A Validation Study of the Alcohol Dependence Scale*

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ABSTRACT. Objective: The primary purpose of this study was to provide a comprehensive assessment of the underlying factor structure of the Alcohol Dependence Scale (ADS). Secondary goals included assessing concurrent validity of the total ADS and subscales derived from the factor analyses with variables related to alcohol dependence and further evaluating the validity of two proposed dichotomously scored, reduced-item ADS measures. **Method:** Responses to the ADS were obtained from participants who met Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, criteria for alcohol dependence in two large randomized clinical trials: COMBINE (Combining Medications and Behavioral Interventions Study; *n* = 1,335; 69% male) and Project MATCH (Matching Alcoholism Treatments to Client Heterogeneity; *n* = 1,666; 75% male). Both exploratory and confirmatory factor analyses were conducted, and validity coefficients were obtained. **Results:** Across samples, analyses supported a correlated, three-factor solution representing loss of behavioral control and heavy drinking, obsessive-compulsive drinking style, and psychoperceptual and psychophysical withdrawal. The ADS was significantly related to other measures of severity of dependence, craving for and preoccupation with drinking, temptation to drink and confidence in the ability to not drink in high-risk relapse situations, heavy and sustained drinking patterns, concerns about negative alcohol-related consequences, and awareness of problematic drinking. **Conclusions:** These findings support a three-factor solution for the ADS and its ability to assess the construct of alcohol dependence in a reliable and valid manner. The 12-item reduced ADS measure (reflecting mostly dependence-related items), as opposed to the 9-item reduced ADS measure (generally excessive drinking items), provided validity coefficients comparable to the total, 25-item ADS. (*J. Stud. Alcohol Drugs* **70:** 689-699, 2009)

THE ALCOHOL DEPENDENCE SCALE (ADS; Horn et al., 1984; Skinner and Horn, 1984) was originally a 29-item, self-report instrument designed to evaluate the degree of severity of the alcohol dependence syndrome (Edwards, 1986; Edwards and Gross, 1976). The ADS was derived from items defining four primary oblique factor scales of the Alcohol Use Inventory (AUI; Horn et al., 1974; Wanberg and Horn, 1983) concerning alcohol use in the previous 12 months, with content weighted substantially toward the physiological aspects of the alcohol dependence syndrome: loss of behavioral control (LBC), obsessive-compulsive drinking style (OCD), and psychophysical and psychoperceptual withdrawal (PPW) symptoms. Subsequently, the ADS was revised by eliminating less discriminating items and adding several new items, resulting in the current 25-item ADS used in this study.

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The factor structure of the ADS was originally determined by Skinner and Allen (1982). With a principal components analysis, and both orthogonal and oblique rotations, they extracted three components, identified as loss of behavioral control over alcohol consumption, obsessive-compulsive drinking, and alcohol withdrawal symptoms. Svanum (1986) and Kivlahan et al. (1989) reported finding similar orthogonal principal components solutions, as did Hodgins and Lightfoot (1989). However, in light of a weak third component, they opted for only two components, defined as loss of control–obsessive drinking style and psychoperceptual–physical symptoms. Unfortunately, the actual loadings derived from the principal components analyses were not presented in these studies for peer review.

In contrast, Allen et al. (1994) assessed the factor structure of the ADS with two samples randomly selected from alcoholism treatment facilities in the United States and Russia and presented the loadings from both samples. Based on a principal components analysis and varimax rotation, they retained four components representing psychoperceptual withdrawal, psychophysical effects of withdrawal, loss of behavioral control over drinking, and obsessive drinking style. They reported the ADS had reasonably high factorial similarity across alcoholic patients in these two cultures but that six items differed between the two samples in terms of the factors on which they loaded highest. However, coefficients of congruence (Tucker, 1951; Wrigley and Neuhaus, 1955) calculated on the component loadings presented in their article are .86, .78, .88, and .76, respectively. These

values, assessed according to the guidelines by MacCallum et al. (1999) (.98 to 1.00 = excellent, .92 to .98 = good, .82 to .92 = borderline, .68 to .82 = poor, and less than .68 = terrible), indicate only poor to borderline similarity.

In contrast to using a principal components analysis, Kahler et al. (2003a,b) examined the ADS factor structure with a maximum likelihood factor procedure, reporting five- and six-factor solutions, respectively. Based on large eigenvalues of the first factor, it was concluded in both studies that although distinct dimensions were obtained, a primary latent alcohol dependence factor accounted for the majority of the common variance. Eigenvalues derived from parallel analysis (Hayton et al., 2004; Horn, 1965; Turner, 1998), using the SAS program written by O'Connor (2000), compared with their reported eigenvalues, indicated three or four factors may be more appropriate in defining the underlying structure of the ADS.

Using item response theory, item characteristic curves, and option characteristic curves, Kahler et al. (2003a,b) also examined extensively the psychometric properties of the ADS and the ability of each item to discriminate among individuals across the continuum of alcohol dependence severity. They derived two different reduced ADS scoring algorithms and concluded different items contributed to its discrimination ability depending on the sample under study. With a sample of alcohol-dependent patients, Kahler et al. (2003a) derived a 12-item, dichotomously scored brief ADS, with item content reflecting mostly dependence-related items: loss of control as the least severe, followed by mild withdrawal symptoms, and then preoccupation with drinking (Items 3, 5, 8, 9, 11, 12, 13, 15, 17, 18, 20, and 22). In contrast, with a sample of alcohol users at high risk for alcohol problems, Kahler et al. (2003b) derived a nine-item, dichotomously scored brief ADS that related almost exclusively to excessive drinking (Items 1, 6, 7, 10, 12, 16, 22, 23, and 24). Therefore, although the ADS may be useful among samples of alcohol users, different items appear to contribute to its discrimination ability depending on the sample under study.

Several studies have assessed the relation of total ADS scores with various other measures of alcohol-related dependence. With a sample of women, the ADS has been positively correlated with previous treatment for alcohol abuse, number of days of alcohol consumption, and the number of positive alcohol symptoms (Chantarujikapong et al., 1997). Connor et al. (1999) found that, for men, difficulty controlling alcohol intake, attempts to limit drinking, and plans to reduce drinking consequences were significantly related to higher ADS total scores. Significant predictors of greater levels of dependence on the ADS for women in this study included difficulty controlling alcohol intake and negative affects as a reason for drinking. In a similar study, Connor et al. (2000) also found difficulty controlling alcohol intake was the best predictor of greater levels of dependence on the ADS with a sample of both men and women and that assertion, dependence, and cognitive changes concerning drinking expectancy were also related to the ADS. In a later study, Connor et al. (2007) reported the ADS was positively related to drinking expectancy and drinking refusal self-efficacy, cognitive emotional preoccupation with drinking, and quantity of drinking. Hodgins and Lightfoot (1989) found that higher scores on the ADS were highly and positively correlated with the number of standard drinks consumed per day, years of problem drinking, the need for assistance with alcohol problems, the role of alcohol and drugs in crime, and aggression when drinking. Higher scores on the ADS have also been associated with higher rates of endorsement of Diagnostic and Statistical Manual of Mental Disorders, Third Edition (DSM-III; American Psychiatric Association, 1980) and DSM, Fourth Edition (DSM-IV; American Psychiatric Association, 1994), symptoms of the severity of alcohol dependence (Langenbucher et al., 1996; Ross et al., 1990), with greater levels of obsessive-compulsive drinking (Moak et al., 1998); more drinking-related health problems (Svanum, 1986); and patients' self-appraised drinking-related social, vocational, and family problems, as well as DSM-III prevalence of alcohol-use disorders and drinks per drinking day (Ross et al., 1990).

Purpose of the present study

The main purpose of the present study was to provide a more justifiable approach and comprehensive assessment of the underlying factor structure of the ADS and to present detailed results for review. Because the ADS has 6 items that are scored on a 2-point item scale (0 or 1), 16 scored on a 3-point item scale (0, 1, 2), and 3 scored on a 4-point item scale (0, 1, 2, or 3), previous analyses on ADS item responses may not have provided the best results. Using principal components or maximum likelihood factor analysis when observed variables are binary or have a small number of ordered categories with unequal intervals can be problematic, and a distorted solution may result (McDonald, 1969, 1985; Muthén, 1983). Therefore it is important to use an analytic approach better suited for dichotomous and ordered polytomous data, such as the weighted least squares factor analysis of polychoric correlations (tetrachoric in the case of binary data) as discussed in Muthén (1978, 1983, 1984) and Muthén et al. (1997).

In addition to the type of extraction, orthogonal rotation is a strategy difficult to justify, because an oblique solution, which does not preclude zero correlations among factors, is the appropriate method when one expects significant associations among underlying dimensions and for justification of calculating a total score from subscale measures. Furthermore, most studies used the eigenvalue-greater-than-one rule for determining the number of factors to extract, which has been shown to be inaccurate, subjective, and too arbitrary

for general use (Fabrigar et al., 1999; Zwick and Velicer, 1986) and may not result in reliable factors (Cliff, 1988). In contrast, parallel analysis (Hayton et al., 2004; Horn, 1965; Turner, 1998) has been demonstrated to be consistently accurate across most conditions when correlation matrices were systematically varied in terms of sample size, number of variables, complexity (variables with nonzero loadings on more than one component), saturation, and component identification (the number of variables defining a factor) (Velicer et al., 2000; Zwick and Velicer, 1986). In addition, the factor analytic procedures used in this study will allow for evaluating the appropriateness of both exploratory and confirmatory solutions with indices of model fit.

Noting that previous studies have focused on validity coefficients with the total ADS score, a secondary goal of this study was to assess the concurrent validity of the total ADS and to include subscale scores derived from the factor analysis with a number of available and selected variables related to alcohol dependence. Another auxiliary goal was to further evaluate the concurrent validity of the 12-item (ADS-12) and 9-item (ADS-9) dichotomously scored brief ADS measures proposed by Kahler et al. (2003a,b), respectively.

Method

Samples

Responses to the ADS were obtained with baseline data collected from two different multisite randomized controlled clinical trials: the COMBINE (Combining Medications and Behavioral Interventions) Study and Project MATCH (Matching Alcoholism Treatments to Client Heterogeneity). Participants in both trials met DSM-IV criteria for alcohol dependence. Detailed information, such as the inclusion/exclusion criterion for study participation, rationale, goals, study design, and assessments, can be found in articles by the COMBINE Study Research Group (2003a,b) and Project MATCH Research Group (1993, 1997).

Of the 1,383 subjects randomized in the COMBINE sample, 1,335 subjects (69% male) had responses on all 25 items of the ADS at baseline and were included in the present analyses. This sample had a mean (SD) age of 44.5 (10.2) years, the majority were non-Hispanic white (76.4%), and 44.6% are either married or cohabitating. The Project MATCH sample included 1,726 subjects, of whom 1,666 (75% male) had responses on 23 items of the ADS at baseline. With the Project MATCH sample, two ADS items—12 ("After a period of abstinence [not drinking], do you end up drinking heavily again?") and 23 ("Have you tried to cut down on your drinking and failed?")—were not available for analysis. This sample had a mean age of 40.3 (11.0) years, the majority were non-Hispanic white (81.1%), and 40.7% are either married or cohabitating.

Data analyses

Cases with responses to the ADS from both studies were randomly divided into two samples. This resulted in a derivation sample of 668 and validation sample of 667 for the COMBINE Study. The derivation and validation samples for Project MATCH data were both of size $n = 833$. Given that previous analyses with the Project MATCH data indicated differences on prior alcohol treatment and alcohol dependence symptoms between clients in outpatient therapy and clients in aftercare subsequent to inpatient or day hospital treatment (Project MATCH Research Group, 1997), both the derivation and validation samples with the Project MATCH data were evaluated to ensure adequate representation by both outpatient and aftercare participants.

With the derivation samples, an exploratory factor analysis was conducted. Factor analytic procedures were selected to appropriately handle the distributional characteristics of the items. This consisted of factor analyzing the polychoric correlations of the responses to the ADS items, using the robust weighted least squares parameter estimation procedure (WLSMV; Muthén et al., 1997) and an oblique, direct quartimin rotation (Jennrich and Sampson, 1966). Based on the results of the exploratory factor analysis, the responses to the ADS with the validation samples were used in a confirmatory factor analysis, using the same estimation procedure on polychoric correlations, allowing the latent factors to be correlated. Confirmatory factor analyses of the ADS items were also conducted to assess any differences in interpretation of the underlying dimensions and indices of model fit by gender and by outpatient versus aftercare for the Project MATCH data. All factor analyses were conducted with the MPLUS software (Version 5; Muthén and Muthén, 1998-2007). The number of factors to extract with the exploratory factor analysis was determined by parallel analysis (Hayton et al., 2004; Horn, 1965; Turner, 1998), interpretation of factors, and indices of model fit. Confirmatory factor analysis was based on the exploratory results and its adequacy by the same indices of model fit. These indices included the comparative fit index (CFI; Bentler, 1990), the Tucker-Lewis incremental fit index (TLI; Tucker and Lewis, 1973), and the root mean square error of approximation (RMSEA; Steiger and Lind, 1980). The magnitudes of the fit indices were evaluated on recommendations given by Hu and Bentler (1999) and Yu and Muthén (2002): >.95 for the CFI and TLI, and <.06 for the RMSEA.

The *t* tests between men and women for each subscale defining a factor and for the total ADS score with both the COMBINE Study and Project MATCH data were conducted to assess gender differences. With the Project MATCH data, *t* tests were also used to evaluate mean differences between participants in outpatient and aftercare on subscale and total ADS scores.

Internal consistency reliability was estimated with Cronbach's alpha coefficient for each subscale defining a factor; for the total ADS score; and for the brief ADS-12 and ADS-9 measures for the derivation, validation, and total samples. Concurrent validity coefficients are zero-order Pearson product-moment correlations. The ADS-12 and ADS-9 were not assessed with the Project MATCH data because Items 12 and 23 were not available. Differences on the ADS measures between participants with and without physiological dependence on the Structured Clinical Interview for DSM (SCID; First et al., 1995), defined as the presence of either tolerance or withdrawal, levels of severity of dependence (mild, moderate, severe) based on SCID interviewers' ratings, and Babor's alcoholism severity typology (Type A/low risk and severity vs Type B/high risk and severity) (Babor et al., 1992), were assessed with analysis of variance and Cohen's (1988) effect size (ES) estimates (ES = mean difference in standard deviation units, using the pooled group standard deviation).

Measures

A number of interview-administered and self-report measures were collected at baseline in both Project MATCH (Connors et al., 1994) and the COMBINE Study (Gastfriend et al., 2005), a number being common to both studies and others of which were included in one but not the other project.

Measures in the present analyses common to both studies included (1) the alcohol dependence section of the SCID (Version III-R in MATCH [Spitzer et al., 1990] and Version IV in COMBINE [First et al., 1995]), a structured interview that provides a diagnosis of alcohol abuse or dependence and information on the severity of alcohol dependence by counting the number of diagnostic symptoms endorsed; (2) the Form 90, a calendar-based assessment of alcohol use during the prior 90 days (Miller, 1996) that provides continuous measures of the percentage of days abstinent (an arcsin square root transformation was used on this measure) and drinks per drinking day during a 90-day time frame; Form 90 has been found to have good to excellent reliability for all key summary measures of alcohol consumption and psychosocial functioning (Tonigan et al., 1997); (3) the total score from the Alcohol Use Disorders Identification Test (AUDIT; Babor et al., 2001; Saunders et al., 1993), a 10-item measure of alcohol consumption/hazardous drinking, alcohol-related problems/harmful drinking, and alcohol-dependence symptoms, shown to be an indicator of the severity of dependence in an alcohol-dependent population (Donovan et al., 2006); (4) the Drinker Inventory of Consequences (Miller et al., 1995), used for assessing adverse consequences of alcohol abuse and dependence in interpersonal, physical, social, impulsive, and intrapersonal areas during the past 90 days with a high degree of reliability (Forcehimes et al., 2007; Miller et al., 1995); (5) an overall readiness to change score, reflecting a second-order factor (Carbonari et al., 1994) derived from the University of Rhode Island Change Assessment scale (McConnaughy et al., 1989) and calculated by adding the mean of the contemplation, action, and maintenance subscales together and then subtracting the precontemplation mean; and (6) the Alcohol Abstinence Self-Efficacy Scale (DiClemente et al., 1994), which assesses individuals' perceived temptation to drink and their efficacy or confidence to abstain in 20 common drinking-related situations having a high risk for relapse.

Measures in the analyses unique to the COMBINE Study included the Clinical Institute Withdrawal Assessment for Alcohol–Revised (CIWA-Ar; Sullivan et al., 1989), which provides a brief index of the severity of the alcohol withdrawal syndrome, and the Obsessive-Compulsive Drinking Scale (OCDS; Anton et al., 1995, 1996), used to characterize and quantify the obsessive and compulsive cognitive aspects of craving and heavy drinking, such as drinking-related thoughts, urges to drink, and the ability to resist those thoughts and urges. A total score and obsessive and compulsive subscale scores were used. The OCDS has been found to be reliable with good construct validity, including a positive relation with the ADS (Anton et al., 1995).

Measures unique to Project MATCH included the following four items: (1) the Ethanol Dependence Syndrome scale (Babor, 1996), which assesses five major components of the alcohol dependence syndrome (salience of drinking, impaired control over drinking, tolerance, withdrawal, and withdrawal relief); (2) the MacAndrew Alcoholism Scale (MacAndrew, 1965), which was designed to be a nonobvious measure derived from the Minnesota Multiphasic Personality Inventory to detect and differentiate alcohol-dependent individuals from psychiatric patients and has been found to correlate with indices of alcohol and substance abuse across a wide variety of populations (Craig, 2005); (3) the Alcoholics Anonymous Involvement scale (Tonigan et al., 1996), a measure of attendance at Alcoholics Anonymous meetings and involvement in 12-step activities, with strong reliability (Cronbach α's > .80) and test-retest correlations >.90 (Tonigan et al., 1996); and (4) the AUI (Wanberg and Horn, 1987; Horn et al., 1987), which provides a multidimensional assessment of an individual's perceived benefits, styles, consequences, and concerns about drinking. Because the ADS was derived from the AUI, only those scales of the AUI that do not contribute items to the ADS were analyzed in order to eliminate concerns about overlapping items that would artificially inflate correlations.

Results

Slight differences in the proportions of subjects in the derivation (outpatient = 53.90%, aftercare = 46.10%) and validation (outpatient = 57.64%, aftercare = 42.36%) samples for the Project MATCH data were observed, but these

differences were not statistically significant ($\chi^2_1 = 2.36$, $p = .12$; $n = 1{,}664$). There were no significant differences in the proportions of men and women between the derivation and validation samples in both the COMBINE Study ($\chi^2_1 = 0.25$, $p = .62$) and Project MATCH ($\chi^2_1 = 0.24$, $p = .63$) data.

Exploratory factor analysis

Parallel analysis and indices of model fit for the exploratory factor analyses indicated a very good fit to a three-factor model for the derivation samples (for the COMBINE Study: CFI = .959, TLI = .979, and RMSEA = 0.040; for Project MATCH: CFI = .963, TLI = .977, and RMSEA = .036). Factor loadings of variables defining each factor ranged from moderate (.30) to very high (.93) in value, with an average defining loading of .64 (Table 1). Based on item content and the results of previous research, these factors were identified as LBC, OCD, and PPW. Coefficients of congruence among the 23 items available to both samples indicated good similarity of the factor structure, with values of .96, .93, and .95, respectively, for the factors defined above.

Confirmatory factor analysis

Based on the results of the exploratory factor analyses, a three-factor model was proposed for each confirmatory factor analysis. The results indicated moderate (.42) to high (.90) loadings for variables defining the latent factors (Table 2). Indices of model fit revealed marginally good support for the three-factor model for the validation samples (for the COMBINE Study: CFI = .900, TLI = .943, and RMSEA = .059; for Project MATCH: CFI = .920, TLI = .958, and RMSEA = .065). Correlations of the latent factors were moderately high, ranging from .54 to .74 between the two validation samples.

In some instances, the exploratory factor analysis results (Table 1) indicated a few items loaded on more than one factor. For example, with the COMBINE Study derivation sample, Item 4 loaded on both Factor 1 (.32) and Factor 3 (.37). Given this situation, the confirmatory factor analyses conducted on the COMBINE Study validation sample considered both options, selecting the model with the best indices of fit and factor loading. With this example, if Item 4 was allowed to load on the first factor, indices of model fit reduced to CFI = .877, TLI = .931, and RMSEA = .068, with a loading of .38 versus a loading of .62 when the item was assigned to define the third factor. In all instances, when the item loaded on more than one factor with the exploratory factor analysis, its highest loading was a good indication of the best model fit with the confirmatory factor analysis.

With the confirmatory factor analysis, a few items had relative low loadings, such as Item 25 (.49) and Item 23 (.42) with the COMBINE Study validation sample. These relatively low loadings are assumed to be due more to the

Table 1. Factor loadings from the exploratory factor analyses, derivation samples

Variable	COMBINE Study ($n = 668$)			Project MATCH ($n = 833$)		
Loss of behavioral control and heavy drinking						
1. How much did you drink the last time you drank?	.57	.21	-.07	.60	.13	-.09
2. Do you often have hangovers on Sunday or Monday mornings?	.49	-.04	.08	.41	.11	.03
6. When you drink, do you stumble about, stagger, and weave?	.63	.07	.09	.60	.05	-.04
10. Have you had blackout ("loss of memory" without passing out) as a result of drinking?	.88	-.10	.03	.76	-.08	.00
13. In the past 12 months, have you passed out as a result of drinking?	.68	.08	-.02	.65	-.02	.12
16. After drinking heavily, has your thinking been fuzzy or unclear?	.37	.17	.28	.38	.21	.17
22. With respect to blackouts (loss of memory):	.81	-.11	.08	.72	-.11	.14
24. Do you gulp drinks (drink quickly)?	.31	.22	-.05	.54	.14	-.07
25. After taking one or two drinks, can you usually stop?	.48	.20	-.18	.44	.39	-.14
Obsessive-compulsive drinking style						
9. Do you panic because you fear you may not have a drink when you need it?	.05	.46	.22	.07	.71	.00
11. Do you carry a bottle with you or keep one close at hand?	-.07	.71	.05	-.08	.71	.11
12. After a period of abstinence (not drinking), do you end up drinking heavily again?	.30	.52	-.17	[a]	[a]	[a]
15. Do you drink throughout the day?	-.09	.69	.14	-.10	.60	.16
18. Do you almost constantly think about drinking and alcohol?	-.02	.62	.15	.07	.77	-.12
23. Have you tried to cut down on your drinking and failed?	.28	.34	-.14	[a]	[a]	[a]
Psychoperceptual and psychophysical withdrawal						
3. Have you had the "shakes" when sobering up (hands tremble, shake inside)?	.20	.21	.42	.04	.37	.44
4. Do you get physically sick (e.g., vomit, stomach cramps) as a result of drinking?	.32	.12	.37	.27	.14	.30
5. Have you had the "DTs" (delirium tremens), i.e., seen, felt, or heard things not really there?	.10	.19	.66	-.01	-.00	.91
7. As a result of drinking, have you felt overly hot and sweaty (feverish)?	.15	.05	.53	.11	.32	.37
8. As a result of drinking, have you seen things that were not really there?	-.01	-.05	.93	-.02	-.05	.92
14. Have you had a convulsion (fit) following a period of drinking?	.18	.25	.30	-.08	.13	.55
17. As a result of drinking, have you felt your heart beating rapidly?	.04	.09	.52	.13	.29	.36
19. As a result of drinking, have you heard "things" that were not really there?	-.02	-.03	.93	.05	-.03	.88
20. Have you had weird and frightening sensations when drinking?	.02	.15	.66	.21	.08	.56
21. As result of drinking, have you "felt things" crawling on you that were not really there?	.03	.03	.79	.04	.11	.66

Notes: COMBINE = Combining Medications and Behavioral Interventions; MATCH = Matching Alcoholism Treatments to Client Heterogeneity. [a]Item not available with Project MATCH.

TABLE 2. Factor loadings from the confirmatory factor analyses, validation samples

Variable	COMBINE Study (n = 667)	Project MATCH (n = 833)
Loss of behavioral control and heavy drinking		
1. How much did you drink the last time you drank?	.67	.59
2. Do you often have hangovers on Sunday or Monday mornings?	.57	.47
6. When you drink, do you stumble about, stagger, and weave?	.75	.60
10. Have you had blackout ("loss of memory" without passing out) as a result of drinking?	.77	.71
13. In the past 12 months, have you passed out as a result of drinking?	.73	.73
16. After drinking heavily, has your thinking been fuzzy or unclear?	.65	.69
22. With respect to blackouts (loss of memory):	.73	.82
24. Do you gulp drinks (drink quickly)?	.53	.49
25. After taking one or two drinks, can you usually stop?	.49	.58
Obsessive-compulsive drinking style		
9. Do you panic because you fear you may not have a drink when you need it?	.71	.76
11. Do you carry a bottle with you or keep one close at hand?	.64	.72
12. After a period of abstinence (not drinking), do you end up drinking heavily again?	.59	[a]
15. Do you drink throughout the day?	.56	.66
18. Do you almost constantly think about drinking and alcohol?	.61	.64
23. Have you tried to cut down on your drinking and failed?	.42	[a]
Psychoperceptual and psychophysical withdrawal		
3. Have you had the "shakes" when sobering up (hands tremble, shake inside)?	.65	.70
4. Do you get physically sick (e.g., vomit, stomach cramps) as a result of drinking?	.62	.57
5. Have you had the "DTs" (delirium tremens), i.e., seen, felt, or heard things not really there?	.77	.84
7. As a result of drinking, have you felt overly hot and sweaty (feverish)?	.66	.70
8. As a result of drinking, have you seen things that were not really there?	.78	.90
14. Have you had a convulsion (fit) following a period of drinking?	.54	.53
17. As a result of drinking, have you felt your heart beating rapidly?	.56	.66
19. As a result of drinking, have you heard "things" that were not really there?	.79	.87
20. Have you had weird and frightening sensations when drinking?	.66	.74
21. As result of drinking, have you "felt things" crawling on you that were not really there?	.66	.70

Notes: COMBINE = Combining Medications and Behavioral Interventions; MATCH = Matching Alcoholism Treatments to Client Heterogeneity. [a]Item not available with Project MATCH.

distributional problems with these items than lack of construct validity. In particular, these items revealed sparseness in some of the response options. For example, Item 25 is rated on a 2-point item scale, and 87% were coded 1, with only 13% coded 0. In a similar manner, Item 23, which is rated on a 3-point item scale, revealed 88% coded 2 and only 12% coded either 1 or 0.

Confirmatory factor analyses also indicated comparable interpretation of the underlying factors and indices of model fit for men (CFI = .91; TLI = .96; RMSEA = .06; n = 924) and women (CFI = .91; TLI = .94; RMSEA = .06; n = 412) in the COMBINE Study, and for men (CFI = .91; TLI = .95; RMSEA = .07; n = 1257) and women (CFI = .90; TLI = .94; RMSEA = .08; n = 411) in Project MATCH. The outpatient subsample (CFI = .93; TLI = .96; RMSEA = .06; n = 928) also revealed similar indices of model fit and representation of the underlying factors to those in aftercare (CFI = .90; TLI = .94; RMSEA = .07; n = 736) with the Project MATCH data.

Gender and outpatient/aftercare differences

There were no statistically significant differences (p > .05) between men and women on any subscale or total ADS score for both the COMBINE Study and Project MATCH data. However, for the Project MATCH data, participants in aftercare revealed statistically significant (p < .0001) higher mean values than outpatient participants on all subscale and total ADS scores, revealing low to moderate ESs: LBC (ES = .33), OCD (ES = .53), PPW (ES = .48), and total ADS (ES = .52).

Reliability and validity

Internal consistency reliability estimates for the total ADS, presented at the top of Table 3, were moderately high for the derivation, validation, and total samples, ranging from .82 to .87. Reliability estimates were the lowest for the OCD factor (.58 to .67). However this factor contains six items for the COMBINE Study and only four items for Project MATCH.

Given the mean differences on the ADS subscales and total score between outpatient and aftercare participants in the Project MATCH study, validity coefficients were obtained for both of these subsamples. However, differences in the values of the coefficients were negligible, with 31 of the 32 measures indicating only an absolute difference of .06 or less in value on total ADS scores. Only one measure, AUI marital problems from drinking, revealed a noticeable difference, with a validity coefficient value with the total ADS of .35 for outpatients and .18 for participants in aftercare. Overall, differences in validity coefficients between the outpatient and

TABLE 3. Reliability and validity coefficients

	COMBINE Study (n = 1,335)						Project MATCH (n = 1,666)			
Variable	LBC	OCD	PPW	Total	ADS-12	ADS-9	LBC	OCD	PPW	Total
Cronbach's α coefficients										
Derivation sample	.72	.61	.77	.83	.74	.66	.79	.67	.81	.86
Validation sample	.74	.58	.73	.82	.71	.68	.77	.65	.80	.87
Total sample	.73	.60	.75	.83	.73	.67	.78	.66	.80	.87
Validity coefficients										
Percentage days abstinent	.24	.02*	.11	.18	.12	.24	.08	-.25	-.06*	-.05*
Drinks per drinking day	.36	.38	.41	.47	.45	.30	.39	.49	.41	.51
AUDIT total score	.50	.49	.45	.59	.55	.46	.51	.50	.42	.58
DrInC total drinking consequences	.52	.49	.51	.63	.58	.47	.56	.51	.49	.64
DrInC impulsive actions	.39	.33	.37	.46	.45	.35	.40	.28	.31	.42
DrInC relationship consequences	.44	.42	.41	.52	.50	.40	.46	.39	.37	.50
DrInC intrapersonal consequences	.42	.40	.35	.48	.42	.38	.48	.48	.42	.56
DrInC physical consequences	.47	.45	.53	.60	.53	.41	.49	.50	.55	.63
DrInC social responsibilities	.48	.45	.49	.59	.56	.42	.52	.43	.46	.58
URICA overall readiness score	.18	.25	.18	.24	.22	.21	.20	.24	.22	.26
AASE self-efficacy confidence	-.16	-.17	-.10	-.17	-.15	-.16	-.07†	-.10	-.10	-.11
AASE self-efficacy temptation	.26	.26	.21	.30	.26	.23	.20	.21	.18	.23
Total CIWA-Ar score	.04§	.16	.16	.13	.17	.08†				
OCDS total score	.40	.51	.37	.51	.50	.34				
OCDS obsessive	.33	.51	.39	.48	.50	.30				
OCDS compulsive	.45	.44	.34	.50	.44	.37				
SCID alcohol dependence score	.39	.37	.34	.45	.41	.37				
SCID no. of dependence symptoms							.45	.52	.50	.59
Ethanol Dependence Syndrome Scale							.48	.63	.55	.65
MacAndrew Alcoholism Scale							.24	.24	.25	.30
AA involvement							.27	.28	.31	.36
AUI awareness of drinking problem							.53	.50	.42	.58
AUI gregarious vs solo drinking							-.02§	-.20	-.09	-.10
AUI guilt and worry with drinking							.51	.42	.44	.57
AUI attempts to deal with drinking							.34	.37	.40	.46
AUI drink to manage mood							.37	.30	.34	.42
AUI drink for marital problems[a]							.15	.05	.16	.17
AUI marital problems from drink[a]							.32	.18	.17	.29
AUI drink for mental functioning							.10	.26	.20	.21
AUI quantity consumed							.37	.31	.30	.40
AUI readiness for help							.19	.17	.14	.20
AUI social role maladaption							.48	.38	.44	.55
AUI drink to improve sociability							.25	.22	.23	.29
AUI sustained vs. periodic drinking							-.00§	.41	.12	.15
AUI uncontrolled life disruption							.58	.51	.58	.69
AUI drink to enhance functioning							.14	.08	.10	.14
AUI acknowledge drinking problem							.47	.44	.37	.56

Notes: The sample sizes for "drink for marital problems" and "marital problems from drink" are 998 and 982, respectively. COMBINE = Combining Medications and Behavioral Interventions; MATCH = Matching Alcoholism Treatments to Client Heterogeneity; LBC = loss of behavioral control and heavy drinking; OCD = obsessive-compulsive drinking style; PPW = psychoperceptual and psychophysical withdrawal; ADS = Alcohol Dependence Scale; AUDIT = Alcohol Use Disorders Identification Test; DrInC = Drinker Inventory of Consequences; URICA = University of Rhode Island Change Assessment scale; AASE = Alcohol Abstinence Self-Efficacy scale; CIWA-Ar = Clinical Institute Withdrawal Assessment for Alcohol–Revised; OCDS = Obsessive Compulsive Drinking Scale; SCID = Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders; AA = Alcoholics Anonymous; AUI = Alcohol Use Inventory.
All p values <.0001 except where indicated with a superscript: *$p < .05$; †$p < .01$; §not significant ($p > .05$).

aftercare participants are considered inconsequential, and only validity coefficients for the total sample of participants from Project MATCH are presented.

In general, the ADS factors or subscales of LBC, OCD, and PPW appear to have similar magnitudes of validity coefficients, except where one would not expect them to (Table 3). The ADS total score tends to have more robust relations with the validation measures than do the subscales. As would be expected of a purported measure of alcohol dependence, the ADS total and subscale scores were significantly and positively related to other indicators of dependence severity. These included the AUDIT, Ethanol Dependence Syndrome scale, and indices derived from the SCID, particularly the number of alcohol dependence diagnostic criteria endorsed. Although the relation between the ADS and percentage of days abstinent derived from the Form 90 was relatively weak and inconsistent across the MATCH and COMBINE samples, it was considerably stronger and positively related to the number of drinks consumed per drinking day. It was similarly related to the quantity of alcohol consumed as measured on the AUI and related to withdrawal distress on the CIWA-Ar. This relation is relatively weak and may have been

TABLE 4. Analysis of variance results: Mean (SD), *F* statistic, and effect size

COMBINE Study Physiological dependence	Without (*n* = 234)	With (*n* = 1,095)	$F_{1/1,327}$	Effect size
LBC	6.99 (3.23)	8.74 (3.71)	44.91	.48
OCD	3.88 (1.69)	5.15 (1.90)	88.92	.66
PPW	2.28 (2.44)	4.59 (3.65)	85.99	.65
Total ADS	13.15 (5.53)	18.49 (7.48)	106.56	.72
ADS-12	3.94 (2.03)	5.73 (2.64)	95.10	.68
ADS-9	6.36 (2.04)	7.18 (1.79)	38.81	.44

Severity of dependence	Mild (*n* = 219)	Moderate (*n* = 755)	Severe (*n* = 342)	$F_{2,1313}$	Mild vs moderate	Moderate vs severe	Mild vs severe
LBC	6.08 (3.39)	8.30 (3.49)	10.23 (3.39)	98.36	.60	.53	1.13
OCD	3.66 (1.54)	4.84 (1.78)	5.96 (1.91)	114.02	.61	.58	1.19
PPW	2.02 (2.25)	3.94 (3.25)	6.14 (3.99)	107.89	.54	.62	1.15
Total ADS	11.76 (5.51)	17.08 (6.64)	22.34 (7.31)	173.51	.71	.71	1.42
ADS-12	3.57 (1.92)	5.20 (2.42)	7.10 (2.53)	154.89	.62	.72	1.34
ADS-9	5.78 (2.17)	7.03 (1.76)	7.83 (1.36)	92.59	.67	.43	1.10

Project MATCH Severity typology	Low risk (*n* = 1,154)	High risk (*n* = 497)	$F_{1/1,649}$	Effect size
LBC	16.84 (3.59)	19.91 (3.36)	262.58	.81
OCD	5.59 (1.51)	6.73 (1.57)	195.46	.71
PPW	14.11 (3.52)	17.14 (4.29)	224.99	.76
Total ADS	36.54 (6.89)	43.78 (7.18)	374.02	.94

Notes: COMBINE = Combining Medications and Behavioral Interventions; LBC = loss of behavioral control and heavy drinking; OCD = obsessive-compulsive drinking style; PPW = psychoperceptual and psychophysical withdrawal; ADS = Alcohol Dependence Scale; MATCH = Matching Alcoholism Treatments to Client Heterogeneity.
All *F* tests are significant ($p < .0001$) and all pairwise comparisons for severity of dependence are statistically significant with a Bonferroni correction of alpha ($\alpha = .05/3$).

attenuated by the fact that participants in the COMBINE Study were required to be abstinent for at least 96 consecutive hours with no more than mild risk of withdrawal based on a score less than 8 on the CIWA-Ar before randomization. Stronger relations were found between the ADS and indices of craving on the OCDS; of particular note is that the obsessive subscale of the OCDS is most highly correlated with the Obsessive-Compulsive Drinking subscale on the ADS found in this study.

Overall, the ADS total and subscale scores tend to be less highly related to AUI indices of drinking styles (e.g., gregarious vs solitary drinking) and perceived benefits (e.g., drinking to improve sociability, to enhance function, for mental functioning) than to measures of alcohol-related consequences. There were two exceptions. First, the OCD subscale of the ADS revealed a considerably higher relation ($r = .41$) to a sustained drinking pattern as compared with the ADS total ($r = .15$), LBC ($r = -.00$), or PPW ($r = .12$). Second, the ADS total and subscale scores were more highly related to drinking to manage moods than to other perceived benefits of drinking. More robust relations are found between the ADS scores and measures of concerns about and negative consequences of drinking on the AUI. Individuals with higher scores on the ADS expressed more guilt and worry about their drinking and experienced more disruption in their lives generally and in their social role functioning more specifically. This pattern is consistent with the relations found between the ADS scores and the negative drinking-related consequences assessed by the Drinker Inventory of Consequences. Higher scores on the ADS were associated with higher levels of negative consequences in interpersonal relationships, emotional function, physical status, personal responsibilities, and impulse control.

The higher levels of dependence and negative consequences reflected by higher ADS scores are associated with an acknowledgment of a drinking problem and more previous attempts to address this problem, both as assessed on the AUI and on the Alcoholics Anonymous Involvement scale. Despite this, although still positive and significantly correlated, the ADS demonstrated a lower relation to the readiness for help scale of the AUI and the readiness to change measure from the University of Rhode Island Change Assessment scale. ADS scores were negatively related to the level of confidence the individual had about being able to abstain in high-risk situations but positively related to the level of temptation to drink in these situations. The relation between the ADS and temptation was considerably stronger than with confidence.

In examining the patterns of relations with the validity measures, the ADS-12 reveals similar values as the total ADS, whereas ADS-9 correlations are noticeably smaller, which would be expected, because the ADS-12 consists of mostly dependence-related items and the ADS-9 contains more excessive drinking items.

The total ADS provided good discrimination (Table 4) between participants with and without physiological dependence, levels of severity of dependence (mild, moderate, severe), and severity typology (Type A/low risk and severity vs

Type B/high risk and severity). Again, the ADS-12 revealed differences and effect sizes among these measures similar to the total ADS. For the COMBINE Study, the LBC subscale and ADS-9 provided the lowest effect sizes for differences on physiological dependence, whereas with Project MATCH data, the LBC subscale and total ADS revealed the highest effect sizes on differences between Babor's severity Types A and B (Babor et al., 1992).

Discussion

This study provides strong support for a three-factor solution of the ADS defined as LBC, OCD, and PPW. Given the goodness of fit indices, the consistency of results found with the derivation and validation samples, and the comparability and replication of findings across the COMBINE Study and Project MATCH, it appears these three factors represent stable, relatively reliable dimensions of the ADS. Although participants in aftercare rated higher than those in outpatient care on these dimensions of dependency with the Project MATCH data, the results of the analyses in this study indicate a similarity of the underlying constructs being measured and comparable validity coefficients for these two groups.

Consistent with the original formulation of the alcohol dependence syndrome concept (Edwards, 1986; Edwards and Gross, 1976) and as embodied in the diagnostic criteria of the DSM-IV (First et al., 1995), these three factors appear to represent essential components of alcohol dependence. The ADS total and subscale scores are significantly related to other measures of severity of dependence, craving for and preoccupation with drinking, temptation to drink with confidence in one's ability or confidence about not drinking in high-risk relapse situations, heavy and sustained drinking patterns, a wide range of concerns about negative alcohol-related consequences, and awareness of a drinking problem. Differences on these scales were also found between Babor's severity types, with Type B (which previously has been characterized as having a positive family history of alcoholism, early onset of problem drinking, rapid progression of drinking problems, greater severity of alcohol symptoms, and poorer prognosis; Babor et al., 1992) having higher scores on the ADS and its subscales than Type A. This pattern is consistent with the core concepts and clinical manifestations of alcohol dependence syndrome, thus providing validation of the ADS as a measure of this construct. Despite this, while still positively correlated, the relations between the ADS and indicators of readiness to change drinking behavior or to seek help were considerably less than between severity of dependence and awareness and acknowledgment of a drinking problem.

Clearly the lengthier total score of the ADS has higher levels of internal consistency than either of the reduced ADS measures. Of the two brief measures, the ADS-12 has better internal consistency and, in general, consistently has higher correlations with the validation measures than the ADS-9. Thus it appears that both of these reduced-length scales could serve as adequate proxy measures for the alcohol dependence syndrome in those circumstances where the use of the lengthier ADS scale is precluded. However, as noted by Kahler et al. (2003b), the ADS-9 may be preferable in samples not drawn from clinical alcoholic populations.

The ADS has been used in research and clinical practice for quite some time, yet the psychometric properties of this instrument have been only minimally explored. The present study demonstrates that the scale does in fact assess the construct it is purported to measure in a reliable, valid fashion, both in its longer form and reduced-item versions.

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