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Evaluation of the Alcohol Craving Questionnaire-Now factor structures: Application of a cue reactivity paradigm

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Abstract

The current study compared the psychometric properties and clinical/research utility of four distinct factor/subscale models of alcohol craving (three factor-derived models, and one rationally-derived model) as measured by the Alcohol Craving Questionnaire-Now in social (n = 52) and alcohol dependent (n = 71) drinkers. All participants completed a self-report measure of alcohol abuse in addition to engaging in a structured interview and cue reactivity protocol. Participants provided self-reported craving, as well as desire to approach or avoid drinking, during a cue exposure task using separate analogue scales. Factor/subscale models were compared in terms of internal consistency, convergent and divergent validity, and ability to predict cue-elicited approach and craving in addition to diagnostic status. All models demonstrated high levels of internal consistency, convergent and divergent validity, and the ability to predict both cue-elicited craving and alcohol dependence status. Specific strengths and weaknesses of each model are examined and the theoretical, clinical, and research utility of the current findings are discussed.

Keywords

Alcohol; Craving; Assessment; Substance use; Addiction

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1. Introduction

The theorized function of “craving”, both in the maintenance of alcohol dependence (e.g., Tiffany, 1990) and in relapse following successful alcohol dependence treatment (e.g., Bottlender and Soyka, 2004), is plentiful throughout the substance abuse literature. Despite consistent reference, craving definitions vary widely from study to study (e.g., Heinz et al., 2003; Modell et al., 1992; Tiffany, 1990). Broadly, craving definitions typically focus on subjective urges to perform (negatively or positively) reinforced instrumental and/or conditioned behaviors related to the use of addictive substances (e.g., alcohol).

Although craving is often assessed as a unitary construct, commonly measured with a single self-report visual analog scale (e.g., Coffey et al., 2006), recent evidence suggests that craving assumes multiple dimensions, which generally correspond to behavioral, cognitive and emotional factors (e.g., Addolorato et al., 2005; Anton, 1999). Accordingly, efficient assessment methods for clinical and research use (e.g., self-report measures) to measure the phenomenon of craving is important. Consideration of the multidimensional structure of craving will likely lead to increased specificity in both assessment and treatment focused on idiosyncratic presentations of alcohol dependence.

Commensurate with the multidimensional nature of craving, factor analytic studies have revealed a variety of specific dimensions (i.e., factors) of alcohol craving. An alcohol craving measure that has undergone considerable study using factor analytic methods is the Alcohol Craving Questionnaire (ACQ-Now; Singleton et al., 1994). The ACQ-Now is a 47-item self-report measure of alcohol craving that provides an overall score of craving as well as five rationally-derived (or deductively) subscales reflecting domains related to alcohol craving. These subscales are labeled (1) Urges and Desires to Use Alcohol, (2) Intent to Use Alcohol, (3) Anticipation of Positive Outcome, (4) Anticipation of Relief from Withdrawal or Negative Outcome, and (5) Lack of Control Over Use. Though the original ACQ-Now includes five subscales, the original factor analysis of the ACQ-Now (Singleton et al., 1995), utilizing data from 219 individuals who had consumed alcohol in the past month, indicated only four separate factors: (1) Compulsivity, (2) Expectancy, (3) Purposefulness, and (4) Emotionality.

Two additional studies have presented different factor models for the ACQ-Now. In one factor analysis (Love et al., 1998), based on a sample of 380 European recreational drinkers, the following three factors were identified: (1) Strong Desires and Intentions to Use Alcohol, (2) No Desire to Drink, and (3) Negative and Positive Reinforcement. Another factor analysis (Raabe et al., 2005), based on 243 Europeans with current diagnosis of alcohol abuse or dependence, extracted only two factors: (1) Urge to Drink/Loss of Control and (2) Reinforcement. Although factor analytic studies are helpful in understanding the dimensional nature of specified constructs, the results are often limited in generalizability to the sample studied (Tabachnick and Fidell, 2007). Thus, the current factor analytic models may indicate specific differences due to sample characteristics (e.g., substance abuse diagnoses) rather than globally relevant dimensional aspects of craving.

Each model provides potential unique contribution to the assessment of alcohol craving. The rationally-derived model offers 5 subscales which cover a variety of craving domains. The original Singleton et al., (1995) factor model offers 4 subscales that overlap in scale content with the rationally-derived model, however in a more concise package. In other words, the craving content assessed in the 5 subscale form (i.e., loss of control, anticipation of positive outcome, intent, and anticipation of relief) is adequately covered in the 4-factor subscale structure. The Love subscale model covers content similar to both Singleton et al models, but is more limited in scope. This model identifies desires and intentions, positive and negative reinforcement, but fails to identify alternative craving aspects such as relief of negative affect

and loss of control. Finally, the Raabe et al (2005) model provides a more limited scope of assessment with only two factor subscales. This model identifies urges and loss of control in addition to reinforcement; however it fails to identify intentions and relief from negative affect. The discrepant factor results call into question the validity of each model, and it remains unclear which model is most useful. Given the inconsistent findings reported in the literature, additional psychometric study of the ACQ-Now, specifically studies comparing the four different factor structures and the rationally-derived subscales, is warranted.

In addition to self-report measures of craving, an experimental paradigm, *cue reactivity*, has been developed, in part, to measure craving in laboratory settings (see Drummond et al., 1995). Cue reactivity paradigms assess cognitive (e.g., self-report), physiological (e.g., salivation), and/or behavioral (e.g., response time) responses elicited by, or associated with, stimuli (e.g., picture slide, object, mental image, etc.) with the hope of better understanding underlying psychological processes associated with a phenomenon (e.g., substance abuse, specific phobia, etc.). Cue-reactivity has been used as a marker of treatment outcome (e.g., Loeber et al., 2006) and relapse (e.g., Bottlender and Soyka, 2004, Rohsenow et al., 1994) for various treatments aimed at ameliorating alcohol dependence (e.g., Monterosso et al., 2001). The use of a self-report craving measure, validated through the use of the cue-reactivity paradigm, may constitute a methodological advancement in the measurement of craving.

However, craving is traditionally associated with the desire to approach alcohol but there is growing sentiment in the field that consideration of both approach and avoidance tendencies in regard to continued substance misuse is important (e.g., Breiner et al., 1999). Rather than simply focusing in the approach tendencies (e.g., desire to consume alcohol), Breiner et al. propose that individuals who misuse alcohol may experience tendencies to approach alcohol as well as tendencies to avoid alcohol. These co-occurring approach-avoidance tendencies result in ambivalence about whether to use alcohol; ambivalence that may negatively impact alcohol relapse. This view of ambivalence about alcohol use is central to the extensive literature on Motivational Interviewing (Miller and Rollnick, 2002), an intervention that directly addresses ambivalence about alcohol use. Accordingly, consideration of both the desire to approach and avoid alcohol will likely provide a more comprehensive assessment of state craving for alcohol.

Therefore, the current study was designed to evaluate the psychometric properties of the ACQ-Now by testing the measure's proposed factor structures (Singleton et al., 1995; Love et al., 1998; Raabe et al., 2005) and rationally constructed subscales (Singleton et al., 1994). Specifically, we sought to compare each model in terms of internal reliability, divergent validity, and convergent validity, including convergent validity of each model in relation to craving elicited by alcohol cues (i.e., cue reactivity). Additionally, we examined the ability of each factor set to differentiate alcohol dependent from non-dependent participants. Measures that more accurately assess the multidimensional nature of alcohol craving may better inform clinically relevant considerations such as treatment conceptualization and outcome evaluation.

2. Method

2.1 Participants

Participants consisted of 123 (67 female) adults. All participants reported use of alcohol ranging from social use to problematic use and 58% of the sample met criteria for alcohol dependence according to the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV; APA 1994). All participants were recruited in the context of a larger study (Coffey et al., 2002;Saladin et al., 2003). Alcohol dependent participants were recruited from local substance use treatment clinics and clinics within a large teaching hospital in Charleston, South Carolina while social drinkers were recruited from the community via newspaper advertisements.

Participants recruited from the community and included in the sample of social drinkers could not have a substance use diagnosis other than nicotine or caffeine dependence. Participants were excluded from the study if they met criteria for a psychotic disorder or were currently experiencing a manic episode. Due to exclusion criteria for the larger study, participants were also excluded from the study if they were receiving cognitive-behavioral or exposure-based treatment for PTSD. All participants gave informed consent prior to participation and were compensated for their participation.

2.2 Measures and Materials

2.2.1 Structured Clinical Interview for DSM-IV (SCID-IV)—Substance dependence and psychiatric status were assessed with the SCID-IV (First, Spitzer, Gibbon, and Williams, 1996). The SCID-IV is a widely used clinical interview that allows for the diagnosis of DSM-IV Axis I disorders and, along with previous versions (e.g., SCID-III-R), has shown high interrater reliability (Skre, Onstad, Torgersen, and Kringlen, 1991; Zanarini et al., 2000) and validity (Kidorf, Brooner, King, Stoller, and Wertz, 1998; Kranzler, Kadden, Babor, and Tennen, 1996, Peters et al., 2000).

2.2.2 Alcohol Craving Questionnaire (ACQ-Now)—As previously stated, the ACQ-Now, a 47-item self-report questionnaire was designed to measure self-report craving symptoms in the present moment. Respondents indicate the degree to which they agree with each statement along a 7-point Likert-type scale ranging from "*Strongly disagree*" to "*Strongly agree*." For the current study, total factor scores were computed for each factor within each model. To do this, reversed scored items were converted to regular scores and items for each factor were then added together.

2.2.3 Short Michigan Alcoholism Screening Test (SMAST)—The SMAST (Selzer, Vinokur, and van Rooijen, 1975) is a 13-item self-report measure used to screen for problematic alcohol use. The SMAST has good reliability across administrations and good validity when used to predict alcoholism status in a community sample and a clinical sample (Selzer et al., 1975). SMAST scores are computed by summing each alcoholism-indicating response, with scores from 0–1 indicating non-alcoholism, 2 indicating probable alcoholism and 3 or more indicating a strong likelihood of alcoholism.

2.2.4 Questionnaire Upon Mental Imagery—*(QUMI;* Sheehan, 1967*)* is a 35-item, self report questionnaire which examines general imagery ability by requiring participants to imagine a variety of images and then rate each image on vividness along a 7-point likert-type scale ranging from "*Perfectly clear*" to "*No image present at all.*" Previous studies report high levels of construct validity and test-retest reliability (Sheehan, 1967).

2.2.5 Cue Reactivity Stimuli—As part of a larger cue reactivity study, participants listened to a neutral imagery script and then were immediately exposed to an alcohol cue or a neutral cue. The imagery stimulus was a 50 s, audio-taped script describing a neutral scene. A trauma imagery script was also presented in the context of the laboratory session but will not be discussed in this report (see Coffey et al., 2002). Scripts were presented to the participants over headphones. The neutral script for each participant was selected based on the participant's self-reported rating of 5 neutral scripts used in prior substance use research (Coffey and Lombardo, 1998; Drobes and Tiffany, 1997). The alcohol cue consisted of each participants' preferred alcoholic beverage presented in a clear glass container directly under the participants' nose on an adjustable-height table in his or her typical manner of consumption. The bottle of the participants' preferred brand of alcohol also was presented with the label facing the participant. The neutral cue consisted of aromatic cedar wood chips presented in front of the participant.

2.2.6 Cue Reactivity Ratings—During the cue reactivity trials (described below), participants were asked to rate subjective feelings of craving, approach (desire to consume alcohol), and avoidance (desire to avoid consuming alcohol) on a visual analog scale (VAS). The approach and avoidance VAS ratings were included to more fully capture the construct of alcohol craving (Breiner et al., 1999). VAS ratings were presented on a 21-point scale with *"not at all"* and *"very much so"* as anchors. The VAS ratings were presented on a computer screen in front of the participants.

2.3 Procedure

All participants attended two sessions. The first session consisted of obtaining informed consent and completing a psychosocial assessment that included the SCID-IV and SMAST. Participants were asked to refrain from all drug and alcohol use for four days prior to the second session.

Cue reactivity was assessed in the second session. Participants who reported drug or alcohol use in the past four days or tested positive during a urine drug screen (UDS; Roche Diagnostic Systems, Inc., Somerville, NJ) or alcohol breathalyzer test (Alcosensor IV, Intoximeters, Inc., St. Louis, MO) were rescheduled. After the drug screening participants completed the ACQ-Now before beginning the cue reactivity assessment. For the cue reactivity assessment, participants were asked to sit in a comfortable chair located in an acoustically isolated subject room. Only experimental procedures relevant to the current study are described here (see Coffey et al., 2002; Saladin et al., 2003 for a full description). Participants first completed a practice script/cue trial which consisted of a neutral script and neutral cue presentation. Participants were instructed to close their eyes and imagine the scene that was played over the headphones. Each individual was informed that following the end of the script they should continue to imagine the scene as vividly as possible. In addition, participants were instructed to experience the emotions elicited by the script and to imagine the physical sensations described in the scene. Following the 50 s script presentation, participants continued to actively imagine the scene for an additional 30 s. At the end of the 30 s active imagery period, an experimenter entered the subject room and placed a neutral cue (i.e., a small tray of aromatic cedar wood chips) on the table in front of the participant and then exited the room. A tone signaled the participant to open his or her eyes and look at the cue while continuing to imagine the scene previously described. The participants observed the neutral cue for 2 min and then another tone signaled the participants to turn to a computer monitor where they completed self-report ratings, which included the alcohol-related VAS ratings described above. After this practice trial, participants were presented with four counterbalanced script/cue combination trials, one of them being a neutral script/alcohol cue trial. The neutral script/alcohol cue trial is the focus of the current report. All script/cue presentations followed the same experimental procedures used during the practice trial.

At the end of the second session, participants were debriefed and a final craving rating was obtained using the same VAS scale employed during the cue reactivity trials. This final craving rating was obtained to ensure participants were returned to baseline levels before being dismissed. If a participant's final craving rating was elevated, an experienced clinical psychologist assisted in reducing the craving to baseline.

2.4 Statistical Analyses

The specific aims of the current study were to evaluate the psychometric properties of three established factor models (Love et al., 1998; Raabe et al., 2005; Singleton et al., 1995) and the original rationally-derived subscale structure (Singleton et al., 1994) of the ACQ-Now. Accordingly, we report correlation analyses to examine convergent and divergent validity. Statistically significant single-order correlations were further examined by regressing factors

from the three factor models and subscales from the rationally-derived model on alcohol cue reactivity measures to further test the convergent validity of the four ACQ-Now models. Divergent validity was confirmed by correlating the factor/subscale data with the QUMI measure of mental imagery. We also report internal reliability estimates. Additionally, since alcohol dependence and alcohol craving are independent but related constructs, we sought to test the various models' ability to predict cue-elicited alcohol craving above an established self-report measure of alcohol dependence (i.e., SMAST). The final purpose of the current study was to assess the ability of the four ACQ-Now models to predict alcohol dependence group membership in terms of percent correctly identified. A direct psychometric comparison of the four ACQ-Now models in a sample of social and problem drinkers, using both traditional means and alcohol cue-elicited craving, will not only further establish the psychometric properties of the ACQ-Now, but also help establish which proposed factor/subscale model of craving may have greatest clinical utility.

3. Results

3.1 Participant Characteristics

The alcohol dependent group comprised of 45 men and 26 women, whereas the non-alcohol dependent group comprised of 11 men and 41 women. The between group sex composition was significantly different (χ^2 (1) = 21.58, $p < 0.001$). The alcohol dependent group (Mean age = 34.71, *SD* = 12.45) comprised of 73% white-not Hispanic with the remainder identifying as black-not Hispanic. The non-alcohol dependent group (Mean age = 36.89, *SD* = 8.75) comprised of 85% white-not Hispanic, 13% black-not Hispanic, and one individual self-identified as Hispanic. Groups did not significantly differ on age ($t(121) = 1.14$, *ns*) or racial composition (χ^2 (2) = 4.38, *ns*). Table 1 reports means and standard deviations for each dependent measure as a function of group membership. Additionally, omnibus test results examining differences between alcohol dependent and non-dependent individuals are presented along with effect size estimates.

3.2 Internal Reliability Analysis

Alpha coefficients and between group effect sizes (Table 1) were generated to evaluate the internal reliability of each proposed subscale or factor of the ACQ-Now. An alpha coefficient cutoff score of 0.70 was used, as indicated by Nunnaly (1978), as an acceptable level of reliability. Broadly, each subscale or factor displayed high levels of internal consistency with alpha coefficients ranging from 0.80–0.94. Internal reliability estimates across all models proved to be acceptable. Further, examination of Cohen's d effect sizes among each ACQ-now factor/subscale fell within the medium to large range indicating acceptable ability to differentiate between pathological and social drinkers. This interpretation is also supported by the findings presented in Table 5.

3.3 Correlation Analysis

To examine convergent and divergent validity of the factors or subscales, Pearson product-moment correlations were calculated (Table 2). Significant positive associations were found among all subscale factors and alcohol cued craving and approach ratings. Interestingly, these positive associations included Love et al.'s Factor 2 (No Desire to Drink). We predicted, based on the content of this factor, that this subscale would be negatively related to craving and approach responding. Supporting divergent validity were the non-significant associations among all factor/subscales compared to the QUMI. Furthermore, there were no ACQ-Now subscales or factors significantly associated with the VAS rating of avoidance. Therefore, follow-up regression equations examining ACQ-Now subscales' or factors' ability to predict cue-elicited avoidance were not performed.

3.4 Craving Self-report Factor/Subscale Ability to Predict Cue Elicited Craving and Cue Elicited Approach

Stepwise regression results examining craving self-report factor/subscale models prediction of cue elicited craving are presented in Table 3. Each model was statistically significant with one subscale/factor contributing unique predictive variance. Additionally, the SMAST contributed unique variance to each model with the exception of the rationally-derived subscale model. The rationally-derived subscale of the ACQ-Now (Lack of control) was found to be the lone predictor of cue-elicited alcohol craving. The inclusion of an alcohol dependence measure failed to add unique predictive ability to the equation. Regression results examining model prediction of cue elicited approach are presented in Table 4. Similar to the cue elicited craving results, each model was statistically significant with one subscale/factor contributing unique predictive variance. The SMAST made a unique contribution to each model. Together, these findings suggest that specific craving sub-domains are uniquely predictive of cue elicited craving and approach, along with a measure of dependency (i.e., SMAST), as opposed to a generalized collection of craving domains within each model.

3.5 Prediction of Alcohol Dependence Group Membership

A series of logistic regression analyses were conducted to determine the relative contributions of the individual craving subscales to predict whether or not an individual was classified as alcohol dependent (coded dichotomously; see Table 5). Similar to the findings regarding cue elicited alcohol craving, these results suggest that specific domains (i.e., subscales or factors) are most predictive of alcohol related constructs, in this case alcohol dependence. Moreover, the rationally-derived subscales of the ACQ-Now correctly classified a significantly greater percentage of the complete sample (χ^2 (1) = 5.92, $p < .02$) and individuals with an alcohol dependence diagnosis (χ^2 (1) = 4.78, $p < .05$) compared to the Raabe et al. (2005) factor model. All other comparisons between models were non-significant ($p > .05$).

4. Discussion

Currently, four distinct factor or subscale structures of the ACQ-Now have been proposed (i.e., Love et al., 1998; Raabe et al., 2005; Singleton et al., 1994; 1995) for the assessment of state alcohol craving. The primary purpose of the current study was to compare and contrast dimensional factors/subscales of the ACQ-Now in terms of basic psychometric properties and clinical utility in a sample of alcohol drinkers, 58% of whom met diagnostic criteria for alcohol dependence (APA, 1994). Accordingly, we examined each subscale/factor structure's relation to alcohol cue reactivity and its ability to predict current alcohol dependence group status.

Comparison of each model's ability to predict cue elicited craving revealed that the rationally-derived ACQ-Now subscales provided unique prediction of cue elicited craving. However, this model differs from the other three models. In the model testing the rationally-derived ACQ-Now subscales, the SMAST failed to contribute unique predictive ability of cue-elicited craving. In contrast, the remaining three models provided unique prediction of cue-elicited craving independent of the significant and unique contribution of the SMAST. This finding suggests that the rationally-derived subscales may assess constructs beyond that of basic state alcohol craving when compared to the alternative models. Thus, this finding may suggest that the rationally derived model may measure a variety of alcohol-relevant constructs, including alcohol craving and dependence. This lack of specificity may be considered a limitation of the rationally derived model if we are to accurately study and identify specific practical and theoretical constructs relating to either cue elicited craving or alcohol dependence in general.

Examination of Cohen's f^2 scores (See Table 3) indicates that all models yielded large effect sizes in the prediction of cue-elicited craving. Prediction of cue-elicited approach resulted in

similar predictive abilities across models. Specifically, each model yielded similar effect size (Cohen's f^2) scores (See Table 4) indicating that all models are effective in predicting cue-elicited approach. These findings suggest that each model is effective in predicting state alcohol craving and cue-elicited approach. Further, each model yielded similar standardized beta scores and similar partial correlation scores.

The rationally-derived ACQ-Now subscales performed significantly better than the Raabe et al. (2005) factor analytically-derived alternative in ability to predict group membership. Specifically, the rationally-derived model correctly classified a greater percentage of the complete sample and alcohol dependence participants than the Raabe et al. factor-derived model. The remaining models did not significantly differ in their ability to predict group membership. These findings indicate a slight preference for the rationally-derived model, over the Raabe et al. model, when evaluating the presence or absence of alcohol dependence. However, this finding may be related to the results presented in tables 3 and 4. The SMAST failed to contribute to each model involving the rationally-derived model suggesting that the rationally-derived model be a less specific model examining a variety of alcohol-relevant constructs including craving and dependence. Again, this may be considered a limitation of the rationally-derived model as it may not provide enough specificity to accurately assess detailed craving domains independent of general measures of dependence.

It is important to note that only one subscale of the rationally-derived model (i.e., Lack of control) provided unique contribution to all 3 regression equations. This finding suggests that only one subscale is predictive of various craving dimensions. In contrast to the rationally-derived model findings, the original factor analysis model (Singleton et al., 1995), the Raabe et al. (2005), and Love et al. (1998) models provide a variety of subscales that are uniquely predictive of craving, approach, and group membership. Following, one could argue that the use of a craving assessment which is broken down into specific domains each predictive of different aspects of craving provides more specific clinical information than one subscale predicting each outcome. Thus, based solely on the number of factors which predict craving related constructs, the factor analytic derived models appear to be favored over the rationally-derived model.

Alcohol cued avoidance was unrelated to each subscale indicating that self-report craving, as measured by the ACQ-Now, is only predictive of self-reported approach and craving, and not related to avoidance tendencies. This finding supports previous experimental studies which found evidence indicating that enhanced approach behavioral tendencies, as opposed to avoidance tendencies, characterize substance dependent individuals compared to non-users for alcohol (Field et al., 2008), tobacco (Bradley et al., 2004) and marijuana (Field et al., 2006). Hence, these findings, coupled with the findings depicting prediction of cue-elicited approach (Table 4) lend support for incentive-motivational theories of addiction (e.g., Robinson & Berridge, 1993; Tomie, 1996), indicating that addiction triggers elicit approach tendencies rather than avoidance tendencies. However, it may be important to consider both approach and avoidance behavioral tendencies when assessing treatment effects. Breiner et al. (1999) asserted that both approach and avoidance decisional tendencies are functional aspects of craving to be considered in the assessment and treatment of addictions. Accordingly, weakening of approach tendencies and strengthening of avoidance tendencies may result in better long-term treatment outcomes. Along these lines, it appears as though the ACQ-Now is limited in its domain assessment of craving. The ACQ-Now does not predict avoidance tendencies of craving, only approach. Further, the absence of an inverse relationship between self-reported craving and cue-elicited avoidance indicates that treatment procedures focused on reducing craving and approach behaviors may be limited when attempting to enhance subsequent alcohol abstinence.

The principle findings of the current study suggest that the original factor-derived ACQ-Now structure (Singleton et al., 1995) and Raabe et al. (2005) factor structure may have the most clinical utility compared to the other models examined (Love et al., 1998; Singleton et al., 2004). Supporting this contention are the findings that the original factor structure and Raabe et al. model each offer multiple subscales with the ability to uniquely predict various aspects of cue-elicited craving and group membership. Although the rationally-derived model proved to be a significantly better predictor of group membership than the Raabe et al. model, this finding may be due to the apparent general scope of the rationally-derived model. Thus the general ability for the rationally-derived model to account for variance in alcohol dependence in addition to craving may potentially elevate the ability of the rationally-derived model to predict alcohol dependence group membership.

Conversely, analyses of the remaining models revealed several limitations. The rationally-derived model appears to be a non-specific measure of alcohol-relevant constructs (i.e., craving and dependence) which may prohibit its ability to uniquely predict various forms of craving beyond measures of dependence. Additionally, this model yielded only one factor predictive of a variety of craving domains limiting its ability to uniquely predict distinct craving domains. The utility of the Love et al., (1998) ‘no desire to drink’ factor is questioned based on its relatively depressed effect size (Table 1) and its surprisingly positive association with various craving constructs (Tables 2 & 4). Thus, the original factor-derived ACQ-Now model and Raabe et al. model appear to be modestly favored as they are comprised of several factors, each independently predicting various forms of craving relatively greater than that of a measure of alcohol dependence.

4.1 General Discussion

Despite historical difficulties in defining craving, numerous theoretical (e.g., Tiffany and Conklin, 2000) and empirical works (e.g., Bottlender and Soyka, 2004; Coffey et al., 2006; McEvoy, Stritzke, French, Lang, and Ketterman, 2004; Rosenhow and Monti, 1999) have emphasized its importance in the substance dependence literature. Accordingly, these models may be used clinically in a number of ways. First, the ACQ-Now contains a variety of clinically-relevant information such as intentions, expected outcomes, and positive and negative reinforcement, and ability to control substance use. Additionally, valid alcohol craving assessment may be used to measure a patient’s current status, treatment progress, and risk of relapse. Further examination of the dimensional aspects of craving and their relation with treatment outcomes can be used to inform current alcohol dependence treatment protocols. Finally, the use of an alcohol craving measure, which is sensitive to state changes, would allow for measurement of alcohol craving habituation through repeated in-vivo or imaginal exposure treatment.

Previous studies have found some support for alcohol cue-elicited craving predicting future drinking behavior. However, currently this relation appears to be unclear. Some evidence suggests that elevated craving predicts less alcohol consumption (e.g., Monti et al., 1993); whereas other findings indicate a positive relation between craving and relapse (e.g., Bottlender and Soyka, 2004). Rohsenow and Monti (1999), in a review of the craving literature, provide evidence indicating that cue-reactivity responding is indicative of relapse following successful treatment. Perhaps specific craving factors or alternative constructs contribute to the prediction of future drinking behavior. For example, previous work indicates that the relation between cue-reactivity and self-reported craving (measured by the ACQ-Now) may be mediated by alternative constructs such as irritability (Chiang et al., 2002). Future studies examining these considerations are indicated, which may result in treatments focused on reducing these tendencies in an effort to reduce the risk of relapse. It should be noted that previous research has reported craving is likely only one facet which contributes to alcohol consumption (e.g.,

Tiffany and Conklin, 2000). Therefore, further study detailing the relative contribution of additional factors such as cognitive and emotion regulation factors, among others, in alcohol consumption is indicated.

Several limitations of the current study are worth mentioning. Cultural factors, in addition to the general understanding that factor analyses are largely dependent on the sample selected, may account for model differences and influence the current interpretations. The Love et al. (1998) and Raabe et al. (2005) factor models are based upon factor analyses using European samples, whereas the original ACQ-Now factor analysis and the current results are based on an American sample. As such, replication of the current study using non-American populations may result in increased clarification of these findings. Additionally, the current sample used a diagnosed sample of alcohol dependent individuals, the Raabe et al. study examined individuals diagnosed with either alcohol dependence or alcohol abuse, whereas the Love et al. sample used recreational drinkers. Consequently, the current findings should be interpreted with these sample distinctions in mind. Due to the limitations of factor analyses (e.g., sample selection), a more valid test of competing craving models may be through the use of in-vivo cue reactivity as opposed to factor analytic procedures. Further studies comparing these two methods for evaluating substance dependence models may result in improved models which, in turn, may generate more successful clinical protocols. The present study did not include physiological measurement indices (e.g., salvation). The inclusion of such indices would contribute an additional dimension to the psychometric validity of the various factor/subscale models. Finally, the sample size (n's = 71 and 52) are relatively small. However, previous empirical findings support the use of smaller sample sizes in factor analytic studies (Mundfrom, Shaw, & Lu Ke (2005).

The current findings, coupled with previous empirical and theoretical writings, emphasize the need for refined, multidimensional craving assessment measures. Future studies are needed to test the resulting interactive effects of specific craving domains with additional psychological constructs related to addiction such as state emotion (e.g., Randall and Cox, 2001), psychophysiology (e.g., Dempsey, Cohen, Hobson, and Randall, 2007), information processing (e.g., Tiffany, 1990; Tiffany and Conklin, 2000), coping skills (e.g., Monti and Rohsenow, 1999) and cue reactivity as predictors of initial treatment success and sustained abstinence. Finally, it is predicted that by improving the assessment of alcohol craving among alcohol dependent populations, case conceptualization and treatment will be improved leading to better long-term treatment outcomes.

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Table 1

Internal reliability coefficients and group means (*SD*) for all dependent measures among alcohol dependent and non-alcohol dependent participants

Descriptive Variables	Alpha Coefficients	Group		Statistical Analyses	
		Alcohol Dependent (*n* = 71)	Non-alcohol dependent (*n* = 52)	Omnibus Tests	Effect Size (Cohen's *d*)
ACQ-Now subscale Urge to Use	0.89	23.89 (13.49)	12.17 (5.02)	$F(1,121) = 35.52$; $p < 0.001$	1.15
ACQ-Now subscale Intent to Use	0.85	21.42 (11.95)	15.38 (7.36)	$F(1,121) = 10.38$; $p < 0.005$	0.61
ACQ-Now subscale Positive Outcome	0.83	27.52 (9.41)	23.48 (7.67)	$F(1,121) = 6.45$; $p < 0.05$	0.47
ACQ-Now subscale Withdrawal Relief	0.94	28.54 (15.47)	13.85 (6.93)	$F(1,121) = 40.80$; $p < 0.001$	1.23
ACQ-Now subscale Lack Control	0.83	29.30 (12.36)	14.04 (6.28)	$F(1,121) = 66.54$; $p < 0.001$	1.56
ACQ-Now factor Compulsiveness	0.92	32.21 (17.47)	15.48 (4.83)	$F(1,120) = 45.08$; $p < 0.001$	1.31
ACQ-Now factor Expectancy	0.85	19.71 (9.82)	11.36 (5.87)	$F(1,120) = 29.66$; $p < 0.001$	1.03
ACQ-Now factor Purposefulness	0.80	25.10 (11.63)	18.58 (9.47)	$F(1,121) = 11.03$; $p < 0.005$	0.61
ACQ-Now factor Emotionality	0.91	10.64 (6.03)	5.56 (3.83)	$F(1,119) = 28.31$; $p < 0.001$	1.01
Love Desire and Urge	0.91	33.16 (17.02)	16.44 (5.26)	$F(1,120) = 46.73$; $p < 0.001$	1.33
Love No Desire	0.82	13.34 (7.75)	9.79 (6.31)	$F(1,121) = 7.34$; $p < 0.01$	0.50
Love Reinforcement	0.93	19.39 (10.97)	9.57 (5.12)	$F(1,120) = 35.71$; $p < 0.001$	1.15
Raabe Urge and Intention	0.92	53.90 (25.81)	35.21 (11.13)	$F(1,121) = 23.96$; $p < 0.001$	0.94
Raabe Reinforcement	0.94	27.21 (13.65)	13.65 (6.67)	$F(1,120) = 37.11$; $p < 0.001$	1.17
VAS Craving		12.15 (7.69)	5.85 (6.62)	$F(1,112) = 20.58$; $p < 0.001$	0.88
VAS Approach		12.51 (7.37)	5.65 (6.57)	$F(1,112) = 25.93$; $p < 0.001$	0.98
VAS Avoidance		8.90 (8.16)	5.15 (7.37)	$F(1,112) = 6.24$; $p < 0.05$	0.48
SMAST		9.04 (3.59)	0.88 (1.26)	$F(1,121) = 244.59$; $p < 0.001$	0.80
QUMI		48.75 (18.99)	47.14 (20.4)	$F(1,119) = 0.202$; $p = 0.654$	0.08

Note: ACQ-Now subscale = Alcohol Craving Questionnaire-Now original subscales; ACQ-Now factor = Alcohol Craving Questionnaire-Now original factors; Love = ACQ-Now factors reported in Love et al., 1998; Raabe = ACQ-Now factors reported in Raabe et al., 2005; VAS = visual analog scale rating elicited by the alcohol cue; SMAST = Short Michigan Alcoholism Screening Test; QUMI = Questionnaire Upon Mental Imagery.

Table 2

Pearson correlation coefficients between alcohol craving self-report measures, alcohol cue reactivity, and alcohol dependence severity (N = 123).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
(1) ACQ-Now subscale Urge & Desire																		
(2) ACQ-Now subscale Intent	**.72**																	
(3) ACQ-Now subscale Positive Outcome	**.64**	**.68**																
(4) ACQ-Now subscale Withdrawal Relief	**.79**	**.57**	**.58**															
(5) ACQ-Now subscale Lack Control	**.78**	**.61**	**.57**	**.77**														
(6) ACQ-Now factor Compulsiveness	**.89**	**.64**	**.59**	**.89**	**.89**													
(7) ACQ-Now factor Expectancy	**.86**	**.83**	**.75**	**.83**	**.76**	**.80**												
(8) ACQ-Now factor Purposefulness	**.75**	**.83**	**.85**	**.56**	**.62**	**.60**	**.74**											
(9) ACQ-Now factor Emotionality	**.72**	**.53**	**.53**	**.95**	**.69**	**.80**	**.73**	**.50**										
(10) Love Desire & Intent	**.93**	**.68**	**.61**	**.86**	**.90**	**.98**	**.85**	**.64**	**.77**									
(11) Love No Desire	**.75**	**.66**	**.78**	**.52**	**.54**	**.55**	**.68**	**.89**	**.49**	**.60**								
(12) Love Reinforcement	**.81**	**.56**	**.56**	**.98**	**.76**	**.90**	**.79**	**.53**	**.95**	**.83**	**.52**							
(13) Raabe Urge & Intent	**.93**	**.84**	**.71**	**.77**	**.79**	**.89**	**.94**	**.74**	**.73**	**.93**	**.69**	**.81**						
(14) Raabe Reinforcement	**.83**	**.59**	**.60**	**.99**	**.78**	**.91**	**.82**	**.57**	**.95**	**.87**	**.54**	**.99**	**.83**					
(15) VAS Craving	**.43**	.25*	**.34**	**.50**	**.54**	**.50**	**.42**	**.34**	**.46**	**.49**	.30*	**.50**	**.40**	**.49**				
(16) VAS Approach	**.42**	**.32**	**.34**	**.43**	**.49**	**.41**	**.46**	**.40**	**.40**	**.42**	.32*	.41*	**.39**	**.42**	**.84**			
(17) VAS Avoidance	.05	−.15	−.13	.17	.14	.12	.01	−.15	.15	.11	−.10	.16	.01	.15	−.14*	−.16*		
(18) SMAST	**.50**	.21*	.21*	**.55**	**.66**	**.61**	**.45**	.21*	**.51**	**.61**	.20*	**.56**	**.44**	**.55**	**.44**	**.44**	20*	
(19) QUMI	.02	.03	.10	.07	.10	.07	.02	.07	.07	.06	.01	.05	.03	.06	−.07	−.04	..02	.06

Note: Two-tailed correlations in bold are significant at $p < 0.001$ while those denoted by * are significant at $p < 0.05$. ACQ-Now subscale = Alcohol Craving Questionnaire-Now original subscales; ACQ-Now factor = Alcohol Craving Questionnaire-Now original factors; Love = ACQ-Now factors reported in Love et al., 1998; Raabe = ACQ-Now factors reported in Raabe et al., 2005; VAS = visual analog scale rating elicited by the alcohol cue; SMAST = Short Michigan Alcoholism Screening Test; QUMI = Questionnaire Upon Mental Imagery.

Table 3

Model summaries for stepwise regressions predicting cue elicited craving from self-report factor/subscale models.

Analysis Number	Predictor Model	Subscale/Factor(s) Retained	R^2	f^2	F(df)	β	SE	pr	$p <$
1	Rationally-derived ACQ-Now subscales model		0.30	0.43	45.48 (1,112)				0.001
		ACQ-Now subscale Lack Control				0.54	0.05	0.54	0.001
2	Singleton et al. (1995) factor model		0.27	0.37	20.17 (2,109)				0.001
		ACQ-Now factor Compulsiveness				0.37	0.05	0.33	0.001
		SMAST				0.21	0.16	0.19	0.05
3	Love et al. (1998) factor model		0.29	0.41	22.04 (2,110)				0.001
		Love Reinforcement				0.38	0.07	0.35	0.001
		SMAST				0.23	0.15	0.22	0.05
4	Raabe et al. (2005) factor model		0.28	0.39	21.70 (2,110)				0.001
		Raabe Reinforcement				0.37	0.05	0.35	0.001
		SMAST				0.23	0.15	0.23	0.05

Note: ACQ-Now subscale = Alcohol Craving Questionnaire-Now original subscales; ACQ-Now factor = Alcohol Craving Questionnaire-Now original factors; Love = ACQ-Now factors reported in Love et al., 1998; Raabe = ACQ-Now factors reported in Raabe et al., 2005; SMAST = Short Michigan Alcoholism Screening Test. Suggested f^2 effect size descriptions range across small (.02), med (.15), and large (.35).

Table 4

Model summaries for stepwise regressions predicting cue elicited approach from self-report factor/subscale models.

Predictor Model	Subscale/Factor(s) Retained	*R*	*f*	*F*(df)	*β*	*SE*	*pr*	*p* <
Rationally-derived ACQ-Now subscales model		0.26	0.35	19.96 (2,111)				0.001
	ACQ-Now subscale Lack Control				0.35	0.07	0.29	0.001
	SMAST				0.22	0.17	0.19	0.05
Singleton et al. (1995) factor model		0.28	0.39	20.79 (2,109)				0.001
	ACQ-Now factor Expectancy				0.34	0.08	0.34	0.001
	SMAST				0.29	0.14	0.29	0.005
Love et al. (1998) factor model		0.25	0.33	18.52 (2,110)				0.001
	Love No Desire To Drink				0.26	0.09	0.28	0.005
	SMAST				0.39	0.13	0.40	0.001
Raabe et al. (2005) factor model		0.25	0.33	18.33 (2,110)				0.001
	Raabe Urge and Intention to Drink				0.28	0.03	0.28	0.005
	SMAST				0.30	0.15	0.29	0.005

Note: ACQ-Now subscale = Alcohol Craving Questionnaire-Now original subscales; ACQ-Now factor = Alcohol Craving Questionnaire-Now original factors; Love = ACQ-Now factors reported in Love et al., 1998; Raabe = ACQ-Now factors reported in Raabe et al., 2005;; SMAST = Short Michigan Alcoholism Screening Test. Suggested f^2 effect size descriptions range across small (.02), med (.15), and large (.35).

Table 5

Model summaries for logistic regressions predicting alcohol dependent classification from self-report factor/subscale models.

Predictor Model	**Subscale/Factor Retained**	**χ^2 (df)**	***p* <**	**% Correctly Classified (*n*)**			***β***	***SE***	***OR***	***P* <**
				Complete Sample	**Alcohol Dependent**	**Not Alcohol Dependent**				
Rationally-derived ACQ subscales model		71.17 (5)	0.001	83.7 (103)	84.5 (60)	82.7 (43)				
	ACQ subscale Lack Control						0.17	0.05	1.18	0.001
Singleton et al. (1995) factor model		57.13 (4)	0.001	81 (98)	78.3 (54)	84.6 (44)				
	ACQ factor Compulsiveness						0.21	0.05	1.23	0.001
Love et al. (1998) factor model		55.29 (3)	0.001	77 (94)	78.6 (55)	75 (39)				
	Love Desire and Intention						0.19	0.05	1.21	0.001
Raabe et al. (2005) factor model		37.17 (2)	0.001	71.3 (87)	70 (49)	73.1 (38)				
	Raabe Reinforcement						0.09	0.03	1.09	0.01