Reliability and Validity of a Short Form of the Marijuana Craving Questionnaire

Stephen J. Heishman[a],[*], **Rebecca J. Evans**[a], **Edward G. Singleton**[b], **Kenneth H. Levin**[a], **Marc L. Copersino**[c], and **David A. Gorelick**[a]

a*Intramural Research Program, National Institute on Drug Abuse, 251 Bayview Blvd., Baltimore, MD 21224, USA*

b*MayaTech Corporation, 1100 Wayne Ave., Silver Spring, MD 20910, USA*

c*McLean Hospital, Harvard Medical School, 115 Mill Street, Belmont, MA 02478, USA*

Abstract

Background—The Marijuana Craving Questionnaire (MCQ) is a valid and reliable, 47-item self-report instrument that assesses marijuana craving along four dimensions: compulsivity, emotionality, expectancy, and purposefulness. For use in research and clinical settings, we constructed a 12-item version of the MCQ by selecting three items from each of the four factors that exhibited the greatest within-factor internal consistency (Cronbach's alpha coefficient).

Methods—Adult marijuana users ($n = 490$), who had made at least one serious attempt to quit marijuana use but were not seeking treatment, completed the MCQ-Short Form (MCQ-SF) in a single session.

Results—Confirmatory factor analysis of the MCQ-SF indicated good fit with the 4-factor MCQ model, and the coefficient of congruence indicated moderate similarity in factor patterns and loadings between the MCQ and MCQ-SF. Homogeneity (unidimensionality and internal consistency) of MCQ-SF factors was also consistent with reliability values obtained in the initial validation of the MCQ.

Conclusions—Findings of psychometric fidelity indicate that the MCQ-SF is a reliable and valid measure of the same multidimensional aspects of marijuana craving as the MCQ in marijuana users not seeking treatment.

Keywords

Marijuana craving; Cannabis; Reliability; Validity; Questionnaire

1. Introduction

Marijuana (cannabis) is the most commonly used illicit drug throughout the world (Coffey et al., 2002; Degenhardt et al., 2008, Perkonigg et al., 2008). In the United States, prevalence among the population aged 12 and older is 40% for lifetime use and 6% for past month use

* Corresponding author: Stephen J. Heishman, Ph.D., NIDA Intramural Research Program, 251 Bayview Blvd., Baltimore, MD 21224, USA, Phone: 443.740.2458, Fax: 443.740.2855, E-mail: heishman@nih.gov.

(Substance Abuse and Mental Health Services Administration, 2007). Across various countries, prevalence of lifetime marijuana dependence ranges from 1% to 7% (Chen et al., 2005; Coffey et al., 2002; Stinson et al., 2006; Perkonigg et al., 2008). Craving is identified as a symptom of marijuana dependence (Coffey et al., 2002) and marijuana withdrawal (Budney et al., 2004; Copersino et al., 2006; Haney, 2005). Craving is typically described as a strong drive or urge, serving to promote continued drug use (dependence symptom) or to trigger relapse during abstinence (withdrawal symptom) (American Psychiatric Association [APA], 2000; Pickens and Johanson, 1992).

Marijuana craving has been reported in individuals seeking treatment and in laboratory studies with daily marijuana users. Among adults presenting for treatment, McRae et al. (2007) found that marijuana-dependent patients reported greater levels of marijuana craving than cocaine-dependent patients reported cocaine craving. In a separate treatment sample, 93% of marijuana-dependent adults reported experiencing mild craving for marijuana, and 44% rated their past craving as severe (Budney et al., 1999). A retrospective survey of marijuana users reporting about their most recent quit attempt revealed that craving was second only to irritability in severity and frequency; more than 50% of participants indicated that craving had contributed to failed quit attempts (Budney et al., 2008). Similarly, craving was the most frequent (82%) withdrawal symptom endorsed by marijuana-dependent adolescents seeking treatment (Cornelius et al., 2008). Daily marijuana users participating in residential (Haney et al., 2004) and nonresidential (Vandrey et al., 2008) laboratory studies reported significant increases in craving during periods of marijuana deprivation. Laboratory studies have also reported increased craving in response to marijuana-related imagery scripts (Singleton et al., 2002) and visual pictures (Wolfling et al., 2008) compared to neutral stimuli.

An impediment to a full understanding of the role of craving in addiction is the lack of agreement regarding its clinical significance, meaning, and measurement (Pickens and Johanson, 1992; Sayette et al., 2000). For example, DSM-IV does not list craving as a criterion of substance dependence (APA, 2000); however, craving is an optional diagnostic criterion in ICD-10 (World Health Organization, 2005). The varied conceptualizations of craving (Heishman et al., 2001) have yielded inconsistent approaches to measurement. The majority of studies described in the preceding paragraph assessed marijuana craving using single-item questions that have face validity, but precluded the determination of internal consistency and reliability (Tiffany, 1992; Wewers et al., 1990). To overcome these deficiencies, measures of craving have been developed, using one to three items assessing urges and desires (e.g., Kozlowski et al., 1996). However, neither single items nor any single measure captures the varied nature of craving experienced by individuals along the drug-dependence continuum and the range of theoretical perspectives on craving (Verheul et al., 1999; Mezinskis et al., 2001). Given the absence of a psychometrically valid instrument with which to measure such multiple dimensions of marijuana craving, we developed the Marijuana Craving Questionnaire (MCQ).

The MCQ is a 47-item multidimensional scale covering a broad range of clinically and theoretically distinct explanations of marijuana craving. In the initial validation study (Heishman et al., 2001), the MCQ was administered to 217 current marijuana smokers not seeking treatment. Exploratory and confirmatory factor analyses yielded 17 items with significant loadings on four latent constructs (factors) that characterized marijuana craving. We examined item content and correlations between factor scores and variables commonly found in marijuana studies to assign meaning to the factors: 1) *compulsivity*, an inability to control marijuana use; 2) *emotionality*, use of marijuana in anticipation of relief from withdrawal or negative mood; 3) *expectancy*, anticipation of positive outcomes from smoking marijuana; and 4) *purposefulness*, intention and planning to use marijuana for positive outcomes. The four MCQ factor subscales had respectable internal consistencies, exhibited low to moderate positive intercorrelations, and were significantly correlated with history of

marijuana use and a wide range of single-item measures of craving. Singleton et al. (2002) further documented the reliability and validity of the 47-item MCQ by demonstrating internal consistency and unidimensionality of the four factors, suggesting that each factor was tapping unique dimensions of marijuana craving. The validity of the MCQ as a state measure of craving has been demonstrated by increases in factor scores after exposure to marijuana-related visual, tactile, and olfactory cues (Lundahl et al., 2007) and auditory imagery scripts that differed in the intensity of marijuana-urge content (Singleton et al., 2002).

A disadvantage of the 47-item MCQ is that it takes 7 min to complete (Heishman et al., 2001), which likely would limit its use in clinical settings where patients are assessed with numerous forms and in research studies where measures are repeated frequently. Indeed, more than one-third of participants in the initial validation study suggested eliminating item repetition. Theoretically, a shorter form of any multiple-item questionnaire can be created without reducing reliability (Tiffany et al., 2000). One approach to constructing a shorter, yet reliable, scale would be to use only the MCQ items with significant factor loadings, but even a 17-item questionnaire might prove too lengthy to administer and score. Additionally, either all or most items on two of the factors (*emotionality* and *purposefulness*) were worded negatively to reduce variance due to acquiescence and might be more indicative of participants' inattention to rating than with their response to item content. Although we included practice items to ensure that participants understood the rating scale, negatively-worded items required additional calculations before summing scores for each factor.

There is no generally accepted limit to the minimum number of items required to maintain psychometric fidelity between original and brief versions of any instrument, although there is agreement that at least three indicators (items) per factor are desirable in the development and validation of multidimensional scales (Marsh and Hau, 1999). Thus, we constructed a 12-item version of the MCQ (MCQ-Short Form, MCQ-SF) by retaining 6 of the 17 items with significant factor loadings (3 items each as indicators for Factors 3 and 4) and by selecting 6 of the remaining 11 items that exhibited the greatest within-factor internal consistency (Cronbach's alpha coefficient) as indicators for Factors 1 and 2 (3 items each). We worded all items in the positive direction, consistent with development of brief versions of similarly-constructed craving questionnaires (Cox et al., 2001; Heishman et al., 2008; Paliwal et al., 2008). We estimated that completion of the MCQ-SF would take about 30 sec, based on results with a similar 12-item tobacco craving scale (Heishman et al., 2004; 2008).

The purpose of this study was to compare the factor structure of the MCQ-SF to that of the MCQ by administering the MCQ-SF to an independent sample of marijuana smokers who were not interested in reducing or quitting their marijuana use. We hypothesized that the MCQ 4-factor structure would be replicated in the MCQ-SF. We examined items for congruence in factor patterns and loadings between the MCQ and MCQ-SF. We also included questions about the intensity, frequency, and duration of recent marijuana craving to explore the convergent validity of the MCQ-SF.

2. Methods

2.1. Participants

Marijuana smokers (*n* = 490) were recruited from the greater Baltimore community via print, radio, and television advertisements. Inclusionary criteria were: at least 18 years old and having made at least one "serious" (self-defined) attempt to quit marijuana. Participants gave written informed consent according to guidelines for the protection of research volunteers of the U.S. Department of Health and Human Services and were paid for their participation. The NIDA Institutional Review Board approved the study.

2.2. Procedure

The study consisted of a single session lasting about 45 min. Participants completed a questionnaire about the "most difficult time you had intentionally stopping all marijuana use while not in a controlled environment such as jail or hospital," including reasons for quitting, coping strategies, and withdrawal symptoms (data to be reported elsewhere). Participants then completed the MCQ-SF and eight additional questions concerning their current, past week, or past month marijuana craving (definition, frequency, duration, change, and intensity). Questions about craving intensity were rated on a 100-mm visual analog scale (VAS), anchored from *low* to *high* or *low* to *most ever in life*.

The distribution of MCQ-SF items based on the 4-factor scale structure of the MCQ is shown in Table 1. Items were rated on a Likert-type scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Factor scores for each participant were obtained by summing the 3 items in each factor scale, yielding a score ranging from 3 to 21. The MCQ-SF factors were operationally defined the same as those of the MCQ: 1) *compulsivity*, an inability to control marijuana use; 2) *emotionality*, use of marijuana in anticipation of relief from withdrawal or negative mood; 3) *expectancy*, anticipation of positive outcomes from smoking marijuana; and 4) *purposefulness*, intention and planning to use marijuana for positive outcomes. In the initial validation study (Heishman et al., 2001), estimates of internal consistency (Cronbach's alpha; Cronbach, 1951) of MCQ Factors 1-4 and number of items in each factor (in parentheses) were 0.82 (7), 0.78 (4), 0.55 (3), and 0.68 (3), respectively.

2.3. Data analysis

The statistical package Comprehensive Exploratory Factor Analysis (CEFA; Browne et al., 2004) was used to determine if the MCQ-SF maintained the 4-factor structure of the MCQ. We conducted confirmatory factor analysis (CFA) using Maximum Wishart Likelihood estimation and oblique rotation with Kaiser normalization to a least squares fit to match the 4-factor MCQ target matrix. Target specification for the assignment of MCQ-SF items to each respective factor matched the manner in which similar items were assigned to the same factor in the MCQ: Factor 1 would include items 2, 7, and 10; Factor 2 would include items 4, 6, and 9; Factor 3 would include items 5, 11, and 12; and Factor 4 would include items 1, 3, and 8. Models assumed no higher-order factors, correlated first-order factors, and uncorrelated residuals. Goodness-of-fit for the unrotated factors was examined using the Steiger-Lind root mean square error of approximation statistic (RMSEA; Steiger, 1980) produced in CEFA. We used hypothesis tests developed to test the statistical significance of the fit (Browne and Cudeck, 1993) for the 4-factor model, with exceedance probabilities for perfect fit (H_0: RMSEA = 0) and close fit (H_0: RMSEA ≤ 0.05). For RMSEA, values < 0.05 constitute good fit, values 0.05-0.08 acceptable fit, values 0.08-0.10 marginal fit, and values > 0.10 poor fit of the model (Browne and Cudeck, 1993).

We compared next the rotated matrices of factor loadings obtained for the 4-factor MCQ-SF model (comparison) and for the assigned items in the original MCQ model (target) using Tucker's coefficient of congruence (*f*) as a statistical index of similarity in factor patterns and magnitude of factor loadings between sets of factors derived from identical items (Wrigley and Neuhaus, 1955). Empirical studies indicate *f* values of 0.70-0.79 represent moderate, 0.80-0.89 high, and > 0.90 very high similarity between target and comparison factors (Koschat and Swayne, 1991; ten Berge, 1986).

We evaluated homogeneity of factors two ways. First, we conducted principal components analysis (PCA) of the assigned items for each MCQ-SF factor. If more than one component per factor was retained by the PCA, this would indicate a significant departure from unidimensionality for that factor. Second, Cronbach's alpha coefficients and inter-item

correlations were calculated for each factor. We conducted internal consistency reliability and inter-item analyses to examine further whether each factor contained an optimal set of items that measured a unique aspect of craving.

Forward stepwise multiple regression analysis was conducted to determine the subset of Factors 1-4 that best predicted current, past-week, and past-month intensity of marijuana craving (VAS). Only factors with significant betas were retained. Multivariate analysis of variance (MANOVA) was used to test differences in factor scores as a function of how participants defined craving and to test the hypothesis that factor scores varied as a function of self-reported frequency and duration of marijuana craving. The tests of significance were based on Wilks' lambda and were converted to F values (Rao's R) by means of a set of procedures developed by Rao (1951).

3. Results

3.1. Participant characteristics

The majority of participants were Black (83%) and male (58%). The sample comprised 240 Black men (49%), 169 Black women (35%), 46 White men (9%), and 35 White women (7%). Mean age was 31.2 years (S.D. = 10.3). Participants reported first marijuana use at age 14.8 (S.D. = 3.2), first regular (at least once per week) marijuana use at age 16.6 (S.D. = 3.7), and an average of 5.4 (S.D. = 7.7) lifetime quit attempts. Eighty-five percent had used marijuana during the past month, 9% in the past 2-12 months, and 6% had not used marijuana for at least a year. The only sex difference was that women began marijuana use 1.5 years later than men (15.7 vs. 14.2, $p < 0.001$). There were no racial differences. A correlational pattern hypothesis for equality of correlation matrices indicated that combining the race and sex subgroups was justified, RMSEA = 0.029, χ^2 (198) = 218.81, $p > .14$.

For comparison, we summarize briefly the sample demographics of the initial MCQ validation study (Heishman et al., 2001). Of the 217 participants, 79% were male, 50% were Black, and 44% were White. Mean age was 31.4 years (S.D. = 7.5). Participants reported first marijuana use at age 15.3 (S.D. = 3.9), use of marijuana for 14.3 years (S.D. = 3.9), and an average of 4.3 (S.D. = 6.7) lifetime quit attempts. Goodness of fit of correlational pattern hypotheses for several subgroups within the sample, indicated that the factor structure of the original validation sample was unaffected by differences in demographics.

3.2. Factor analysis and reliability of the MCQ-SF

Table 2 compares factor loadings of the MCQ-SF with those of the MCQ validation study (Heishman et al., 2001). CFA of the MCQ-SF items showed a close fit with the 4-factor target model, χ^2 (24, $n = 490$) = 32.20; RMSEA = 0.026 (90% confidence interval = 0.000-0.055), perfect fit $p > 0.122$, close fit $p > 0.965$. Factor scale means (S.D.) were 7.6 (4.8), 8.9 (5.5), 10.3 (5.6), and 11.5 (6.3) for Factors 1-4, respectively.

Factors exhibited positive intercorrelations (all p's < 0.001), with Pearson's r ranging from 0.43 (Factor 1 with Factor 3) to 0.78 (Factor 2 with Factor 3). Cronbach's alpha coefficient and average inter-item correlation (in parentheses) were 0.61 (0.34), 0.75 (0.51), 0.72 (0.46), and 0.84 (0.64) for Factors 1-4, respectively. Individual PCA extracted only one component per factor; component loadings exceeded 0.72 for all items comprising each factor. The variance accounted for was 56%, 67%, 64%, and 75% for Factors 1-4, respectively. The congruence coefficient (f) was 0.78.

3.3. Validity of the MCQ-SF

Participants were asked to indicate on average the intensity of marijuana craving for the past month, past week, and right now on a VAS, anchored from *low* to *high*. There was a trend towards decreased intensity with recency of the time period [past month ($M = 49.7$, S.D. = 32.4); past week ($M = 48.5$, S.D. = 33.8); right now ($M = 41.8$, S.D. = 35.9)]. Participants also rated intensity of current craving on a VAS from *low* to *most ever in life* ($M = 33.0$, S.D. = 30.2). Multiple regression revealed that all MCQ-SF factors were positively and significantly associated with current craving intensity; β ranged from 0.10 (Factor 3) to 0.45 (Factor 4), all *p*'s < 0.05. Factors 1, 3, and 4 were positively and significantly associated with past month intensity (β = 0.14, 0.21, and 0.31, respectively), and with past week intensity (β = 0.14, 0.19 and 0.37, respectively), all *p*'s < 0.001. Factors 1, 2, and 4 were positively and significantly associated with intensity of current craving compared to most ever in life (β = 0.19, 0.19 and 0.32, respectively), all *p*'s < 0.001.

3.4. Definition of craving

Participants were asked to choose between two definitions of craving for marijuana. They were almost evenly divided between craving as "only a strong urge or desire to smoke marijuana" (53%) versus "any urge or desire to smoke marijuana, even a weak one" (47%). There was no difference between the two response groups on Factors 1-4, Rao's *R* (4, 482) = 0.42, *p* > 0.46.

3.5. Frequency, duration, and change in craving

Participants were asked to indicate the average frequency (number of times per day) and duration (in minutes) of their craving for marijuana during the past week. A majority of participants (57%) reported craving marijuana 1-4 times per day, and 18% reported more than 5 episodes per day; 22% reported no craving episodes. With respect to the duration of each craving episode, 56% reported less than 30 min, and 20% reported greater than 30 min. Fig. 1 shows mean MCQ-SF factor scale scores as a function of frequency and duration of craving episodes. MANOVA indicated significant increases in factor scores as a function of increasing frequency, Rao's *R* (20, 1546) = 8.68, *p* < 0.001, and duration, Rao's *R* (28, 1667) = 4.81, *p* < 0.001. Univariate *F* tests indicated significant main effects for frequency and duration for all factors (all *p*'s < 0.001). Excluding participants who reported no frequency or no duration of craving did not change outcomes of either the MANOVA or univariate *F* tests.

Participants were also asked to indicate how their craving for marijuana had changed during the past week; the majority (73%) reported no change. MANOVA indicated significant increases and decreases in factor scores as a function of change, Rao's *R* (8, 962) = 7.09, *p* < 0.001. Univariate *F* tests indicated significant main effects for change for all factors (all *p*'s < 0.001). Post hoc tests revealed that scores on all factors were significantly lower for participants who reported decreased craving compared with those who reported either increased or no change in craving during the past week (all *p*'s < 0.01). Only Factor 4 scores were significantly higher for participants who reported increased craving compared with those who reported no change during the past week (*p* < 0.01). Finally, there was no difference between the two definitional response groups (section 3.4) on frequency, duration, and change of craving (all *p*'s > 0.23).

4. Discussion

We developed the MCQ to be a multidimensional questionnaire using clinically- and theoretically-based categories of craving and found that four factors best characterized marijuana craving. Confirmatory factor analysis of the 4-factor MCQ-SF model indicated good fit to the 4-factor MCQ model. We specified a priori how the MCQ-SF items would empirically

fit into four factors, corresponding to item fit on the MCQ. The coefficient of congruence indicated moderate similarity in factor patterns and loadings between the MCQ and MCQ-SF. Visual inspection of the rotated factor structure indicated that factor patterns for significant items (> 0.30) loaded exactly between target (MCQ) and comparison (MCQ-SF) factors, suggesting convergent validity (Kline, 2005). These findings suggest that the MCQ-SF measures the same four latent constructs as the MCQ.

The common practice of assigning items to the factor with the highest loading would have resulted in item 6 being assigned incorrectly to Factor 3 and item 11 being assigned incorrectly to Factor 2. We conducted internal consistency reliability and inter-item analyses to delete all items that were not consistent with Factors 2 and 3 (not shown), but this would have resulted in marked reductions for Factor 2 with item 6 removed (Cronbach's alpha = 0.64 vs. 0.75) and for Factor 3 with item 11 removed (Cronbach's alpha = 0.60 vs. 0.72). Given that some similar items loaded on the same factor (e.g., items 2 and 7, Factor 1), we also examined whether it was possible to delete one of the pair to make the MCQ-SF even shorter without sacrificing reliability. In each case, deleting one item reduced Cronbach's alpha. Retaining all 12 items resulted in a high intercorrelation among the four primary factors, which could indicate that an alternative model with one secondary higher-order factor might explain much of the common variance. Hierarchical factor analysis, however, yielded two secondary higher-order factors influencing four primary factors. Thus, the four factors of the MCQ-SF demonstrate the same unique variance as the MCQ.

Internal consistency reliability estimates ranged from 0.61 (Factor 1) to 0.84 (Factor 4). There were differences in reliability coefficients between the MCQ and MCQ-SF. Cronbach's alpha for MCQ-SF Factors 1 and 2 decreased, whereas Factors 3 and 4 increased compared with Cronbach's alpha for corresponding MCQ factors. Although there is no commonly agreed minimum alpha level (Cortina, 1993; Schmitt, 1996), 0.70 has become convention (Nunnally, 1978). As defined by Cronbach (1951) and elaborated by others (Kaiser & Michael, 1975), alpha is a single-sample measure of internal consistency. Both internal consistency and unidimensionality are needed to establish homogeneity of factor scales. Thus, the central issue is not only whether the three items in each factor are internally consistent, but also are they tapping one dimension of craving.

We used established procedures to evaluate unidimensionality (Cortina, 1993; Schmitt, 1996). According to these authors, when a measure has desirable properties, such as meaningful content coverage and reasonable unidimensionality, low alpha should not be the sole impediment to its use. In this study, PCAs extracted only one measured component per factor, indicating no significant departure from unidimensionality and suggesting that each factor consistently tapped a unique aspect of marijuana craving. If a test is unidimensional, then it has sufficient internal consistency (Gardner, 1995). Taken together, goodness-of-fit, congruence of factors, homogeneity (unidimensionality and internal consistency), and uniqueness of factors suggest that the MCQ-SF reliably measures the same multidimensional aspects of marijuana craving as the MCQ.

Similar to the initial MCQ valiadation study (Heishman et al., 2001), a nearly equal number of participants in the present study defined craving for marijuana as "only a strong urge or desire" or "any urge or desire." Participants endorsing one definition or the other did not differ with respect to MCQ-SF factor scores. This finding with marijuana users is consistent with responses from users of other drugs, including cocaine (Tiffany et al., 1993), alcohol (Kozlowski et al., 1989), and nicotine (Heishman et al., 2003).

Scores on all MCQ-SF factors increased as a function of increasing frequency and duration of craving episodes. Participants who reported craving three or more times per day and those

whose cravings lasted more than 10 min had significantly higher scores on all MCQ-SF factors compared with participants who reported no daily craving (Fig. 1). In general, factor scores did not plateau, which might have suggested effective coping skills to prevent escalating craving. Individuals reporting the most frequent and longest lasting craving episodes may be at greatest risk for relapse to marijuana use following a quit attempt. Future studies utilizing ecological momentary assessment (e.g., Epstein et al., in press) are needed to examine relationships between frequency and intensity of craving episodes and marijuana use.

Several limitations of the study should be mentioned. The reliability and validity of the MCQ and MCQ-SF have been investigated in marijuana users who were not interested in reducing or quitting their marijuana use. Thus, these results may not generalize to those trying to quit, former-users, or those who use marijuana only occasionally. The sample comprised a large proportion of Blacks and men; however, the correlational pattern hypothesis test suggested that the factor structure of the MCQ-SF was unaffected by race or sex. Future testing of the MCQ-SF with a more balanced sample may identify a different factor structure. Finally, we have not investigated the utility of the MCQ-SF or MCQ in predicting treatment outcomes. Because self-reported craving is a predictor of treatment outcome among other drugs of abuse (Heinz et al., 2006; Killen et al., 2006; Mol et al., 2007; Paliwal et al., 2008), evaluation of the MCQ-SF in a treatment trial is a next logical step for future validity and reliability testing.

To our knowledge, the MCQ and MCQ-SF are the only multidimensional questionnaires for the assessment of marijuana craving. In this study, we report on the development, reliability, and validity of the MCQ-SF. Results suggest that the MCQ-SF is as valid and reliable as the 47-item MCQ in measuring marijuana craving. Replication of the psychometric properties in an independent sample with different characteristics from the MCQ sample demonstrates further the fidelity between the original and brief versions of the questionnaire. The MCQ-SF provides an assessment of marijuana craving that is minimally burdensome to participants and easy to administer and score.

References

American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition-Text Revision. American Psychiatric Association; Washington, DC: 2000.

Browne, MW.; Cudeck, R. Alternative ways of assessing model fit. In: Bollen, KA.; Long, JS., editors. Testing Structural Equation Models. Sage Press; Newbury Park, CA: 1993. p. 136-161.

Browne, MW.; Cudeck, R.; Tateneni, K.; Mels, G. CEFA: Comprehensive Exploratory Factor Analysis, Version 2.00 [Computer software and manual]. 2004 [January 16, 2009]. Retrieved from http://faculty.psy.ohio-state.edu/browne/programs.htm

Budney AJ, Hughes JR, Moore BA, Vandrey R. Review of the validity and significance of cannabis withdrawal syndrome. Am J Psychiatry 2004;161:1967–1977. [PubMed: 15514394]

Budney AJ, Novy PL, Hughes JR. Marijuana withdrawal among adults seeking treatment for marijuana dependence. Addiction 1999;94:1311–1321. [PubMed: 10615717]

Budney AJ, Vandrey RG, Hughes JR, Thostenson JD, Bursac Z. Comparison of cannabis and tobacco withdrawal: severity and contribution to relapse. J Subst Abuse Treat. 200810.1016/j.jsat2008.01.002

Chen CY, O'Brien MS, Anthony JC. Who becomes cannabis dependent soon after onset of use? Epidemiological evidence from the United States: 2000-2001. Drug Alcohol Depend 2005;79:11–22. [PubMed: 15943940]

Coffey C, Carlin JB, Degenhardt L, Lynskey M, Sanci L, Patton GC. Cannabis dependence in young adults: an Australian population study. Addiction 2002;97:187–194. [PubMed: 11860390]

Copersino ML, Boyd SJ, Tashkin DP, Huestis MA, Heishman SJ, Dermand JC, Simmons MS, Gorelick DA. Cannabis withdrawal among non-treatment-seeking adult cannabis users. Am J Addict 2006;15:8–14. [PubMed: 16449088]

Cornelius JR, Chung T, Matin C, Wood DS, Clark DB. Cannabis withdrawal is common among treatment-seeking adolescents with cannabis dependence and major depression, and is associated with rapid relapse to dependence. Addict Behav 2008;33:1500–1505. [PubMed: 18313860]

Cortina JM. What is coefficient alpha? An examination of theory. J Appl Psychol 1993;78:98–104.

Cox LS, Tiffany ST, Christen AG. Evaluation of the brief questionnaire of smoking urges (QSU-brief) in laboratory and clinical settings. Nicotine Tob Res 2001;3:7–16. [PubMed: 11260806]

Cronbach LJ. Coefficient alpha and the internal structure of tests. Psychometrika 1951;16:297–334.

Degenhardt L, Chiu WT, Sampson N, Kessler RC, Anthony JC, Angermeyer M, Bruffaerts R, de Girolamo G, Gureje O, Huang Y, Karam A, Kostyuchenko S, Lepine JP, Mora M, Neumark Y, Ormel JH, Pinto-Meza A, Posada-Villa J, Stein DJ, Takeshima T, Wells JE. Toward a global view of alcohol, tobacco, cannabis, and cocaine use: findings from the WHO World Mental Health Surveys. PLoS Med 2008;5:e141.10.1371/journal.pmed.0050141 [PubMed: 18597549]

Epstein DH, Willner-Reid J, Vahabzadeh M, Mezghanni M, Lin JL, Preston KL. You can see it coming: real-time electronic-diary reports of cue exposure and mood in the hours before drug craving and use. Arch Gen Psychiatry. in press

Gardner PL. Measuring attitudes to science: Unidimensionality and internal consistency revisited. Res Sci Educ 1995;25:283–289.

Haney M. The marijuana withdrawal syndrome: diagnosis and treatment. Curr Psychiatric Rep 2005;7:360–366.

Haney M, Hart CL, Vosburg SK, Nasser J, Bennett A, Zubaran C, Foltin RW. Marijuana withdrawal in humans: effects of oral THC or divalproex. Neuropsychopharmacology 2004;29:158–170. [PubMed: 14560320]

Heinz AJ, Epstein DH, Schroeder JR, Singleton EG, Heishman SJ, Preston KL. Heroin and cocaine craving and use during treatment: measurement validation and potential relationships. J Subst Abuse Treat 2006;31:355–364. [PubMed: 17084789]

Heishman SJ, Saha S, Singleton EG. Imagery-induced tobacco craving: Duration and lack of assessment reactivity bias. Psychol Addict Behav 2004;18:284–288. [PubMed: 15482084]

Heishman SJ, Singleton EG, Liguori A. Marijuana Craving Questionnaire: development and initial validation of a self-report instrument. Addiction 2001;96:1023–1034. [PubMed: 11440613]

Heishman SJ, Singleton EG, Moolchan ET. Tobacco Craving Questionnaire: reliability and validity of a new multifactorial instrument. Nicotine Tob Res 2003;5:645–654. [PubMed: 14577981]

Heishman SJ, Singleton EG, Pickworth WB. Reliability and validity of a Short Form of the Tobacco Craving Questionnaire. Nicotine Tob Res 2008;10:643–651. [PubMed: 18418787]

Kaiser HF, Michael WB. Domain validity and generalizability. Educ Psychol Meas 1975;35:31–35.

Killen JD, Fortmann SP, Murphy GM, Hayward C, Arredondo C, Cromp D, Celio M, Abe L, Wang Y, Schatzberg AF. Extended treatment with bupropion SR for cigarette smoking cessation. J Consult Clin Psychol 2006;74:286–294. [PubMed: 16649873]

Kline, RB. Principles and Practice of Structural Equation Modeling. Vol. 2nd. Guilford Press; New York: 2005.

Koschat MA, Swayne DF. A weighted procrustes criteria. Psychometrika 1991;56:229–239.

Kozlowski LT, Mann RE, Wilkinson DA, Poulos CX. "Cravings" are ambiguous: ask about urges or desires. Addict Behav 1989;14:443–445. [PubMed: 2782125]

Kozlowski LT, Pillitteri JL, Sweeney CT, Whitfield KE, Graham JW. Asking questions about urges or cravings for cigarettes. Psychol Addict Behav 1996;10:248–260.

Lundahl, LH.; Cederlind, L.; Johanson, CE. Oral THC attenuates cue-induced marijuana craving in cannabis-dependent humans. Presented at College of Problems of Drug Dependence; 2007.

Marsh, HW.; Hau, KT. Confirmatory Factor Analysis: Strategies for Small Sample Sizes. In: Hoyle, RH., editor. Statistical Strategies for Small Sample Research. Sage Publications; Thousand Oaks, CA: 1999. p. 250

McRae AL, Hedden SL, Malcolm RJ, Carter RE, Brady KT. Characteristics of cocaine- and marijuana-dependent subjects presenting for medication treatment trials. Addict Behav 2007;32:1433–1440. [PubMed: 17150310]

Mezinskis JP, Honos-Webb L, Kropp F, Somoza E. The measurement of craving. J Addict Dis 2001;20:67–85. [PubMed: 11681594]

Mol A, Voshaar R, Gorgels W, Breteler M, van Balkom A, van de Lisdonk E, Kan CC, Zitman FG. The role of craving in relapse after discontinuation of long-term benzodiazepine use. J Clin Psychiatry 2007;68:1894–1900. [PubMed: 18162020]

Nunnally, JC. Psychometrics. McGraw-Hill; New York: 1978.

Paliwal P, Hyman SM, Sinha R. Craving predicts time to cocaine relapse: further validation of the Now and Brief versions of the cocaine craving questionnaire. Drug Alcohol Depend 2008;93:252–259. [PubMed: 18063320]

Perkonigg A, Goodwin RD, Fielder A, Behrendt S, Beesdo K, Lieb R, Wittchen HU. The natural course of cannabis use, abuse and dependence during the first decades of life. Addiction 2008;103:439–449. [PubMed: 18269364]

Pickens RW, Johanson CE. Craving: consensus of status and agenda for future research. Drug Alcohol Depend 1992;30:127–131. [PubMed: 1633752]

Rao CR. An asymptotic expansion of the distribution of Wilks' criterion. Bull Int Stat Inst 1951;33:177–181.

Sayette MA, Shiffman S, Tiffany ST, Niaura RS, Martin CS, Shadel WG. The measurement of drug craving. Addiction 2000;95:S189–210. [PubMed: 11002914]

Schmitt N. Uses and abuses of cofficient alpha. Psychol Assess 1966;8:350–353.

Singleton EG, Trotman AJ, Zavahir M, Taylor RC, Heishman SJ. Determination of the reliability and validity of the Marijuana Craving Questionnaire using imagery scripts. Exp Clin Psychopharmacol 2002;10:47–53. [PubMed: 11871362]

Steiger JH. Tests for comparing elements of a correlation matrix. Psychol Bull 1980;87:245–251.

Stinson FS, Ruan WJ, Pickering R, Grant BF. Cannabis use disorders in the USA: prevalence, correlates and co-morbidity. Psychol Med 2006;36:1447–1460. [PubMed: 16854249]

Substance Abuse and Mental Health Services Administration. US Department of Health and Human Services Publication No. SMA 07-4293. Substance Abuse and Mental Health Services Administration; Rockville, MD: 2007. Results from the 2006 National Survey on Drug Use and Health: National Findings.

ten Berge JMF. Rotation to perfect congruence and the cross-validation of component weights across populations. Multivariate Behav Res 1986;21:41–64.

Tiffany ST. A critique of contemporary urge and craving research: methodological, psychometric, and theoretical issues. Adv Behav Res Ther 1992;14:123–139.

Tiffany ST, Carter BL, Singleton EG. Challenges in the manipulation, assessment and interpretation of craving relevant variables. Addiction 2000;95:S177–187. [PubMed: 11002913]

Tiffany ST, Singleton E, Haertzen CA, Henningfield JE. The development of a cocaine craving questionnaire. Drug Alcohol Depend 1993;34:19–28. [PubMed: 8174499]

Vandrey RG, Budney AJ, Hughes JR, Liguori A. A within-subject comparison of withdrawal symptoms during abstinence from cannabis, tobacco, and both substances. Drug Alcohol Depend 2008;92:48–54. [PubMed: 17643868]

Verheul R, van den Brink W, Geerlings P. A three-pathway psychobiological model of craving for alcohol. Alcohol Alcohol 1999;34:197–222. [PubMed: 10344781]

Wewers ME, Rachfal C, Ahijevych K. A psychometric evaluation of a visual analogue scale of craving for cigarettes. West J Nurs Res 1990;12:672–681. [PubMed: 2238644]

Wolfling K, Flor H, Grüsser SM. Psychophysiological responses to drug-associated stimuli in chronic heavy cannabis use. Eur J Neurosci 2008;27:976–983. [PubMed: 18333968]

World Health Organization. International Statistical Classification of Diseases and Health Related Problems. ICD-10. World Health Organization; Geneva: 2005.

Wrigley CS, Neuhaus JO. The matching of two sets of factors. Am Psychol 1955;10:418–419.
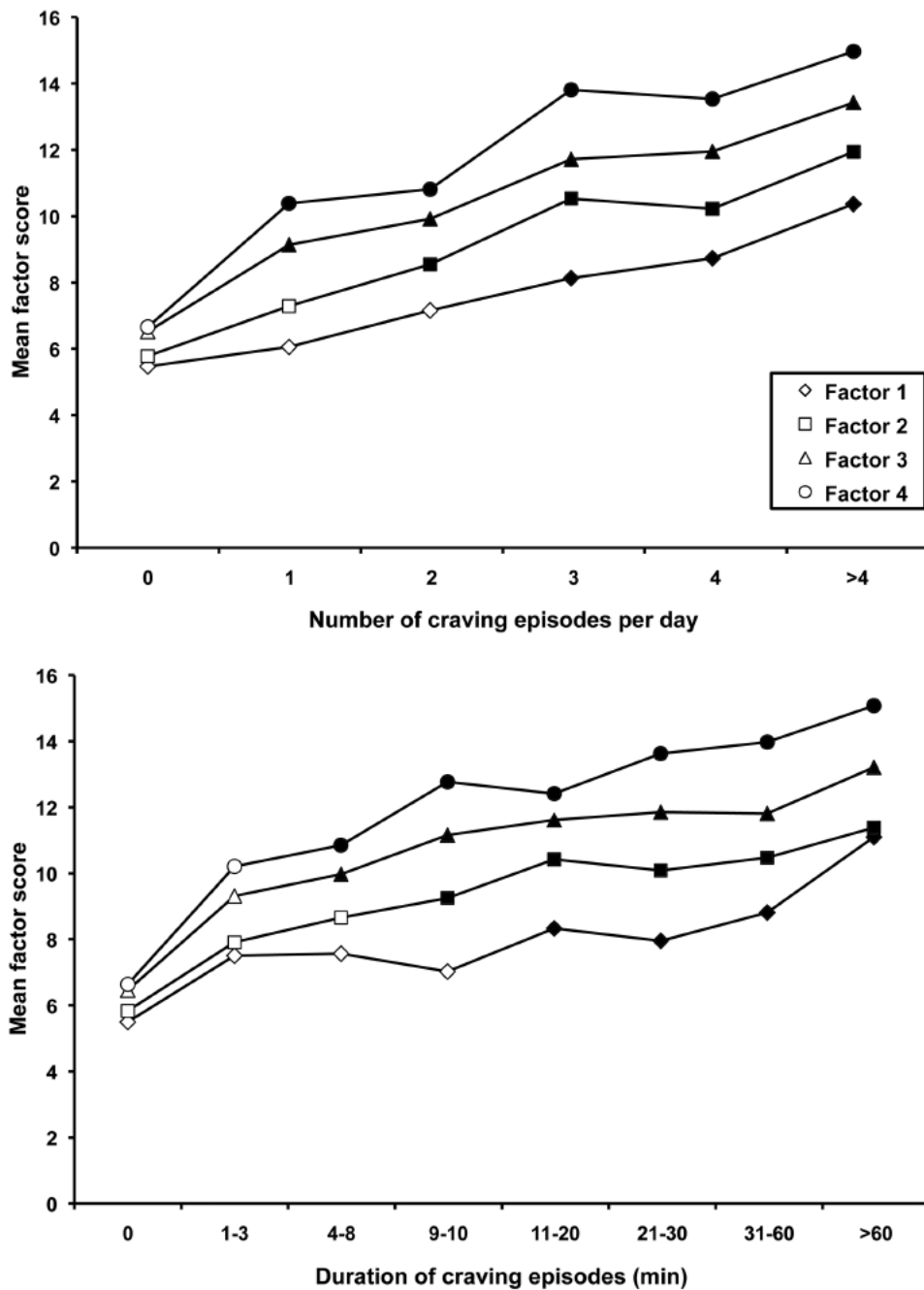
Fig. 1.
Mean scores for Factor 1 (*compulsivity*), Factor 2 (*emotionality*), Factor 3 (*expectancy*), and Factor 4 (*purposefulness*) of the Marijuana Craving Questionnaire-Short Form as a function of self-reported frequency of daily craving episodes (top panel) and duration of average craving episode (bottom panel) during the past week. Filled symbols indicate a significant (*p* < 0.05) difference from zero.

Table 1

Factor Structure of the Marijuana Craving Questionnaire-Short Form

Factor 1 (*Compulsivity*)

2.	I could not easily limit how much marijuana I smoked right now.
7.	I would not be able to control how much marijuana I smoked if I had some here.
10.	I need to smoke marijuana now.

Factor 2 (*Emotionality*)

4.	I would feel more in control of things right now if I could smoke marijuana.
6.	If I smoked marijuana right now, I would feel less tense.
9.	I would feel less anxious if I smoked marijuana right now.

Factor 3 (*Expectancy*)

5.	Smoking marijuana would help me sleep better at night.
11.	If I were smoking marijuana right now, I would feel less nervous.
12.	Smoking marijuana would make me content.

Factor 4 (*Purposefulness*)

1.	Smoking marijuana would be pleasant right now.
3.	Right now, I am making plans to use marijuana.
8.	It would be great to smoke marijuana right now.

Table 2

Oblique rotated factor matrix for the Marijuana Craving Questionnaire (MCQ) and Marijuana Craving Questionnaire-Short Form (MCQ-SF)

Item	Factor 1 Compulsivity		Factor 2 Emotionality		Factor 3 Expectancy		Factor 4 Purposefulness	
	MCQ[a]	MCQ-SF[b]	MCQ[a]	MCQ-SF[b]	MCQ[a]	MCQ-SF[b]	MCQ[a]	MCQ-SF[b]
1.	.10	.07	.25	-.11	.14	.43	**.51**	**.62**
2.	**.63**	**.45**	.08	.02	.02	.05	.03	.10
3.	.29	.36	.09	.07	.18	.05	**.46**	**.58**
4.	.02	.30	**.68**	**.32**	.07	.11	.16	.27
5.	.07	-.03	-.07	.27	**.45**	**.32**	.06	.24
6.	-.13	-.01	**.63**	**.44**	.08	.46	.12	.12
7.	**.64**	**.67**	-.06	-.23	.09	.45	.20	-.36
8.	.27	.11	.21	-.04	.24	.48	**.77**	**.62**
9.	-.15	.00	**.60**	**.59**	-.06	.49	-.01	.05
10.	**.72**	**.65**	.10	.38	.05	-.15	.27	.35
11.	.20	.14	.11	.66	**.65**	**.38**	.16	-.04
12.	.23	.05	.26	.31	**.36**	**.41**	.20	.35

Bolded factor loadings indicate target (MCQ) and comparison (MCQ-SF) item pattern.

[a]MCQ validation study ($n = 217$; Heishman et al., 2001).

[b]MCQ-SF validation study ($n = 490$; present study).