Published in final edited form as:

Drug Alcohol Depend. 2009 December 1; 105(3): 177–184. doi:10.1016/j.drugalcdep.2009.06.025.

An IRT-based measure of alcohol trait severity and the role of traitedness in trait validity: A reanalysis of Project MATCH data

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Abstract

With the variability among alcohol users in mind, Project MATCH hypothesized several treatment matching relationships based on alcohol severity and alcohol dependence, but found limited effects. However, it is possible that the existing examinations of Project MATCH data did not fully characterize the nature of severity of alcohol dependence, as these analyses have examined dependence severity as an additive symptom count similar to the diagnostic strategy represented in the DSM-IV. We examined dependence severity as a latent trait hypothesized to have a characteristic developmental progression using Item Response Theory (IRT), and examined the implications of this approach to severity scaling in the Project MATCH data. The IRT-derived empirical continuum corresponded to an earlier theoretical model of the developmental course of alcoholism, demonstrated convergent and discriminant validity, and incremented other severity markers in predicting Alcoholics Anonymous involvement, social functioning, and readiness of change. However, it did not predict treatment outcomes or other validating variables more effectively than the measures used in the original design. Furthermore, an empirical index of person fit to this continuum did not moderate trait-validator relations including treatment outcome and treatment matching effects. Overall, findings did not support the incremental utility of a latent trait representation of alcohol severity.

Keywords

Assessment; alcohol dependence; nosology; item response theory

1. Introduction

Although most alcohol researchers agree that alcohol users represent a heterogeneous group (Babor et al., 1992; Chang & Martin, 2001; Morey, Skinner, & Blashfield, 1984), there have been a wide variety of strategies proposed to represent this heterogeneity. One important source of heterogeneity in samples of individuals with alcohol-related problems involves the severity of these problems. While research attempting to match alcoholics to treatments on the basis of various typological characteristics has met limited success (Kadden et al., 2001; Ouimette,

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Finney, & Moos, 1997; Project MATCH Research Group 1997a, b), it is possible that hypothesized effects have been obscured because a critical factor underlying client heterogeneity—the severity of alcohol dependence—has not been adequately conceptualized and measured.

Such a severity continuum, which often correlates with important variables in alcohol research such as alcohol treatment outcome (McKay & Weiss, 2001; Walton et al., 2003), can be conceptualized in various ways. The DSM-IV (APA, 1994) classifies two types of alcohol-use disorders, abuse and dependence. Abuse requires fewer symptoms to diagnose than dependence and is excluded for individuals who meet the criteria for dependence. Thus, an important difference between the two diagnoses involves the number of problems, as opposed to the types of problems manifested. Although some of the criteria for alcohol dependence include physiological markers of alcohol effects (e.g., tolerance, withdrawal), it is not necessary for these markers to occur to meet the diagnostic criteria. Factor analytic research does indicate that features of withdrawal have high symptom loadings on the dependence factor (Langenbucher et al., 2000). Also, requiring withdrawal symptoms for the diagnosis of alcohol dependence increases the reliability of the diagnosis, results in higher predictive validity, and is more consistent with theoretical models of the relationship between abuse and dependence (Langenbucher, et al.). It is thus possible that the current distinction between abuse and dependence confounds problems associated with using alcohol (e.g., impulsive behaviors) with more core problems related to the developmental course of alcohol (i.e. alcoholism).

Other models have sought to understand the nature of alcohol problems toward a more theoretically driven concept of severity. For Edwards (Edwards & Gross, 1976; Edwards, 1986), the *alcohol dependence syndrome* consists of core, dependence-related behaviors such as loss of control over drinking and compulsions to drink. Greater severity is understood as having symptoms from more classes of the syndrome. However, not all symptoms are equivalent, in that specific symptoms may reliably relate to levels of dependence, whereas others may indicate what Edwards described as “alcohol related disabilities” that reflect important impairments but are limited as markers of dependence. Skinner (e.g., Skinner & Allen, 1982) formalized measurement of the core dependence syndrome by creating the Alcohol Dependence Scale (ADS), a subset of items of the Alcohol Use Inventory (AUI: Horn et al., 1974; Wanberg, Horn, & Foster, 1977) that reflected the primary factor underlying the AUI scales. Early research (Skinner & Allen, 1982; Morey et al., 1984) found that the ADS correlated with greater social consequences of drinking, greater psychopathology and health problems, and an increased likelihood of treatment noncompliance. However, as it is typically used in such research, the total ADS score still represents dependence severity as an additive model of consequences, as this score is simply the number of items endorsed by the participant. Although perhaps better articulated than the DSM-IV approach, the ADS also essentially implies that individuals with the most severe alcohol problems are those with the largest number of consequences.

Recent research by Kahler et al. (2003) and Krueger et al. (2004) using Item Response Theory (IRT; Lord, 1980) has provided an important alternative method to represent alcohol severity. IRT offers a number of improvements upon the additive approach embodied in scales such as the ADS or DSM-IV syndromes, particularly in that these methods allow a better delineation of the properties of various markers of a latent trait at different levels of that trait. Kahler et al. found that whereas some ADS items appeared to have limited ability to make reliable discriminations at different levels of alcohol dependence, a subset of 12 items provided solid coverage across this continuum. These authors noted that the establishment of these level estimates not only informs the refinement of the scale, but also may offer information about the potential developmental progression of symptoms in the alcohol dependence syndrome. They noted that Langenbucher and Chung’s (1995) survival analyses of age of onset of the

DSM criteria implied a similar progression. Krueger et al. found that interview data could be used to model a comparable continuum. Their model comprised 110 items, and thus provided a potentially more comprehensive set of developmental stages.

Such findings suggest that certain alcoholism symptoms reliably occur in a developmental sequence, which may reflect a potential key to understanding the nature of severity. One advantage of this method is that it considers both the nature and frequency of alcohol problems and thus has the potential to make the measurement of severity more reliable and perhaps more conceptually meaningful. Also, this approach provides the potential to separate those individuals later in an alcoholism progression from those who are simply having many problems, which may result in more homogeneous severity-based partitioning of individuals with alcohol problems.

Perhaps the best known developmental model for alcohol dependence was proposed by Jellinek (1946, 1962), who was the first to present a clearly articulated and empirically-based representation of the developmental course of alcoholism. He analyzed survey data obtained from a sample of individuals formerly or currently enrolled in Alcoholics Anonymous (AA) and proposed a normative course involving a sequence of developmental events that he partitioned into four distinct phases. The first, *pre-alcoholic*, phase of alcoholism was indicated by socially-motivated drinking. In this stage there is no qualitative difference between developing alcoholics and non-alcoholics, although in the former the relationship between alcohol and stress-relief begins developing. Covering-up behaviors and blackouts begin occurring in the *prodromal* stage of alcoholism, during which the difference between the alcoholic and the casual drinker becomes more prominent. Jellinek noted that, because of emerging guilt feelings and the developing fear of alcohol's potential harmful effects, this is an optimal time for intervention. The third, *crucial* stage of alcoholism is characterized by a decrease in self-esteem, the loss of social footing, and the emergence of a physical need for alcohol. Jellinek thought that loss of control was the primary marker of the onset of the crucial phase. During the *chronic* phase, marked by the occurrence of 'benders,' or prolonged intoxications, profound physical and moral difficulties precede the failure of the rationalization system and increasing interpersonal, vocational, and perhaps legal troubles. Severe alcohol-related problems, such as psychosis, cognitive deficits, and tremors most often occur during this stage.

Research has generally supported the validity of an alcoholic course (Nelson, Heath & Kessler, 1998; Schuckit et al., 1995; Yeager, Piazza & Yates, 1992), with some modifications to Jellinek's original proposal. For example, loss of control in drinking appears to occur earlier in the course than Jellinek had proposed (Yeager, et al., 1992). Importantly, as noted by Kahler et al. (2003), IRT holds potential for reliably measuring the developmental course of alcoholism in that IRT-derived measures could enhance both the utility of classifying alcoholics in terms of severity and the ability to distinguish individuals with dependence features from non-alcoholics experiencing multiple alcohol-related problems.

IRT can also represent the empirical fit, or *traitedness*, of individual item response patterns to the theoretical assumptions of psychological dimensions. Broadly speaking, *traitedness* is a way to quantify the degree to which specific traits are consequential in affecting an individual's behaviors, thoughts, and affects (Sheppard, 1999). Reise and Waller (1993), working toward a more specific operationalization of this concept, stated that *traitedness* refers to "the degree to which a person's behavior is consistent with a dimensional trait construct." These investigators explored *traitedness* as a variable to evaluate the degree to which an individual's pattern of responses is not congruent with theoretically anticipated response patterns on a particular dimension.

Traitedness is typically examined in personality research as a potential moderator of critical trait-behavior relationships (Tellegen, Kamp, & Watson, 1982) under the assumption that such relationships will only be strong for individuals who truly appear to manifest the trait. For example, in the context of alcoholism research, the extent to which traitleteness on a core dependence indicator moderates the relationship between dependence severity and important variables such as treatment outcome and differential treatment response can be examined. Excluding alcohol users who have exhibited some severe alcohol-related behaviors, yet have not followed the normative developmental course, may eliminate ‘noise’ from alcohol diagnostic data and increase power to find matching effects. Such noise might occur by the inclusion of individuals who have a lot of problems consequent to alcohol use (e.g., occupational, social, and legal problems) even though they do not manifest the more severe symptoms of alcoholism (e.g., withdrawals). Thus, IRT is well equipped to operationalize Jellinek’s idea that severity can be reliably defined by one’s position on a developmental course, and it also provides empirical strategies to assess an individual’s fit to the identified course (i.e., the extent to which a person can be reliably described as somewhere in the course of alcoholism).

Although IRT has been recently used with some success in measuring alcohol dependence (e.g., Kahler et al., 2003; Krueger et al. 2004), such research is very preliminary. Research thus far has been limited in its theoretical linkage to a developmental course, with few tests of direct or moderating influences upon treatment outcome, and the impact of traitleteness on severity assessment has not been tested. We used IRT to model an alcohol continuum and to compute both severity and traitleteness coefficients for each participant in data from Project MATCH, an extensive alcohol-related dataset that includes treatment data from three interventions. We hypothesized that measuring both *severity of alcoholism* and *traitleteness of alcoholism* using an IRT approach would enhance the measurement of alcohol severity and perhaps uncover treatment matching effects, both in Project MATCH and in subsequent investigations.

More specifically, we tested the following three hypotheses. First, we predicted that an alcohol dependence continuum could be derived from measures of alcohol use by applying IRT methods to markers selected to be consistent with Jellinek’s developmental theory. Second, we hypothesized that this continuum would increment the validity of additive measures of alcohol use in predicting clinically-relevant criteria. Third, we hypothesized that traitleteness on this continuum would moderate its validity in predicting external criteria including treatment response, meaning that severity would prove to be a more powerful predictor of outcome in a group of individuals with alcohol problems when they demonstrate a pattern of alcohol involvement that is consistent with a developmental progression of increasing alcohol dependence.

2. Method

2.1 Procedures

Details regarding specific procedures in Project MATCH are described in primary sources (Project MATCH Research Group, 1997a).

2.2 Participants

The Project MATCH sample included a total of 1,726 patients divided into two groups: the Aftercare ($n = 774$) and Outpatient ($n = 952$) arms (Project MATCH Research Group, 1997). The majority of subjects were male (72% in the outpatient arm and 80% in the aftercare arm). In the outpatient sample, the mean age was 38.9 ($SD = 10.7$), and 80% were White, 6% were African American, and 12% were Hispanic. In the aftercare sample, the mean age was 41.9 ($SD = 11.1$), 80% were White, 15% African American, and 3% Hispanic. Many had been

treated for alcohol problems prior to treatment (62% of outpatients and 45% of aftercare participants) and were unemployed at the beginning of the study (48% of outpatients and 51% of aftercare participants). Subjects in the outpatient arm were selected from outpatient centers in the community. Subjects in the aftercare arm were treated immediately following intensive inpatient or day-hospitalizations. Subjects were selected in this way to accommodate the ongoing practice of clinical research units to specialize in either outpatient or aftercare patients, and to increase the generalizability of findings to anyone with alcohol-related problems. Participants did not differ on treatment assignment, assessment, matching hypotheses, or analytical strategies as a function of which arm they were in. All study participants met the following inclusion criteria: 1) met DSM-III-R criteria for alcohol dependence or abuse, 2) listed alcohol as their principal drug of abuse, 3) were at least 18 years old 4) had been drinking for the three months prior to their participation, 5) had a 6th grade reading level or better, and 6) were free of probation or parole requirements that would interfere with participation. Exclusion criteria for Project MATCH included the following (Project MATCH Research Group, 1993): 1) meeting DSM-III-R criteria for dependence on sedative/hypnotics, stimulants, cocaine, or opiates or if they had taken any of these substances intravenously in the last 6 months, 2) current danger to self or others, 3) lack of prospects for residential stability, or inability to verify a place of residence or a person who could help locate them, 4) symptoms of acute psychosis or severe organic impairment, and 5) plans involving an alcohol-treatment program independent of those offered by Project MATCH.

For the current study, analyses were collapsed across arms of Project MATCH, and only participants with no missing data were retained for analyses, resulting in a total N of 1535 (1160 men). The majority of the sample were White (N = 1269), with fewer participants being Black (138), Hispanic (104) or other ethnicities. The average age in the sample at baseline was 40.24 (S.D. = 10.99). Subjects were randomly assigned to one of three treatment conditions: *Twelve Step Facilitation* therapy (TSF; Nowinski, Baker & Carrol, 1992), *Cognitive Behavioral Therapy* (CBT; Kadden et al., 1992), or *Motivational Enhancement Therapy* (MET; Miller et al., 1992).

2.3 Measures

A comprehensive review of all of the assessment procedures in Project MATCH can be found in the paper outlining the rationale and methods of the study (Project MATCH Research Group, 1993) and in subsequent papers (Project MATCH Research Group, 1997a, 1997b). In general, measures of matching and outcome variables were selected based on several desirable characteristics, including wide use, theoretical ties to study hypotheses, and acceptable psychometric characteristics (Connors et al., 1994). Instruments used in the current project are listed below.

Indicators of Alcohol Continuum—The following measures provide items that were evaluated as indicators of the putative alcohol dependence continuum:

2.3.1 Drinker Inventory of Consequences (DrlnC; Miller, Tonigan, & Longabaugh, 1995)—A self-report inventory developed specifically for Project MATCH, consisting of 50 dichotomously scored questions related to various consequences of alcohol use. It was used in Project MATCH to measure alcohol-related consequences, psychosocial functioning and the physical effects of drinking, and to classify participants by type.

2.3.2 Alcohol Use Inventory (AUI; Wanberg, Horn, & Foster, 1977)—A self-report inventory consisting of 228 items of varying item length designed to assess several aspects of alcohol use. The AUI was used by Project MATCH to quantify alcohol use severity.

2.3.3 Structured Interview for DSM-III-R (SCID; Spitzer & Williams, 1985)—A widely used structured interview developed to assess psychiatric symptoms in concordance with the DSM-III-R. This interview was used by Project MATCH to diagnose alcohol and drug use disorders and to screen for psychosis.

2.4 Validating Variables

Nineteen variables were used to evaluate the concurrent validity and additional correlates of the estimated trait level. These variables were selected for their theoretical relationships to alcoholism severity and corresponded to the primary (Project MATCH Research Group, 1997a) and secondary (Project MATCH Research Group, 1997b) matching variables used in Project MATCH.

Three validating variables represent measures of alcohol severity. These include *Alcohol Involvement* (as measured by an additive AUI scale), *Alcohol Dependence*, and an *Alcohol Typology* differentiating individuals who were thought to be vulnerable and severe from those who were not. Notably, alcohol involvement and the typology use items from the AUI and DrInC, respectively, which were used to mark severity in this study. As such, validity comparisons involving the IRT-based measure and these additive indicators represent tests of the hypotheses that organizing information from these instruments in a theoretically-driven manner increases their utility.

The remaining 16 variables include *Cognitive Impairment*, *Conceptual Level*, *Meaning-Seeking*, *Motivation for Change*, *Psychiatric Severity*, *Sociopathy*, *Social Support for Drinking*, *Anger*, *Antisocial Personality*, *Interpersonal Dependency*, *Psychopathology*, *Alcoholics Anonymous (AA) Involvement*, *Religiosity*, *Confidence in Abstinence*, *Temptation – Confidence in Abstinence*, *Social Functioning*, and *Readiness to Change*. Instruments used to measure these variables were reported in original studies by the Project MATCH Research group (1997a, b). We altered the scoring of the social functioning variable because Project MATCH analyses included DrInC items that are used for the severity marker in this study. Thus, the *Psychosocial Functioning Inventory* (Feragne et al., 1983) score was used for this variable.

2.5 Analyses

The analyses conducted in this study occurred in four stages: 1) establishment of an IRT-based dependence severity continuum and examination of its psychometric characteristics and relations to demographic variables, 2) examining the concurrent and incremental validity of that continuum, 3) scaling Project MATCH participants with regard to their placement (i.e., severity level) and fit (i.e., traitedness) to the empirically-developed severity continuum and 4) examining correlates of traitedness and the severity x traitedness interaction, including treatment response and differential outcome across treatments.

2.5.1 Alcohol Trait Severity—IRT is a set of mathematical procedures for estimating the item parameters as well as the placement of individuals along some latent trait. A key concept in IRT is that item parameters define an item characteristic curve (ICC), a function that relates the latent trait score to probability of a positive score on that indicator. In its simplest form, the Rasch model, the ICC function is estimated by one parameter for each indicator: a measure of where on the latent trait the item provides maximal discrimination (sometimes referred to as threshold, severity, or “difficulty” on ability measures).

In the proposed project, an IRT-derived Rasch model was used to scale items from several instruments (as discussed above) with respect to their ability to discriminate individuals at varying levels of alcoholic severity. These indicators were initially selected for their content: items from selected instruments that instantiated Jellinek’s 43 developmental markers of

alcoholism represented the initial pool for consideration. This initial set of indicators was subsequently purified in an effort to construct a preliminary scale providing a unidimensional set of indicators. The papers by Kahler et al. (2002) and Krueger et al. (2004) provide useful illustrations of the application of similar procedures to alcohol data, although these authors did not have the opportunity to test their continua against an extensive set of external markers, including treatment outcome, which is afforded by the Project MATCH data.

2.5.2 Concurrent and Incremental Validity of Alcohol Trait Severity—The concurrent validity of alcohol trait severity was tested in three steps. First, correlations between the IRT-derived continuum score and other indicators of alcohol severity from Project MATCH were computed, providing an initial estimate of concurrent validity with alternative markers of the severity construct. Second, correlations with other variables that have established relations with alcohol severity were computed, and compared with analogous correlations with other alcohol severity variables used in the study. Finally, the incremental validity of alcohol trait severity was tested by computing partial correlations between it and the external variables, controlling for the effects of other severity markers. This final set of analyses tested the ability of the empirically-derived continuum to provide more information than commonly used alternatives.

2.5.3 Traitedness—Once appropriate items were fit to a Rasch model and item parameters were estimated, specific estimates of dependence trait level and traitedness could be computed for each participant in the project. Assessment of traitedness to these models was derived from the INFIT statistic (Linacre, 2005). Once traitedness was estimated for study individuals, the relation of this variable to other study variables was examined.

2.5.4 Severity x Traitedness Interactions—It was hypothesized that traitedness would moderate the relationship of alcohol trait severity to concurrent validators, such that the relationship would be stronger for those individuals who fit the empirical model (and thus, the developmental sequence). The design of these analyses used a variant of moderated regression that has proved to be useful when the influence of traitedness upon a latent trait has been investigated (e.g., Tellegen et al., 1982). Moderated multiple regression, examining traitedness as a continuous moderator, does not force a dichotomy onto a concept that is largely thought to be dimensional in nature, and any potential loss of power is eliminated with the use of the entire sample. Additionally, any linear relationship between alcohol trait severity level and traitedness is controlled statistically within the regression model.

The multiple-step strategy for hierarchical regression analysis suggested by Tellegen et al. (1982) involves an initial entry of standardized trait level and standardized traitedness as main effects upon the pertinent dependent variable. At the next level of the hierarchical analysis, the two-way interaction between these terms is entered. It was hypothesized that significant interactions would be observed indicating that the continuum is more valid for those individuals who fit a normative model of alcohol dependence severity than those who do not fit the model. These regressions were conducted for all of the concurrent validating variables described above, as well as for treatment outcome (defined as % days abstinent and drinks per drinking day) as assessed following treatment and at one-year post-treatment follow-up.

3. Results

3.1 Alcohol Trait Severity

The first step of analyses was to select items from the Project MATCH dataset that corresponded to each stage of Jellinek's model of the developmental course of alcoholism. Table 1 describes the items used in the continuum, as well as the instrument from which they

were drawn and the corresponding stage in Jellinek's model. One additional developmental marker (visual distortions) was chosen because it corresponded to an item in the Krueger et al. (2004) study, and was thus judged to be important for an alcohol severity continuum, even though it was not in Jellinek's model. Satisfactory items could not be identified for three of Jellinek's developmental stages: increased frequency of blackouts, changed drinking patterns, and jealousy. Twenty-four DrInC items, 1 SCID item, and 12 AUI items were selected based on content analyses to represent stages from Jellinek's model. Of the 12 AUI items, 8 were polytomous, and these items were dichotomized according to the description of the corresponding stages by Jellinek by two independent raters for the purposes of IRT modeling. Raters independently agreed on 7 out of 8 of these ratings, with the discrepancy resolved by re-consulting Jellinek's description. Independent raters agreed on the dichotomization point for the SCID item.

Selected items were next fit to a Rasch model. This model was chosen rather than more complex, multi-parameter IRT models for consistency with Jellinek's theory, which focused on developmental sequence and not the relative discriminability of each stage. However, to ensure a linear dimension, items that did not fit the model were excluded based on the OUTFIT statistic (Linacre, 2005). The severity parameters for the Rasch model are given for each item in Table 1, with higher values signifying items indicative of more severe problems. The correspondence between empirical and theoretical representations of the severity of the various indicators was assessed by computing the rank-order correlation between the order hypothesized by Jellinek and the observed empirical ordering of items. This coefficient ($\rho = .39$) suggested moderate correspondence.

The relation of the IRT-derived severity score with demographic variables is depicted in Table 2. The severity score was higher among men than women, as was also the case with alcohol dependence but not involvement. The score was negatively related to age, suggesting that younger patients tended to obtain higher alcohol severity scores than older patients. Both alcohol dependence and involvement were also negatively related to age. Conversely, traitedness, or the extent to which people fit the expected pattern of responses, was positively correlated with age, suggesting that older patients were more likely to have an alcohol use trajectory that fits the developmental course of alcohol as defined by the empirically derived model. With regard to ethnicity, White participants had a higher score than Hispanic participants and were less traited than either Hispanic or Black participants. There were no ethnic differences on alcohol dependence or involvement scores.

3.2 Convergent, Concurrent and Incremental Validity of Alcohol Trait Severity

The next step involved testing the validity of the empirically-developed severity continuum. To examine the convergent validity of this continuum, it was correlated with other alcohol severity markers in the Project MATCH dataset. As shown in Table 3, the empirical continuum correlated strongly with these indicators.

To test the concurrent validity of alcohol trait severity, it was correlated with multiple measures used as matching variables in Project MATCH. Overall, the pattern of validity coefficients was very similar to that observed for other severity markers. In particular, alcohol trait severity as conceptualized using IRT did not generally appear to correlate more strongly than alcohol involvement. To test the incremental validity over the markers used in Project MATCH, partial correlations were computed between the alcohol trait severity score and concurrent variables after controlling for each of the severity markers used in Project MATCH (Table 3). Overall, these effects were limited; only 6 out of 51 (12%) incremental correlations were $> .30$, suggesting that the IRT-based score generally provides limited incremental information above and beyond additive scores derived from classical test theory methods for alcohol severity. To the extent that an IRT-based measure of alcohol severity did increment other measures, it did

so with respect to AA involvement (average incremental $r = .34$), social functioning ($-.27$), and readiness for change (.34).

3.3 Traitedness

Traitedness coefficients were computed for each participant with regard to the fit of their patterns of alcohol problems to the empirically-derived alcohol trait severity continuum. Thus, high scores on traitedness indicate a pattern consistent with the characteristic progression, whereas low scores indicate a pattern inconsistent with the progression (for example, a person who has used technical products such as rubbing alcohol to achieve intoxication—the highest severity item—who had never experienced remorse about drinking, the lowest severity item). This traitedness statistic was unrelated to trait severity ($r = .00$), alcohol dependence ($r = .03$), and the alcohol typology ($r = .02$), but was modestly related to alcohol involvement ($r = .12$).

Trait severity, traitedness, and their interaction were entered into a series of hierarchical regression analyses to assess their relations to external variables. These analyses suggested that, as anticipated and as shown in Table 4, the trait severity score relates to most of the concurrent validating variables. Traitedness as a main effect showed few relations, with the exceptions of small effects in predicting cognitive impairment and AA involvement. The interaction failed to increment the main effects across any of the dependent variables, disconfirming the hypothesis that person-fit to the empirically derived continuum would help isolate individuals for whom that continuum would be most salient.

Furthermore, none of the relations between trait level, traitedness, and their interaction with % of drinking days and drinks per drinking day at outcome, either post-therapy or at one-year follow up were significant, suggesting that alcohol severity does not relate to drinking outcomes, regardless of the degree to which participants fit this continuum. There were also no relations between trait level, traitedness, and their interaction on outcomes within each of the treatment modalities, or in the prediction of change in drinking patterns (controlling for baseline values) within or across treatment groups. Consistent with these results, alcohol severity markers used in the original study (i.e., alcohol involvement and severity) were also largely unrelated to drinking outcomes (Project MATCH Research Group, 1997a). In addition, although some evidence suggested a severity by treatment arm interaction in predicting treatment effects in the original study, such an interaction was not present using the empirically-derived continuum in the current study.

4.0 Discussion

The purpose of this study was to test the viability of an IRT-derived developmental continuum to describe the severity of alcohol problems in individuals participating in a large treatment matching study (Project MATCH), and to investigate the moderating role of empirical fit to this continuum in the prediction of external validators including treatment outcome. Overall, results were consistent with the first study hypothesis in suggesting that such a continuum could be derived using information from three measures of alcohol use and related problems. Furthermore, there was moderate correspondence between the ordering of severity markers on this continuum and those suggested by Jellinek's (1946, 1962) in his classic description of the developmental course of alcoholism.

This severity continuum also demonstrated an expected pattern of convergent and discriminant validity with a host of concurrent variables, although, as with similar representations of alcohol use severity used previously in Project MATCH, it was limited in its ability to predict treatment outcome either as a main effect or in its interaction with treatment condition. Furthermore, it had limited ability to increment explained variance in validating variables once alcohol dependence and involvement scores were controlled. Three exceptions are worth noting:

alcohol trait severity incremented additive markers in relation to AA involvement, social functioning and readiness for change. As these variables are potentially important for treatment-related decisions, this may suggest some promise for the IRT-derived continuum to augment more simple additive indications of alcohol severity in treatment planning, a possibility that merits additional research.

The moderate correspondence of the empirical continuum with Jellinek's model in terms of the sequence of developmental indicators does suggest some continuity over time and across measurement and modeling methods, and is furthermore consistent with Jellinek's notion that alcohol problems tend to occur in a developmental sequence. Specification of the kinds of problems experienced by drinkers may thus be important in predicting problems that will likely occur in the near future. For example, the current data suggest that self-doubting cognitions (e.g., remorse, inability to rationalize drinking habits, and guilt) may be harbingers of a worsening progression, whereas severe psychiatric symptoms (e.g., psychosis, sensory deficits, and fearfulness) are more likely to signal profound alcoholism. The articulation of this sequence across several research groups also provides a potential basis for computer adaptive testing of alcohol symptoms, which has the potential to economize the assessment of the various indicators of alcohol use disorder.

Traitedness, or the extent to which people fit the expected pattern of responses on an alcohol trait severity continuum, did not serve to identify (as was hypothesized) individuals for whom the trait might be more predictive of behavior. In particular, traitedness did not serve as a significant moderator variable in understanding external criteria including treatment response. It was anticipated that alcohol problems that appear to be occurring in a predictable sequence would be more consistently related to outcome than problems occurring out of sequence, with the latter perhaps related to situational rather than developmental factors. This null finding indicates that the manifestation of multiple problems tends to predict other life difficulties, regardless of whether they are observed in the specified ordering. It should be noted that previous research on the concept of traitedness as a moderator of the validity of psychological scales tends to yield mixed findings. Although some studies have demonstrated this effect (e.g., Baumeister & Tice, 1988; Britt, 1993; Robinson, Goetz, Wilkowski, & Hoffman, 2006), several others have reported small and inconsistent findings with regard to the moderation of trait-behavior relations by traitedness (Dwight, Wolf, & Golden, 2002; Hopwood & Morey, 2007; Paunonen & Jackson, 1985; Tracey, 2003; Warner, 2007). Some authors have suggested that mixed results may be due to varying methods for assessing traitedness and suggested sophisticated alternatives (e.g., Reise & Waller, 1993; Tellegen, 1988). However, research exploring both traditional and more complex methods for computing traitedness has continued to uncover modest and inconsistent findings with regard to the moderation of trait-based behavioral predictions (Cucina & Vasilopoulos, 2005).

Perhaps future examinations of alternative approaches to the meaning of traitedness may clarify the current results. The strongest correlate of traitedness on the alcohol dependence continuum among examined variables was cognitive dysfunction. Traitedness was also modestly related to alcohol involvement, even with the alcohol dependence continuum trait score controlled. This pattern might suggest that individuals who reach the highest levels of alcohol involvement (hence perhaps leading to cognitive impairment) are those who manifest a particular characteristic progression of alcohol-related symptoms. Although empirical adherence to this progression did not appear to influence or moderate treatment outcome in Project MATCH, future research--perhaps using samples with wide variability in current placement on a putative developmental progression of alcohol dependence--is clearly needed to further understand this potentially important concept.

It is important to recognize several limitations to this study that could have affected results and potential clinical inferences. First, results were limited by study characteristics such as available assessment instruments, types of treatment, and demographic homogeneity. It should also be noted that the items used to develop the alcohol continuum used here, while generally mapping well onto Jellinek's theory, were not generated for this purpose and may not correspond directly to each of his developmental stages. Finally, the representation of "severity" in this model is an abstract representation of a location on an alcohol dependence continuum that will not necessarily map onto some aspects of clinical severity that impact important treatment decisions. For example, such factors may be central in determining need for hospitalization but not be directly related to a core alcohol dependence continuum, such as health risks associated with comorbid medical conditions, or acute suicidal ideation. Although we believe that greater severity scores would generally translate to greater clinical concern, future research should further test the implications of IRT alcoholism severity indicators for clinical work with alcoholic patients.

In summary, the current results converge with other recent efforts in depicting a developmental course of alcoholism progression with potentially important clinical implications. However, further analysis suggested that severity scores from this latent trait did not generally increment additive scores from other measures of alcoholic severity. Furthermore, the trait was comparably predictive regardless of the degree to which participants were traisted. Overall, results suggest the need for further research on the potential for IRT to depict alcohol severity as a latent trait.

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Table 1

Empirically developed continuum of alcoholism development: Severity parameters of theory-derived symptoms.

Jellinek Stage	Empirical Stage	Severity	Item
15	Persistent Remorse	16.90	DRINC 2
12	Social Pressure to Quit	21.21	DRINC 4
45	Failure of Rationalization System	22.63	AUI 112 (1,2,3,4)
7	Guilt about Drinking	23.07	DRINC 16
10	Loss of Control	31.43	DRINC 67
25	Change in Family Habits	33.27	DRINC 30
14	Aggression	34.53	DRINC 21
20	Alcohol-Centered Behavior	35.65	DRINC 61
3	Blackouts	37.97	AUI 29 (1:2,3,4)
28	Nutritional Neglect	39.29	DRINC 13
21	Loss of Outside Interests	40.91	DRINC 34
33	Benders	42.43	AUI 84 (1:2,3,4)
34	Ethical Deterioration	43.55	DRINC 20
2	Increase in Tolerance	43.86	DRINC 59
23	Self-Pity	44.16	AUI 111
22	Reinterpretation of Relationships	44.80	DRINC 39
6	Vigorous Drinking	47.20	AUI 105
39	Loss of Tolerance	49.48	SCID 7 (1,2,3)
42	Psychomotor Inhibition	50.58	DRINC 54
41	Tremors	50.87	DRINC 56
30	Decreased Sex Drive	50.87	DRINC 33
4	Concealed Drinking	54.88	AUI 26
32	Morning Drinking	55.26	DRINC 65
37	Drinking with 'Dregs of Society'	55.94	AUI 171
35	Impaired Thinking	56.17	DRINC 53
26	Unreasonable Resentment	58.13	AUI 176
5	Preoccupation with Alcohol	58.23	AUI 57 (4,3,2,1)
18	Drop Friends	59.42	DRINC 46
43	Obsessive Drinking	60.54	DRINC 63
29	First Hospitalization	62.64	AUI 93 (1:2,3)
27	Protection of Alcohol Supply	62.64	AUI 83 (1:2,3,4)
40	Indefinable Fears	63.45	AUI 92
19	Quit Job	64.09	DRINC 44
24	Geographic Escape	73.78	AUI 125 (1:2,3)
N/A	Visual Distortions	79.96	AUI 31 (1:2,3)
36	Psychotic Symptoms	81.52	DRINC 57
38	Use of Technical Products	98.71	AUI 189
Items that did not fit the model			
1	Relief Drinking		DRINC 15
8	Avoidance of Reference to Alcohol		AUI 35
11	Rationalization of Use		DRINC 45
13	Grandiosity		DRINC 4
16	Periods of Total Abstinence		AUI 65
44	Vague Religious Desires		AUI 36
No satisfactory items in MATCH data			
9	Increased Frequency of Blackouts		
17	Changed Drinking Patterns/Rules		
31	Jealousy		

Table 2
Mean differences of the empirically-derived alcoholism severity score and traitedness across demographic groups and correlations with age

	N	Severity		Traitedness	
Gender					
Men	1160	.06	$F = 4.01$	.02	$F = 1.09$
Women	376	-.18	$p < .001$	-.05	<i>ns</i>
Ethnicity					
White	1269	.04	$F = 4.09$	-.05	$F = 7.77$
Black	138	-.10	$p < .01$	.32	$p < .001$
Hispanic	104	-.28		.23	
Other	25	-.17		-.04	
Age	1536	$r = -.07$	$p < .001$	$r = .10$	$p < .001$

Note. Values given in standardized units. Post-hoc testing (Tukey's HSD) indicate that White participants had a higher score than Hispanic participants ($p < .01$) and lower traitedness than both Black and Hispanic ($p < .01$) participants.

Table 3

Concurrent and incremental validity of the empirically-derived alcoholism continuum: Bivariate and partial correlations with validating criteria

	Empirical Continuum	Involvement	Dependence	Typology	Continuum Involvement	Continuum Dependence	Continuum Typology
Alcohol Involvement	.84						
Alcohol Dependence	.66	.69					
Alcohol Typology	.45	.45	.44				
Cognitive Impairment	.04	.09	.10	.09	-.05	-.03	.03
Conceptual Level	-.13	-.20	-.14	-.20	.07	-.03	-.04
Meaning Seeking	.46	.51	.39	.33	.06	.29	.36
Motivation for Change	.31	.28	.29	.11	.10	.15	.28
Psychiatric Severity	.21	.29	.19	.15	-.06	.12	.15
Sociopathy	.40	.43	.35	.43	.07	.24	.22
Social Support for Drinking	-.10	-.06	.00	.07	-.07	-.14	-.16
Anger	.30	.35	.25	.28	-.01	.17	.18
Antisocial Personality	.22	.26	.20	.42	.00	.11	.01
Interpersonal Dependency	-.08	-.10	-.14	-.09	-.01	.00	-.07
Psychopathology	.28	.35	.24	.20	-.02	.17	.22
AA Involvement	.45	.40	.29	.17	.23	.36	.42
Religiosity	.09	.08	.06	.00	.02	.06	.09
Confidence in Abstinence	-.13	-.15	-.09	-.02	.01	-.09	-.10
Temptation - Confidence	.26	.29	.21	.12	.03	.17	.21
Social Functioning	-.41	-.41	-.30	-.19	-.14	-.29	-.37
Readiness for Change	.50	.45	.43	.24	.24	.33	.44

Note. Because Alcohol Typology is a dichotomous variable, its relations to other variables are represented by point-biserial correlation coefficients. The last three columns represent partial correlations controlling for other indicators of alcohol severity as indicated in the column headings.

Table 4
Relation of the empirically-derived alcoholism severity score, traitedness and their interaction to concurrent validating variables

	Severity	Traitedness	R ²	Interaction	ΔR ²
Cognitive Impairment	.04 (.04)	.15 (.16)	.02	-.03	.00
Conceptual Level	-.13 (-.13)	-.05 (-.05)	.02	.01	.00
Meaning Seeking	.46 (.46)	.04 (.04)	.21	-.02	.00
Motivation	.31 (.31)	-.01 (-.00)	.09	-.03	.00
Psychiatric Severity	.21 (.21)	.00 (.01)	.04	-.02	.00
Sociopathy	.40 (.40)	.02 (.01)	.16	.02	.00
Social Support for Drinking	-.10 (-.10)	.00 (.00)	.01	.01	.00
Anger	.30 (.30)	.02 (.02)	.09	.00	.00
Antisocial Personality	.22 (.22)	.08 (.07)	.06	.06	.00
Interpersonal Dependency	-.08 (-.08)	-.03 (-.03)	.01	.02	.00
Psychopathology	.28 (.28)	.04 (.04)	.08	.01	.00
AA Involvement	.45 (.45)	.12 (.11)	.22	.05	.00
Religiosity	.09 (.08)	.08 (.07)	.01	.01	.00
Confidence in Abstinence	-.13 (-.13)	-.05 (-.05)	.02	.02	.00
Temptation - Confidence	.26 (.27)	.06 (.06)	.07	-.04	.00
Social Functioning	-.41 (-.41)	.05 (.04)	.17	.03	.00
Readiness for Change	.51 (.50)	-.06 (-.06)	.26	.02	.00

Note. Values represent Beta coefficients and R² values for each step in hierarchical regression. For Score and Traitedness, parenthetical coefficient reflects value in the model that includes the interaction term.