	-	-	0.851	**0.815**	0.142
Factor correlation	-	0.293		-	0.226	
Eigenvalue	7.910	8.632		8.631	9.369	
Comparative Fit Index (CFI)	0.995	0.999		0.995	0.999	
Tucker Lewis Index (TLI)	0.993	0.998		0.994	0.998	
Root mean squared error of approximation RMSEA	0.031	0.015		0.030	0.017	

Table 4. Item Response Theory analyses of alcohol use disorder by Emergency Room Collaborative Alcohol Analysis Project (ERCAAP) sites

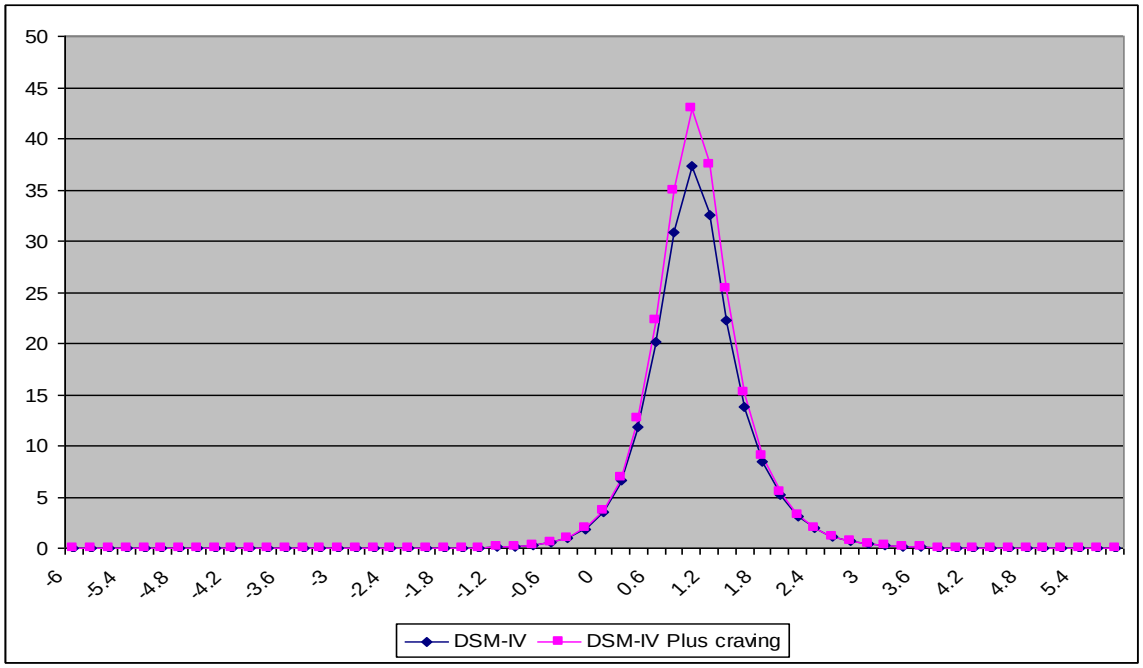
	Base Model (DSM-IV 11 criteria)		**Model with Craving (DSM-IV 11 criteria + craving)**	
Santa Clara, US	Discrimination (S.E.)	Severity (S.E.)	Discrimination (S.E.)	Severity (S.E.)
Tolerance (D)	1.97 (0.2)	1.10 (0.07)	2.00 (0.2)	1.09 (0.07)
Withdrawal (D)	2.15 (0.2)	0.86 (0.06)	2.17 (0.2)	0.86 (0.06)
Larger/Longer (D)	2.19 (0.3)	0.73 (0.06)	2.18 (0.3)	0.73 (0.06)
Quit/Control (D)	2.99 (0.4)	1.00 (0.06)	2.96 (0.4)	1.00 (0.06)
Time spent (D)	3.52 (0.5)	0.98 (0.06)	3.69 (0.6)	0.97 (0.06)
Activities given up (D)	3.03 (0.5)	1.19 (0.07)	3.08 (0.5)	1.18 (0.07)
Physical/psychological problems (D)	1.89 (0.2)	0.80 (0.06)	1.93 (0.2)	0.79 (0.06)
Neglect roles (A)	1.38 (0.1)	1.24 (0.09)	1.37 (0.1)	1.24 (0.09)
Hazardous use (A)	1.39 (0.2)	1.52 (0.11)	1.41 (0.2)	1.51 (0.10)
Legal problems (A)	1.79 (0.2)	1.52 (0.09)	1.75 (0.2)	1.53 (0.09)
Social/Interpersonal problems (A)	1.73 (0.2)	0.98 (0.07)	1.70 (0.2)	0.98 (0.07)
Craving	-	-	2.62 (0.3)	1.10 (0.07)
Bayesian Information Criterion (BIC)	5602.446		5933.384	
Sample-Size Adjusted BIC	5532.578		5857.165	
Akaike (AIC)	5497.188		5818.557	
Pachuca, Mexico	Discrimination (S.E.)	Severity (S.E.)	Discrimination (S.E.)	Severity (S.E.)
Tolerance (D)	2.32 (0.4)	1.69 (0.11)	2.43 (0.4)	1.69 (0.11)
Withdrawal (D)	1.38 (0.2)	1.14 (0.10)	1.36 (0.2)	1.15 (0.10)
Larger/Longer (D)	3.41 (0.6)	1.11 (0.07)	3.38 (0.6)	1.11 (0.7)
Quit/Control (D)	1.33 (0.2)	1.44 (0.12)	1.34 (0.2)	1.44 (0.11)
Time spent (D)	2.88 (0.5)	1.46 (0.09)	2.75 (0.4)	1.47 (0.09)
Activities given up (D)	2.14 (0.4)	1.67 (0.11)	2.08 (0.4)	1.69 (0.12)
Physical/psychological problems (D)	1.88 (0.3)	1.30 (0.09)	1.85 (0.3)	1.30 (0.09)
Neglect roles (A)	2.13 (0.3)	1.13 (0.08)	2.11 (0.3)	1.13 (0.08)
Hazardous use (A)	1.23 (0.2)	2.18 (0.23)	1.21 (0.2)	2.20 (0.23)
Legal problems (A)	1.76 (0.4)	2.39 (0.25)	1.95 (0.5)	2.32 (0.22)
Social/Interpersonal problems (A)	1.91 (0.3)	1.62 (0.11)	1.94 (0.3)	1.62 (0.11)
Craving	-	-	1.91 (0.3)	1.70 (0.12)
Bayesian Information Criterion (BIC)	2680.439		2846.414	
Sample-Size Adjusted BIC	2610.602		2770.228	
Akaike (AIC)	2585.741		2743.107	

TABLE 4. Continued

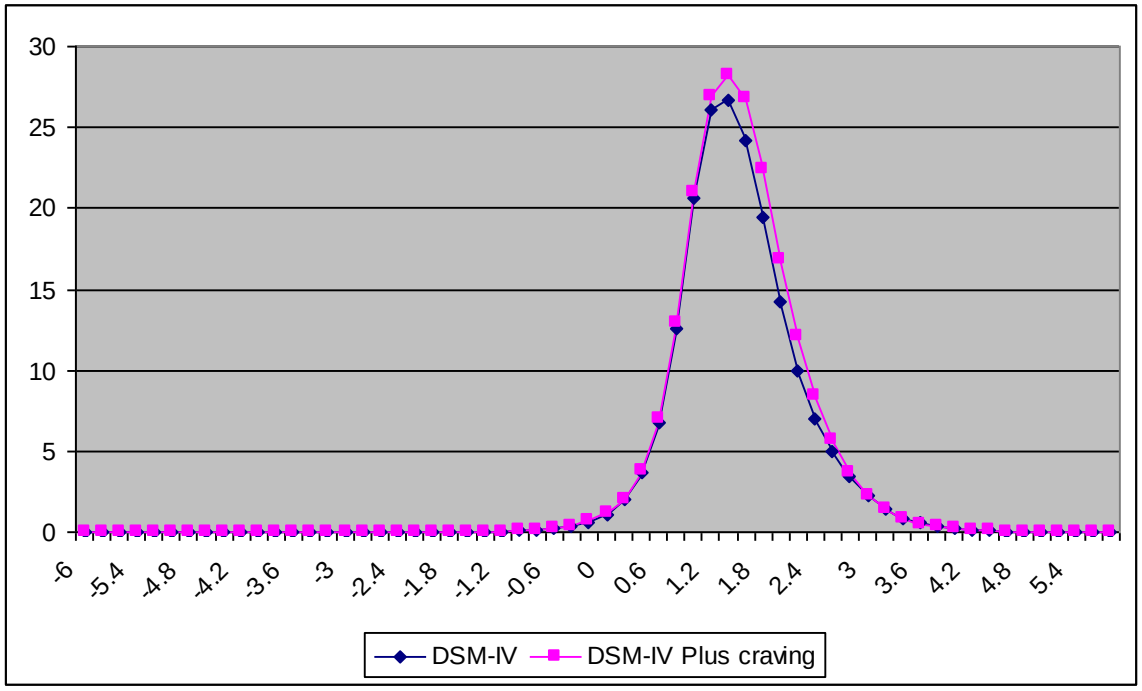
	Base Model (DSM-IV 11 criteria)		**Model with Craving (DSM-IV 11 criteria + craving)**	
Mar Del Plata, Argentina	Discrimination (S.E.)	Severity (S.E.)	Discrimination (S.E.)	Severity (S.E.)
Tolerance (D)	1.43 (0.2)	1.74 (0.14)	1.39 (0.2)	1.76 (0.14)
Withdrawal (D)	1.26 (0.2)	1.72 (0.14)	1.29 (0.2)	1.71 (0.14)
Larger/Longer (D)	1.99 (0.3)	1.23 (0.09)	2.06 (0.3)	1.21 (0.08)
Quit/Control (D)	1.60 (0.2)	1.68 (0.13)	1.60 (0.2)	1.68 (0.13)
Time spent (D)	2.88 (0.5)	1.30 (0.08)	2.81 (0.5)	1.30 (0.08)
Activities given up (D)	3.45 (0.9)	1.69 (0.11)	3.59 (0.9)	1.68 (0.10)
Physical/psychological problems (D)	2.57 (0.4)	1.25 (0.08)	2.63 (0.4)	1.25 (0.08)
Neglect roles (A)	1.57 (0.2)	1.58 (0.12)	1.55 (0.2)	1.59 (0.12)
Hazardous use (A)	1.49 (0.2)	1.74 (0.14)	1.45 (0.2)	1.76 (0.14)
Legal problems (A)	2.35 (0.7)	2.32 (0.19)	2.22 (0.6)	2.35 (0.19)
Social/Interpersonal problems (A)	1.87 (0.3)	1.67 (0.12)	1.86 (0.3)	1.67 (0.12)
Craving	-	-	1.84 (0.3)	1.73 (0.13)
Bayesian Information Criterion (BIC)	2907.884		3097.797	
Sample-Size Adjusted BIC	2838.033		3021.596	
Akaike (AIC)	2808.988		2989.911	
Warsaw & Sosnowiec, Poland	Discrimination (S.E.)	Severity (S.E.)	Discrimination (S.E.)	Severity (S.E.)
Tolerance (D)	1.33 (0.2)	2.18 (0.14)	1.30 (0.2)	2.21 (0.15)
Withdrawal (D)	1.58 (0.2)	1.44 (0.08)	1.58 (0.2)	1.44 (0.08)
Larger/Longer (D)	1.28 (0.1)	1.61 (0.10)	1.26 (0.1)	1.62 (0.10)
Quit/Control (D)	1.78 (0.3)	2.11 (0.13)	1.71 (0.3)	2.14 (0.14)
Time spent (D)	2.76 (0.5)	2.02 (0.10)	2.75 (0.5)	2.03 (0.10)
Activities given up (D)	2.13 (0.3)	2.21 (0.12)	2.07 (0.3)	2.23 (0.13)
Physical/psychological problems (D)	1.58 (0.2)	1.54 (0.09)	1.57 (0.2)	1.54 (0.09)
Neglect roles (A)	1.48 (0.2)	1.82 (0.11)	1.42 (0.2)	1.85 (0.11)
Hazardous use (A)	1.34 (0.2)	2.12 (0.14)	1.30 (0.2)	2.15 (0.15)
Legal problems (A)	2.38 (0.4)	2.22 (0.13)	2.33 (0.4)	2.24 (0.13)
Social/Interpersonal problems (A)	2.44 (0.4)	1.61 (0.08)	2.44 (0.4)	1.61 (0.08)
Craving	-	-	1.64 (0.3)	2.01 (0.13)
Bayesian Information Criterion (BIC)	4054.591		4327.394	
Sample-Size Adjusted BIC	3984.713		4251.164	
Akaike (AIC)	3944.563		4207.364	

Figure 1. Aggregate Information Curves along latent AUD continuum (x-axis) for 11 DSM-IV existing criteria and 12 criteria with craving added

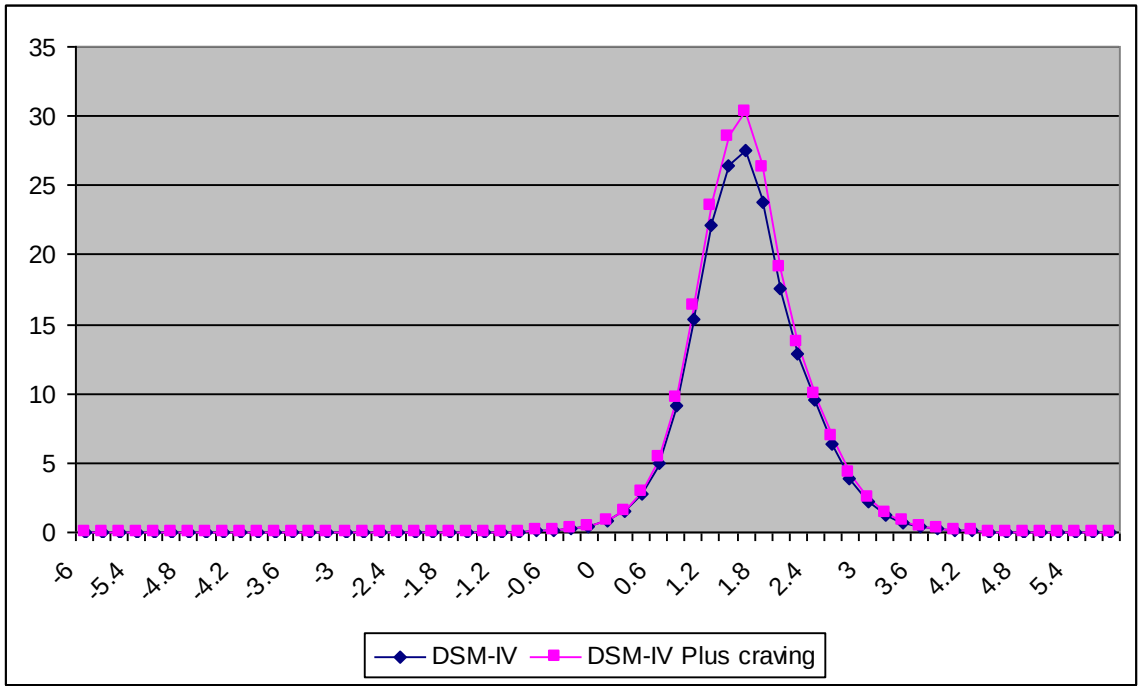
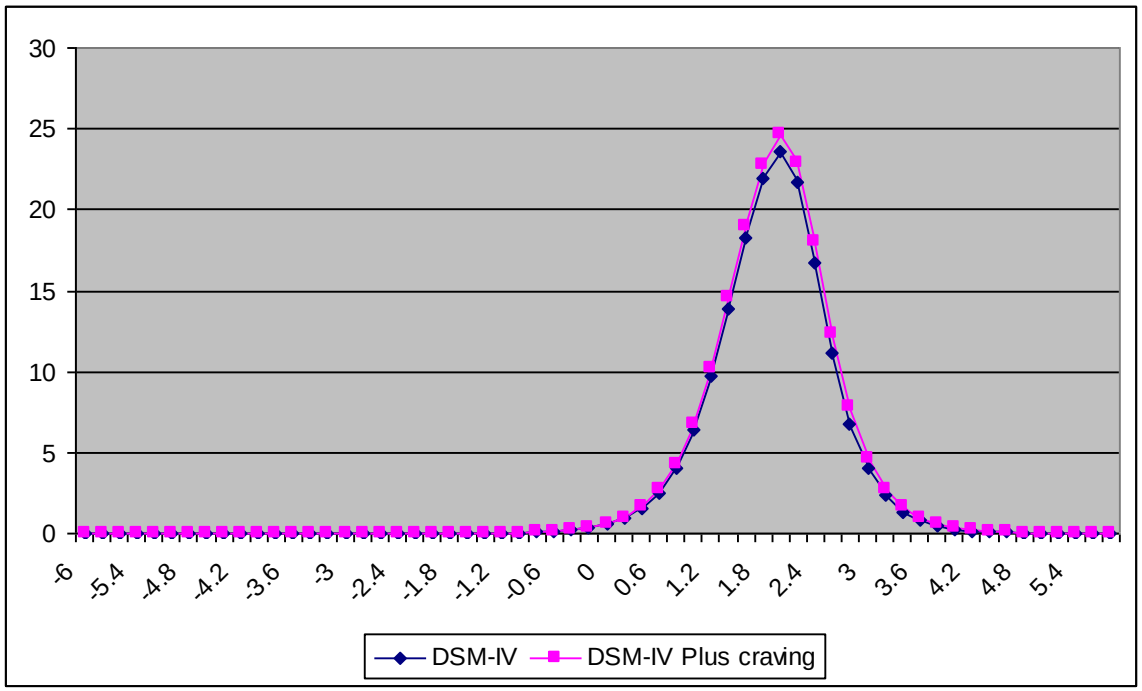
Santa Clara US



Pachuca Mexico



Mar Del Plata Argentina



Warsaw/Sosnowiec Poland