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Evaluation of the brief questionnaire of smoking urges (QSU-brief) in laboratory and clinical settings

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A brief, 10-item version of the Questionnaire of Smoking Urges (QSU; Tiffany & Drobes, *British Journal of Addiction* 86:1467–1476, 1991) was administered to 221 active cigarette smokers in a laboratory setting (Study 1) and to 112 smokers enrolled in a comprehensive smoking cessation program (Study 2). In the laboratory setting, craving to smoke was evaluated in response to neutral and smoking-related stimuli. In the clinical setting, craving was assessed prior to cessation and again during treatment. Factor analyses revealed that a two-factor solution best described the item structure of the QSU-Brief across conditions. Factor 1 items reflected a strong desire and intention to smoke, with smoking perceived as rewarding for active smokers. Factor 2 items represented an anticipation of relief from negative affect with an urgent desire to smoke. The findings were consistent with the expressions of craving found in the 32-item version of the QSU (Tiffany & Drobes, 1991). Regression analyses demonstrated stronger baseline mood intensity and self-reported tendency to smoke to achieve pleasurable effects and to experience the desire to smoke when cigarettes are unavailable were predictive of general levels of craving report in active smokers in the laboratory and clinical setting. The findings supported a multidimensional conceptualization of craving to smoke and demonstrated the utility of a brief multidimensional measure of craving.

Introduction

The conceptualization of craving to smoke is theoretically and clinically central to understanding continued cigarette use and relapse. Therefore, it is important to develop psychometrically sound assessments of craving for both research and clinical work on nicotine dependence. Craving is the most prominent and bothersome symptom experienced during nicotine withdrawal (Shiffman & Jarvik, 1976; West, Hajek, & Belcher, 1989) and is anticipated by smokers as the most difficult aspect of quitting (Orleans, Rimer, Cristinzio, Keintz, & Fleisher, 1991). In addition, cravings may be significant predictors of smoking relapse (Doherty, Kinnunen, Militello, & Garvey, 1995; Killen, Fortmann, Newman, & Varady, 1991; Shiffman, Engberg, Paty, Perz, Gnys, Kassel, & Hickcox, 1997; Swan, Ward, & Jack, 1996, Killen & Fortmann, 1997). Given that craving may impede smoking cessation, an improved understanding of the development, course, and nature of craving may lead to advanced strategies for reducing craving or increasing smokers' abilities to cope with craving. The ability to reliably assess craving may provide information regarding the impact of current treatment strategies on craving or the need for enhanced cessation treatment. Furthermore, if craving is predictive of relapse, craving assessment may identify smokers at greatest risk for treatment failure and allow necessary changes in individual treatment planning.

Many models of drug use view urges and cravings as subjective, motivational states responsible for ongoing drug use and the inception of relapse. These models generally conceptualize craving in relation to (1) negatively reinforcing effects of drug withdrawal (e.g., Ludwig & Wikler, 1974; Shiffman, 1979; West & Schneider, 1987), (2) positively reinforcing drug effects related to appetitive drug use (e.g., Robinson & Berridge,

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1993; Wise, 1988), or (3) a combination of both negatively and positively reinforcing effects (e.g., Baker, Morse, & Sherman, 1987). Within these models, craving is assumed to drive drug-use behavior. An alternative cognitive model (Tiffany, 1990) proposes that craving may operate independently of drug use. In this model, cravings are not assumed to index directly the central motivational processes leading to drug use or relapse. The model contends that craving arises from the interruption of highly automated drug-use sequences in the addict. When activated, craving represents the addict's effortful cognitive processing devoted to either interrupting or aiding drug-use behavior. This theoretical model specifically maintains that the addict's intention whether or not to use drugs should have some influence over the features of craving report. The model predicts that desire and intent to use drugs will be strongly coupled in active smokers who will work to overcome obstacles to smoking. In contrast, desire and intention to smoke may become uncoupled in individuals who are trying to quit smoking (Tiffany, 1990).

Although the concept of craving is central to clinical and theoretical considerations of addiction, the development of craving assessment has been limited. Until recently, clinical and laboratory research has assessed craving with instruments having questionable psychometric properties. The majority of studies have measured craving with single face-valid items (e.g., Abelin, Muller, Buehler, Vesanen, & Imhof, 1989; Daughton *et al.*, 1991; Doherty *et al.*, 1995; Glassman, Jackson, Walsh, Roose, & Rosenfield, 1984; Gross & Stitzer, 1989; Hughes, Hatsukami, Pickens, Krahn, Malin, & Luknic, 1984; Merz, Keller-Stanislawski, Huber, Woodcock, & Rietbrock, 1993; Nil, Buzzi, & Battig, 1984). Such assessment only permits a unidimensional picture of craving, and the reliability of a single-item measure cannot be determined (Tiffany, 1992). A few studies have added a second item addressing how often a smoker experiences craving during the day (e.g., West *et al.*, 1989; West, Hajek, & Belcher, 1987), or how upsetting craving is to a smoker (Killen *et al.*, 1991). Some multiple-item questionnaires have been developed (e.g., five items, West, Jarvis, Russell, Carruthers, & Feyerabend, 1984; seven items, Shiffman & Jarvik, 1976) but have limited utility due to validation with small samples, lack of information about psychometric properties of the scales, and a unidimensional conceptualization of craving.

Tiffany and Drobes (1991) developed the Questionnaire on Smoking Urges (QSU) to provide a more reliable measure and to assess the potential multidimensional nature of craving report. The QSU consists of 32 items comprising four putative features of craving including anticipation of relief of nicotine withdrawal, anticipation of positive outcomes of smoking, desire to smoke, and intention to smoke. The diversity of item content permitted a broad view of the semantic structure of craving report consistent with multiple theoretical conceptualizations of craving. Exploratory factor analysis of the QSU administered to 230 current smokers found a two-factor item structure representing (1) a desire and intention to smoke with smoking anticipated as pleasurable, and (2) an anticipation of relief from negative affect and nicotine withdrawal, with an urgent desire to smoke (Tiffany & Drobes, 1991). The quality of desire represented on the first factor was characterized by items such as 'I have an urge for a cigarette,' and 'I have no desire for a cigarette right now' (negatively keyed). In contrast, the second factor appeared to represent a more pressing and urgent state of desire as indicated by items such as 'All I want right now is a cigarette,' and 'My desire to smoke seems overpowering.' The empirically derived two factor structure was found in smokers abstinent from cigarettes for 0, 1, or 6 h. Scores representing these two factors demonstrated strong internal consistency (Cronbach's alpha=0.95 and 0.93, respectively).

Because of its length, the QSU is impractical for use in laboratory settings when multiple craving assessments are necessary or for clinical settings when craving assessment is combined with additional measures. Therefore, an abbreviated questionnaire was developed to represent the two factors found in the longer QSU. The items taken from the original QSU were selected (1) on the strength of the factor loadings of each item, and (2) on the ability of the items to maintain semantic content broad enough to capture various conceptualizations of craving. The resulting QSU-Brief form contains 10 items and can be completed in less than 2 min. Individuals are instructed to respond to statements using a 100-point scale ranging from strongly disagree to strongly agree. The QSU-Brief has been used in numerous laboratory studies with continuing smokers (Burton & Tiffany, 1997; Cepeda-Benito & Tiffany, 1996; Drobes, Meier, & Tiffany, 1994; Drobes & Tiffany, 1997; Elash, Tiffany, & Vrana, 1995; Maude-Griffin & Tiffany, 1996; Tiffany, Cox, & Elash, in press; Tiffany & Drobes, 1990, 1991). Although the QSU-Brief has produced consistent findings across studies, its psychometric properties have not been systematically evaluated.

The primary goals of the current study were to establish the utility of the QSU-Brief as a comprehensive measure of craving to smoke and to evaluate further the nature of craving. Craving was assessed in 221 cigarette smokers in laboratory studies involving neutral and smoking cues as well as in 112 smokers before and during participation in a cessation treatment program. This study permitted evaluation of craving to smoke expressed (1) by active smokers with no intention of quitting as compared to smokers quitting in a clinical setting, and (2) by the same individuals before and after quitting. Such evaluation is critical in order to examine whether a single measure can be used to assess craving report across laboratory and clinical settings. In order to appraise the unidimensional or multidimensional nature of craving, this research also evaluated the factor structure of the QSU-Brief and measured the stability of

that structure and the correlates of craving factors under a variety of conditions.

Study 1: Laboratory-based evaluation

Study 1 was designed to examine the psychometric properties and factor structure of the QSU-Brief used with active smokers in a laboratory setting. The data from part of three laboratory studies (Burton & Tiffany, 1997; Drobes & Tiffany, 1997; Tiffany *et al.*, in press) were combined for evaluation in the current study. Each of these studies involved subject participation in two sessions. The procedures of the first session were identical in each study: therefore, current analyses were restricted to data collected from the first session of each of the three studies. Craving was measured when smokers were exposed to neutral and craving-inducing stimuli.

The expression of craving measured by the QSU-Brief might be best described as capturing global or general craving. Alternately, craving report on the QSU-Brief may display two distinct facets of craving, as has been found with the long QSU. If the construct of craving has a latent structure involving multiple dimensions, it would be important to identify whether the QSU-Brief captures such distinct conceptualizations. Confirmatory maximum-likelihood factor analysis was used to test explicitly the hypothesis, based on data from evaluation of the original QSU (Tiffany & Drobes, 1991), that a multiple-factor structure of craving expression would emerge within the QSU-Brief scores and that this structure would be consistent with findings from the QSU.

The data from this study also were examined in order to identify individual differences that might be correlated with craving. Tiffany and Drobes (1991) found QSU craving report was significantly associated with individual smoking motivation, but was not associated with positive or negative mood. In contrast, other studies have demonstrated a strong relationship between craving to smoke and mood states (e.g., Piasecki, Kenford, Smith, Fiore, & Baker, 1997). Identification of individual characteristics found to be significantly associated with craving to smoke would potentially enhance current models of drug craving and facilitate understanding of individual differences in craving response. Therefore, baseline assessment of smoking history, mood, and smoking motivation were examined as correlates of subsequent craving to smoke.

Method

Participants. Participants were 221 current cigarette smokers recruited from the general community in Lafayette and West Lafayette, Indiana. Participants were required to be at least 18 years of age, smoke at least one pack of cigarettes per day, and have no current plan to quit smoking as reported during a telephone screening interview. Table 1 provides a summary of demographic and smoking history information. Of the 221 participants, 172 (77.8%) had made at least one quit attempt in the past.

Table 1. Participant characteristics, mean (SD)

	Study 1 Continuing smokers	Study 2 Smokers contemplating quitting/actively abstaining
N	221	112
Age	30.23 (10.27)	43.15 (11.60)
Male/female	111/110	49/63
Cigarettes/day	26.95 (10.68)	27.82 (12.57)
Age began smoking	13.88 (3.55)	15.33 (4.20)
Quit attempts	3.50 (2.63)	4.40 (2.62)
Quit confidence*	1.93 (0.98)	2.66 (1.26)

* Item 'If you were to try to quit smoking now, how confident are you that you could go for 1 year without smoking?' rated 0=no confidence, 5=extreme confidence.

Measures. The Reasons for Smoking Questionnaire (RFS) is a self-report measure differentiating six identified motives for smoking (Horn & Waingrow, 1966; Ikard, Green, & Horn, 1969). The Mood Form (Diener & Emmons, 1984) is a self-report measure of positive and negative affect. The QSU and QSU-Brief measured self-reported craving to smoke.

Procedures. The laboratory sessions for all participants began between 8 a.m. and 12 p.m. and lasted approximately 90 min. Individuals provided informed consent and completed the Mood Form and QSU. Participants then smoked one cigarette of their own brand so as to equate participants on amount of time since their last cigarette. Participants also completed the Reasons for Smoking Questionnaire (RFS) and a smoking history form. An imagery/*in vivo* procedure was used to manipulate smoking urges. The procedure involved (1) four imagery trials in which participants vividly imagined audio-taped scripts having smoking (urge) or neutral content interspersed with (2) four *in vivo* trials in which participants watched the experimenter either light and smoke a cigarette (urge) or drink water (neutral). Trials were spaced by an interval of 5 min. The mode of presentation and urge content of the stimulus materials were ordered randomly for each subject. After each trial, participants rated the intensity of their cravings to smoke by completing the QSU-Brief. This imagery/*in vivo* procedure has consistently produced significantly greater self-reported craving in response to smoking-related stimuli relative to neutral cues (for detailed analyses, see Burton & Tiffany, 1997; Drobes & Tiffany, 1997; Tiffany *et al.*, in press). While the basic procedures were identical within the three studies, two of the studies (Drobes & Tiffany, 1997; Tiffany *et al.*, in press) included a total of 12 trials. In order to equate the comparison within the current study, only the first two of three administrations of any of the four trial types were utilized from the 12-trial studies.

Data analyses. Because questionnaires from an individual subject were non-independent, the data from multiple administrations were aggregated. Furthermore, because previous analyses had revealed no systematic difference in craving level as a function of mode of cue manipulation (e.g., Drobes & Tiffany, 1997), data from imagery and *in vivo* trials were collapsed based on urge content. Therefore, for each participant, an average QSU-Brief score was determined from the four urge trials (two urge–imagery, two urge–*in vivo*) and the four neutral trials (two neutral–imagery, two neutral–*in vivo*).

Maximum-likelihood factor analysis was utilized to determine if the QSU-Brief maintained the hypothesized two-factor structure originally found in the QSU. In the case of emergence of a multiple factor-structure, item loadings for both conditions were indexed by the reference-vector pattern matrix. Subscales were formed by assigning each item to a scale if it loaded 0.40 or greater on a given factor and less than 0.25 on the other factor, and if the item loadings for the two factors differed by at least 0.20. Replication of the factor structure of the original QSU would produce variables loading according to the following model specification: Factor 1 would include items 1, 3, 6, 7, 10 and Factor 2 would include items 2, 4, 5, 8, 9. The findings from factor analyses of the QSU-Brief from the No Urge and Urge stimulus conditions are presented in Table 2. The adequacy of the confirmatory solution was evaluated using a chi-square test ($p<0.01$). Finally, multiple regression analyses were used to evaluate the relationship between craving factors measured with the QSU-Brief and baseline self-reported smoking history, smoking motivation, and mood. The significance level for these analyses was set at 0.01. The statistical package *SPSS for Windows* was used for these analyses.

Results and discussion

QSU-Brief factor analyses. Maximum-likelihood factor analyses indicated that a multiple-factor structure best captured the data for both conditions (Table 2). These factors were generally consistent with the findings from the evaluation of the original QSU. The chi-square test demonstrated that a two-factor solution in the No Urge (χ^2=213.75, df=26) and Urge (χ^2=214.38, df=26) conditions provided a better estimate of the model ($p<0.001$) when compared with a single-factor solution for the No Urge (χ^2=513.66, df=35) and Urge (χ^2=612.58, df=35) data. Although these findings suggested more than two latent variables might exist in this data set, analysis of three factors revealed multiple communality estimates greater than 1.0 and thereby produced an improper solution.[1] (Correlation matrices for all 10 items for these and subsequent samples are available from the authors.)

Analysis of the two-factor solution for data from the No Urge condition showed the two separate factors accounted for 78.9 and 5.8% of the item variance, respectively. The two factors demonstrated inter-factor correlation of 0.796, indicating the presence of a second-order craving factor. Higher-order analysis showed that the two primary factors loaded 0.89 on the second-order factor. Items 1, 3, 6, 7, and 10 emerged within the first factor, supporting the hypothesized structure derived from the QSU Factor 1. Items 4, 8, and 9 were found within a second factor consistent with the items loading on the QSU Factor 2 (items 2, 4, 5, 8, 9). QSU-Brief Factors 1 and 2 yielded strong internal consistency coefficients within the No Urge condition (Cronbach's alpha=0.96, 0.93 respectively).

In the Urge condition, the two factors accounted for 77.3 and 8.3% of the variance, respectively. Factor 1 (items 1, 3, 6, 7, 10) and Factor 2 (items 4, 8, 9) demonstrated high reliability (alpha=0.97, 0.92, respectively). The significant inter-factor correlation of these primary factors (0.731) revealed the presence of a second-order factor: higher order analysis demonstrated the two factors loaded 0.85 on the second-order factor.

When the 10 items were used as a single global measure of craving within the No Urge and Urge conditions, the QSU-Brief demonstrated excellent reliability (Cronbach's alpha=0.97 for both conditions). This global measure from the QSU-Brief was significantly

Table 2. Factor structure of QSU-Brief items in Study 1

Item	No urge		Urge	
	Factor 1	Factor 2	Factor 1	Factor 2
1. I have a desire for a cigarette right now.	**0.896**	0.007	**0.884**	0.081
2. Nothing would be better than smoking a cigarette right now.	*0.434*	0.565	0.487	0.526
3. If it were possible, I probably would smoke now.	**0.934**	−0.040	**0.992**	−0.057
4. I could control things better right now if I could smoke.	0.149	**0.777**	0.006	**0.882**
5. All I want right now is a cigarette.	*0.547*	0.473	0.553	0.477
6. I have an urge for a cigarette.	**0.898**	0.087	**0.897**	0.068
7. A cigarette would taste good now.	**0.933**	−0.103	**1.009**	−0.100
8. I would do almost anything for a cigarette now.	0.036	**0.913**	0.139	**0.797**
9. Smoking would make me less depressed.	−0.083	**0.930**	−0.076	**0.901**
10. I am going to smoke as soon as possible.	**0.755**	0.160	**0.878**	0.064

Bold: items assigned to respective factors; italics: items loaded on both factors.

correlated with the global craving score of the full length QSU (r=0.5123, p<0.001).

Regression analyses. The total QSU-Brief score averaged across the Urge and No-Urge conditions was used within a simultaneous multiple regression analysis to regress this global craving score on demographic and smoking history data, baseline RFS subscale scores, and baseline Mood Form scores. In this analysis, the overall regression model was significant, sR^2=0.398, F(13,201)=10.21, p<0.0001. Examination of the standardized beta weights for the variables in the model demonstrated that Negative Mood, beta=0.261, F(1, 201)=18.68, p<0.0001, Positive Mood, beta=0.247, F(1,201)=12.83, p<0.001, and RFS Stimulation score, beta=0.192, F(1,201)=11.05, p<0.01, contributed significantly and positively to the prediction of QSU-Brief global craving report. In order to examine unique baseline predictors of each QSU-Brief factor scale independent of the other factor scale, simultaneous multiple regression analyses were conducted separately on covariate-adjusted Factor 1 and Factor 2 scores (averaged across urge conditions). The adjusted scores were created by covarying each factor score from the other score. These analyses showed that the overall model for predicting the covariate-adjusted QSU-Brief Factor 1 scores was significant, sR^2=0.125, F(13, 201)=2.21, p<0.01. Within this model, RFS Craving scores were associated significantly with higher Factor 1 scores, beta=0.240, F(1, 200)=7.15, p<0.01. The overall model for predicting covariate-adjusted Factor 2 scores was also significant, sR^2=0.155, F(13, 200)=2.827. Within this model, higher Negative Mood scores were predictive of higher Factor 2 scores, beta=0.222, F(1, 200)=9.60, p<0.01. A comparison of the models generated to predict adjusted Factor 1 and Factor 2 scores revealed that the regression parameters for these two models differed significantly, F(13, 200)=1.90, p<0.05.

Summary. The analyses showed that the QSU-Brief provided a highly reliable assessment of craving report in a laboratory setting with active smokers exposed to neutral and smoking-related stimuli. This brief measure was significantly correlated with the original QSU. Predictors of general craving in response to neutral or smoking cues included a propensity to report more intense negative and positive mood, and to report a tendency to smoke for stimulation. The analyses of the QSU-Brief responses revealed two facets of craving report, consistent in content with the full QSU. Factor 1 represented a desire and intention to smoke with smoking perceived as rewarding, while Factor 2 of the QSU-Brief represented an anticipation of relief from negative affect with an urgent desire to smoke. Factor–1 craving was predicted by a self-reported tendency to experience urges to smoke when cigarettes were unavailable. In contrast, more intense negative mood was predictive of Factor–2 craving across stimulus conditions. This latter finding is not surprising in light of the interpretation of Factor 2 as reflecting, in part, the belief that smoking would relieve dysphoria. Presumably, a smoker would be more likely to describe craving as relief from negative affect to the extent that he or she was experiencing some degree of negative affect at the time of the assessment. Overall, these findings support the conceptualization of these two factors as distinct expressions of craving that provide unique perspectives on two different aspects of craving to smoke.

Study 2: Clinically based evaluation

Method

Participants. Participants were 112 adult chronic, daily cigarette smokers treated in the outpatient clinic of the Indiana University Nicotine Dependence Center, Indianapolis, Indiana. Data were collected through chart abstraction. Individuals included in this study attended an initial evaluation and at least one follow-up session and had completed forms on record. Table 1 provides selected demographic and smoking history information for participants in Study 2. One hundred and seven participants (95.5%) had made at least one quit attempt prior to entering the treatment program. Relative to the continuing smokers in Study 1, participants in Study 2 were older, were older at the age of first cigarette, made more quit attempts in the past, and had greater confidence in their ability to quit smoking (p<0.05).

Procedures. Nicotine dependence treatment was based on the modified protocol of the Mayo Clinic Model (Hurt *et al.*, 1992; Christen, McDonald, Klein, Christen, & Guba, 1994). Treatment included individual counseling, psychoeducation, and use of nicotine polacrilex gum, nicotine transdermal patches, or a combination of both nicotine replacement products. A trained nicotine dependence counselor conducted treatment.

Participants attended an initial planning session to discuss quitting smoking, learn about the treatment program, obtain baseline data, review completed questionnaires (health history survey, smoking history, RFS, Mood Form, QSU-Brief), discuss and plan treatment options, gain initial counseling, and set a quit date within 2 weeks of the initial session. The quit-date session occurred the day prior to quitting smoking; participants received information about the use of nicotine replacement products during treatment. Approximately one week after quitting smoking, participants returned for a follow-up session to review progress, alter medication dosage if required, and receive additional counseling. Participants again completed the Mood Form and QSU-Brief at the follow-up session.

Data analyses. The data analytic plan for Study 2 followed the procedures used in Study 1. Maximum-likelihood factor analyses of the QSU-Brief were conducted on questionnaires administered during (1) the Initial Session (pre-treatment baseline for smokers

Table 3. Factor structure of QSU-Brief items in Study 2

Item	Initial session		Follow-up session	
	Factor 1	Factor 2	Factor 1	Factor 2
1. I have a desire for a cigarette right now.	**0.830**	0.043	**0.953**	−0.066
2. Nothing would be better than smoking a cigarette right now.	*0.301*	0.565	0.420	0.431
3. If it were possible, I probably would smoke now.	**0.836**	−0.079	*0.400*	0.312
4. I could control things better right now if I could smoke.	−0.078	**0.648**	−0.021	**0.646**
5. All I want right now is a cigarette.	0.176	**0.703**	*0.336*	0.589
6. I have an urge for a cigarette.	**0.750**	0.078	**0.741**	0.162
7. A cigarette would taste good now.	**0.556**	0.149	*0.335*	0.385
8. I would do almost anything for a cigarette now.	0.078	**0.684**	0.017	**0.735**
9. Smoking would make me less depressed.	−0.035	**0.571**	−0.073	**0.610**
10. I am going to smoke as soon as possible.	**0.602**	−0.030	*0.214*	*−0.022*

Bold: items assigned to respective factors; italics: items loaded on both factors.

contemplating quitting smoking), and (2) the 1-week Follow-up Session (in treatment, abstinent smokers) to identify whether the two-factor structure found in Study 1 was maintained in Study 2.

Results and discussion

QSU-Brief factor analyses. The findings from factor analyses of the QSU-Brief in the Initial and Follow-up Sessions are reported in Table 3. Subscales were formed for the factors using the same conventions described for Study 1. As in Study 1, analyses of data from the Initial Session revealed multidimensional expression of craving. Chi-square testing demonstrated that, compared to a single-factor solution (χ^2=117.43, df=35), a two-factor solution (χ^2=62.55, df=26) provided a better reproduction of the data (p<0.001). A three-factor solution (χ^2=33.32, df=18) was unable to provide a better solution for the craving data.

The two factors from the Initial Session accounted for 45.7 and 7.2% of the item variance, respectively, and demonstrated an inter-factor correlation of 0.685. Higher order analysis showed that the two primary factors loaded 0.83 on the second order factor. Consistent with the findings from the QSU-Brief in Study 1, items 1, 3, 6, 7, and 10 loaded on the first factor. Items 4, 5, 8, and 9 emerged as a second factor generally consistent with findings from Study 1 (items 4, 8, 9). Within the Initial Session, separate analysis of Factors 1 and 2 produced strong to moderate internal consistencies (alpha=0.86, 0.78 respectively).

Within the Follow-up Session, a two-factor solution (χ^2=68.59, df=26) provided a better estimate (p<0.001) of the QSU-Brief craving data than a single-factor solution (χ^2=108.49, df=35). As in Study 1, a three-factor model produced an improper factor solution (multiple communality estimates>1.0). The two separate factors found within the Follow-up Session accounted for 43.6 and 6.8% of the variance, respectively. Factor 1 contained items 1 and 6 (alpha=0.76). Factor 2 replicated the subscale found in Study 1 (items 4, 8, 9) and had comparable reliability, alpha=0.70. These findings were similar to the structure found in the Initial Session and in Study 1. Items 2, 3, 5, 7, and 10 loaded on both factors. Factors 1 and 2 exhibited an inter-factor correlation of 0.599 and higher-order analysis found that the two primary factors loaded 0.77 on the second order factor.

Although the two-factor structure may provide additional information about the expression of craving, reduced reliability of the individual factor scores and potential existence of additional latent variables may promote the use of the total QSU-Brief as a general craving measure in the clinical setting. When scored as a 10-item scale, the QSU-Brief demonstrated high reliability as a measure of global craving in both the Initial and Follow-up Sessions (alpha=0.89 and 0.87, respectively).

Stages of change. An ANOVA on total QSU-brief craving data showed a significant main effect of session, F(1,110)=128.614, p<0.001. Global craving scores were greater in the initial session when individuals were contemplating quitting (mean±SD: 47.57±22.57), relative to follow-up session when individuals were abstaining in treatment (17.55±15.98). Thus, craving to smoke was more severe when individuals were still smoking but contemplating abstinence and less severe following approximately 1 week of treatment. These findings were consistent with the observation that active smokers frequently report some degree of craving even without nicotine deprivation (e.g., Hughes, 1992). Such findings are of interest given smokers' concerns about struggling with craving during abstinence.

Regression analyses. The total QSU-Brief score was used within a multiple regression analysis in order to evaluate whether the baseline variables predictive of craving in Study 1 (Negative and Positive Mood scores, RFS Stimulation score) would also predict craving in the clinical setting with smokers preparing to quit. QSU-Brief craving score was regressed on the three variables. Variables were entered into the regression equation simultaneously. Analysis of these three variables showed that the model predicted the total QSU-Brief score at the

Initial Session, R^2=0.181, $F(3, 105)$=7.75, p<0.0001. No other variables entered into the model produced any significant increase in the prediction of craving. These findings suggested that predictors of QSU-Brief craving report in the laboratory setting with active smokers were able to predict craving levels of active smokers in the clinical setting. Examination of the standardized beta weights for each of the three variables contained within this model demonstrated that the Negative Mood score, beta=0.266, $F(1, 104)$=8.75, p<0.01, and RFS Stimulation score, beta=0.238, $F(1, 104)$=7.03, p<0.01, contributed significantly to the model.

In order to identify unique predictors of each QSU-Brief factor scale collected from the Initial Session, regression analyses were conducted on each factor with the other factor forced first into the model. These analyses revealed no significant predictor of the adjusted Factor 1 score independent of the Factor 2 score. In contrast, the overall model predicting the covariate-adjusted Factor 2 scores was significant, R^2=0.263, $F(13, 90)$=2.67, p<0.01. However, none of the individual beta weights of the predictor variables was significantly different from zero.

Within the Follow-up Session, multiple regression analyses again were used in order to evaluate whether the baseline variables predictive of craving in Study 1 (Negative and Positive Mood scores, RFS Stimulation score) would predict craving in the clinical setting with smokers abstaining within treatment. This analysis demonstrated that the three-variable model significantly predicted QSU-Brief craving, R^2=0.246, $F(3,104)$=11.31, p<0.0001. No other variables entered into this model produced any significant increase in the prediction of craving. Within this three-variable model, Negative Mood displayed a significant positive association with craving, beta=0.268, $F(1, 103)$=8.32, p<0.01, whereas Positive Mood displayed a negative association with craving, beta=–0.299, $F(1, 103)$=10.45, p<0.01. A simultaneous regression model of covariate-adjusted Factor 1 from the Follow-up Session was significant, R^2=0.346, $F(13, 89)$=3.92, p<0.0001. Examination of the standardized beta weights across the predictors revealed that only Negative Mood contributed significantly to the model, beta=0.443, $F(1, 89)$=21.74, p<0.0001. The overall model for covariate-adjusted Factor 2 scores was also significant, R^2=0.245, $F(13, 89)$=2.40, p<0.01, but none of the beta weights of the predictors was significantly different from zero. A comparison of the models generated to predict adjusted Factor 1 and Factor 2 scores collected from the second session revealed that the regression parameters for these two models differed significantly, $F(13, 89)$=2.30, p<0.05. More extensive research is needed to determine if baseline differences other than those evaluated in these studies may predict craving and if craving correlates vary across stages of drug use.

Summary. Analyses of the QSU-Brief in a clinical-treatment setting demonstrated the continued reliability and utility of this multi-item craving measure. The global-craving score derived from the QSU-Brief displayed strong reliability in both sessions of this clinical study. Regression analyses revealed that the predictors of craving identified in Study 1 were significantly associated with the global-craving score from both sessions of Study 2. Notably, higher levels of negative mood were associated with higher craving levels on both sessions. On the other hand, positive mood report was correlated negatively with craving reports from session 2. This finding stands in contrast to the positive association between craving report and positive mood in Study 1.

The factor analyses revealed two moderately reliable craving factors that were generally consistent across phases of treatment. The two different presentations of craving to smoke can be viewed in terms of the specific content of the items within each factor. The Factor 1 scale reflected a desire and intention to smoke in both sessions, with reported anticipation of smoking producing pleasure or reward for active smokers.[2] Scores on this factor were associated with higher levels of negative mood in the second session. The Factor 2 scale represented an anticipation of relief from negative affect with an urgent desire to smoke. The factor-analytic findings, which were consistent with results from Study 1 and the full-length QSU (Tiffany & Drobes, 1991), provide evidence for two manifestations of craving evident across stages of drug use.

General discussion

These studies clearly established the reliability of the QSU-Brief within a controlled laboratory setting and an outpatient smoking cessation clinic and demonstrated that this measure was able to capture multidimensional features of self-reported craving. In the laboratory, the QSU-Brief was strongly correlated with the long version of the QSU. When used to derive a global measure of craving, the QSU-Brief displayed high internal consistency across settings with smokers at differing stages of drug use, providing convenient and reliable assessment of desire to smoke. Furthermore, factor analyses of the craving items yielded two distinct manifestations of verbal report of craving.[3] Factor 1 consistently represented a strong desire and intention to smoke, with smoking perceived as rewarding for active smokers, while Factor 2 reflected an anticipation of relief from negative affect and an urgent desire to smoke.

The overall latent structure of the QSU-Brief appeared to be hierarchical in nature, with a strong general craving factor that could be subdivided into two lower-order factors. This was the same basic structure identified with the full version of the QSU (Tiffany & Drobes, 1991). Because of the general stability of the two-factor structure of the QSU-Brief, this measure might be used to capture two distinct manifestations of craving across settings and stages of drug use. The use of the QSU-Brief to derive two distinct factor scores may be of particular import to researchers in terms of addressing models of

craving or assessing relationships between craving structure and other variables.[4]

It is important to consider that item differences in the specific structure of craving observed across settings may be related to differences in administration of the QSU-Brief. Within the controlled laboratory setting, this measure was administered eight times within a session. Repeated measures and aggregation of scores reduce error and contribute to greater structure stability and higher internal consistency. Because the QSU-Brief was administered only once within each session in the clinical setting to a fewer number of individuals, it is not surprising that the factors identified in this study had reduced stability, and reduced reliability. However, the findings from the current studies capture the psychometric properties of the QSU-Brief under conditions in which this measure would most commonly be used. An alternate explanation is that the observed difference in craving structure could reflect change in smoking deprivation rather than change in setting. Active smokers (Study 1, Initial Session of Study 2) may produce craving reports that are structurally different from those of individuals abstaining from cigarettes (Follow-up Session of Study 2). Further examination of craving structure as a function of smoking deprivation is merited.

Within the current evaluation it is notable that item 2 did not load on either Factor 1 or Factor 2. *Post hoc* factor analyses of the items without item 2 found that the current factor structures across studies were maintained in the absence of item 2. However, the current findings are presented including item 2 for the following reasons. First, as this is the first psychometric evaluation of the QSU-Brief, it may be premature to delete a given item because it did not display factor specificity in its loading. Such risk is pronounced when using confirmatory factor analyses that reduce the likelihood of reproducing identical factor loadings for all items. Furthermore, because the QSU-Brief was administered with all 10 items in the current research, future administrations of this questionnaire would be unable to generalize from the present psychometric data unless all items were administered. Finally, item 2 contributes to the general factor represented in the global craving score derived from aggregating across all 10 items: thus, the 10-item scale is appropriate for use as a global craving measure.

As suggested by the present data, each factor represented a somewhat different expression of craving to smoke. Measures of craving querying only the desire to smoke (Kozlowski, Mann, Wilkinson, & Poulos, 1989) or even multiple items of want, craving, and desire (Kozlowski, Pillitteri, Sweeney, Whitfield, & Graham, 1996) would not capture expressions of craving other than those directly reflecting statements of desire. Indeed, Kozlowski and colleagues (1996) examined an abbreviated version of the QSU and found that factor analyses replicated a two-factor structure. Although their analyses provided support for multidimensional concepts of craving, they concluded that a two- or three-item unidimensional scale was preferable to a multidimensional questionnaire (Kozlowski *et al.*, 1996). Such recommendations might be difficult to justify theoretically (Baker *et al.*, 1987; Tiffany, 1990) or empirically (e.g., Tiffany and Drobes, 1991; Tiffany, Singleton, Haertzen and Henningfield, 1993; Wilner, Hardman, & Eaton, 1995). The findings in the current study suggest the presence of at least two expressions of craving and support the use of craving measures able to capture distinct manifestations of craving report. Nevertheless, this distinction between craving dimensions may be less significant to researchers or clinicians with the goals of obtaining a general measure of craving.

Findings that multiple facets of craving are evident across samples, craving manipulations, and settings provide further support for theories of craving and drug use that do not solely embrace either positive or negative reinforcement conceptualizations of craving. Indeed, these findings support models that incorporate multidimensional perspectives. Baker and colleagues (Baker *et al.*, 1987) proposed a dual-affect model of drug motivation involving two distinct, incompatible (mutually inhibitory) urge networks related to affective information processing. In this model, positive affect urges involve an appetitive-motivation system while negative affect urges are withdrawal-based. While the two QSU-Brief craving factors might be broadly interpreted as representing positive-reinforcement urges and negative-reinforcement urges (e.g., Wilner *et al.*, 1995), certain aspects of the findings were not particularly consistent with the dual-affect model. Most critically, this model predicts that the two craving factors should be mutually inhibitory. The current studies showed that, although the two craving factors had distinguishable sets of predictors and represented semantically distinct expressions of craving, both factors were strongly, positively associated across all samples.

Because of infrequent craving assessment and lack of reliable assessment instruments, most treatment studies have been unable to provide a description of the duration or severity of craving during treatment and long-term abstinence (Cox, 2000). The present studies have made a contribution by developing another option for reliable measurement of craving. However, the current research is limited in terms of the frequency of assessment during treatment. The second study examined craving only in the initial period of cessation. Clearly, more information is needed about the expression of craving during initial cessation, during the course of treatment, and throughout abstinence maintenance. For example, the covariation of craving and withdrawal over the course of smoking cessation and abstinence maintenance should be examined. While general withdrawal symptoms initially increase and reliably decrease during the first few weeks of drug abstinence (Hughes, Higgins, & Bickel, 1994), craving may persist over time (Brigham *et al.*, 1991; Hughes, 1992). In order to examine more adequately the roles of cravings and withdrawal in drug use and in initial treatment outcome, it may be beneficial to better quantify and differentiate these factors.

Overall, the QSU-Brief offers an assessment of craving that provides numerous advantages over the conventional use of single-item craving ratings. The instrument is sufficiently short to allow for a rapid assessment of craving, yet it is long enough to generate an extremely reliable general craving score as well as capture possible multidimensional features of craving. The data indicated that the basic psychometric properties of the questionnaire remained relatively consistent across settings and samples. In summary, the results from the present studies suggested that the QSU-Brief offers a psychometrically sound measurement of craving to smoke suitable for use in both laboratory and clinical settings.

Notes

1. Communalities are the variance of an observed variable accounted for by common factors. Because they are squared correlations, communalities would be expected to lie between 0 and 1.0. A communality estimate greater than 1 produces an ultra-Heywood case, which implies that a unique factor has negative variance. Therefore, an ultra-Heywood case makes a factor solution invalid. The maximum-likelihood method is especially susceptible to ultra-Heywood cases. Potential causes of this problem include small samples producing fewer data than needed to provide stable estimates.
2. In the clinical setting, the semantic content of Factor 1 evidenced change from the expression of a desire to smoke with smoking anticipated as positively reinforcing by individuals preparing to quit, to the expression of desire only when those individuals abstained in treatment. This observed change in Factor 1 content may reflect a real change in craving expression across phases of drug use. In contrast, the observed changes could be a function of properties of the confirmatory factor analyses. By definition, confirmatory factor analyses are restricted solutions. Estimated parameters become less consistent as variance across samples increases, and large samples are needed to minimize sensitivity to small variance (Gorsuch, 1983). Therefore, further examination of the specific structure and semantic meaning of craving as measured by QSU-Brief is needed to further clarify this issue.
3. In evaluating the two-factor structure of the 32-item QSU, Tiffany and Drobes (1991) examined the potential that two factors emerged as a result of negatively keying certain items, and that subsequent reverse scoring could influence the formation of a distinct factor. The authors concluded that there was not evidence to support such a concern. In the current study, the 10-items of the QSU-Brief are positively worded, and therefore the two factors could not have emerged as a result of method variance associated with reverse scoring. The finding that the two factors from the QSU-Brief are consistent with the factor structure of the original QSU provides additional support that these factors represent distinct expressions of craving independent of positive or negative item structure.
4. For example, Wilner, Hardman, & Eaton (1995) used the 32-item QSU to examine the relationship between self-reported craving to smoke and actual smoking behavior in nicotine deprived and non-deprived smokers. Findings supported the two-factor structure of the QSU and demonstrated that smoking behavior was more strongly associated with positive reinforcement (Factor 1) in non-deprived smokers, but become more strongly associated with negative reinforcement (Factor 2) during abstinence. The authors concluded that these findings suggest processes conceptualized within a negative reinforcement model may account, in part, for initial lapse to smoking, while positive reinforcement theories may be better suited for explanation of continued drug use.

References

Abelin T, Muller P, Buehler A, Vesanen K, Imhof PR. 1989. Controlled trial of transdermal nicotine patch in tobacco withdrawal. *Lancet* 1:7–10.

Baker TB, Morse E, Sherman JE. 1987. The motivation to use drugs: a psychobiological analysis of urges. In Rivers PC, ed. *The Nebraska Symposium on Motivation: Alcohol Use and Abuse.* Lincoln: University of Nebraska Press, pp. 257–323.

Brigham J, Henningfield JE, Stitzer ML. 1991. Smoking relapse: a review. *The International Journal of the Addictions* 25:1239–1255.

Burton SM, Tiffany ST. 1997. The effect of alcohol consumption on craving to smoke. *Addiction* 92:15–26.

Cepeda-Benito A, Tiffany ST. 1996. The use of a dual-task procedure for the assessment of cognitive effort associated with cigarette craving. *Psychopharmacology* 127:155–163.

Christen AG, McDonald JL, Klein, JA, Christen, JA, Guba CJ. 1994. *A Smoking Cessation Program for the Dental Office.* Indianapolis: Indiana University School of Dentistry.

Cox LS. 2000. Examination of the mechanism of action of nicotine replacement therapy in smoking cessation. Manuscript in preparation.

Daughton DM, Heatley SA, Prendergast JJ, Causey D, Knowles M, Rolf CN, Cheney, RA, Hatlelid K, Thompson AB, Rennard SI. 1991. Effect of transdermal nicotine delivery as an adjunct to low-intervention smoking cessation therapy: a randomized, placebo-controlled, double-blind study. *Archives of Internal Medicine* 151:749–752.

Diener E, Emmons RA. 1984. The independence of positive and negative affect. *Journal of Personality and Social Psychology* 47:1105–1117.

Doherty K, Kinnunen T, Militello FS, Garvey AJ. 1995. Urges to smoke during the first month of abstinence: relationship to relapse and predictors. *Psychopharmacology* 119:171–178.

Drobes DJ, Meier EA, Tiffany ST. 1994. Assessment of the effects of urges and negative affect on smokers' coping skills. *Behaviour Research & Therapy* 32:165–174.

Drobes DJ, Tiffany, ST. 1997. Induction of smoking urges through imaginal and *in vivo* procedures: physiological and self-report manifestations. *Journal of Abnormal Psychology* 106:15–25.

Elash CA, Tiffany ST, Vrana SR. 1995. Manipulation of smoking urges and affect through a brief-imagery procedure: self-report, psychophysiological, and startle probe responses. *Experimental & Clinical Psychopharmacology* 3:156–162.

Glassman AH, Jackson WK, Walsh BT, Roose, SP, & Rosenfield B. 1984. Cigarette craving, smoking withdrawal, and clonidin. *Science* 226:864–866.

Gorsuch RL. 1983. *Factor Analysis*, 2nd edn. Hillsdale, NJ: Erlbaum.

Gross J, Stitzer ML. 1989. Nicotine replacement: ten-week effects on tobacco withdrawal symptoms. *Psychopharmacology* 98:334–341.

Horn D, Waingrow S. 1966. Some dimensions of a model for smoking behavior change. *American Journal of Public Health* 56:21–26.

Hughes JR. 1992. Tobacco withdrawal in self-quitters. *Journal of Consulting and Clinical Psychology* 60:689–697.

Hughes JR, Hatsukami DK, Pickens RW, Krahn D, Malin S, Luknic A. 1984. Effect of nicotine on the tobacco withdrawal syndrome. *Psychopharmacology* 83:82–87.

Hughes JR, Higgins ST, Bickel WK. 1994. Nicotine withdrawal versus other drug withdrawal syndromes: similarities and dissimilarities. *Addiction* 89:1461–1470.

Hurt RD, Dale LC, McClain FL, Eberman KM, Offord KP, Bruce BK, Lauger GG. 1992. A comprehensive model for the treatment of nicotine dependence in a medical setting. *Medical Clinics of North America* 76:495–514.

Ikard F, Green D, Horn D. 1969. A scale to differentiate between types of smoking as related to the management of affect. *The International Journal of the Addictions* 4:649–659.

Killen JD, Fortmann SP. 1997. Craving is associated with smoking relapse: findings from three prospective studies. *Experimental and Clinical Psychopharmacology* 5:137–142.

Killen JD, Fortmann SP, Newman B, Varady A. 1991. Prospective study factors influencing the development of craving associated with smoking cessation. *Psychopharmacology* 105:191–196.

Kozlowski LT, Mann RE, Wilkinson DA, Poulos CX. 1989. Cravings are ambiguous: ask about urges or desires. *Addictive Behaviors* 14:443–445.

Kozlowski LT, Pillitteri JL, Sweeney CT, Whitfield KE, Graham JW. 1996. Asking questions about urges and cravings for cigarettes. *Psychology of Addictive Behaviors* 10:248–260.

Ludwig AM, Wikler A. 1974. Craving and relapse to drink. *Quarterly Journal of Studies on Alcohol* 35:108–130.

Maude-Griffin P, Tiffany ST. 1996. Production of smoking urges through imagery: the impact of affect and smoking abstinence. *Experimental & Clinical Psychopharmacology* 4:198–208.

Merz PG, Keller-Stanislawski B, Huber T, Woodcock BG, Rietbrock N. 1993. Transdermal nicotine in smoking cessation and involvement of non-specific influences. *International Journal of Clinical Pharmacology, Therapy, and Toxicology* 31:476–482.

Nil R, Buzzi R, Battig K. 1984. Effects of single doses of alcohol and caffeine on cigarette puffing behavior. *Pharmacology, Biochemistry & Behavior* 20:583–590.

Orleans CT, Rimer BK, Cristinzio S, Keintz MK, Fleisher L. 1991. A national survey of older smokers: treatment needs for a growing population. *Health Psychology* 10:343–351.

Piasecki TM, Kenford SL, Smith SS, Fiore MC, Baker TB. 1997. Listening to nicotine: negative affect and the smoking withdrawal conundrum. *Psychological Science* 8:184–189.

Robinson TE, Berridge KC. 1993. The neural basis of drug craving: an incentive-sensitization theory of addiction. *Brain Research* 18:247–291.

Shiffman S. 1979. The tobacco withdrawal syndrome. In Krasnegor NW, ed. *Cigarette Smoking as a Dependence Process*. Washington, DC: National Institute on Drug Abuse, pp. 158–184.

Shiffman S, Engberg JB, Paty JA, Perz WG, Gnys M, Kassel JD, Hickcox M. 1997. A day at a time: predicting smoking lapse from daily urge. *Journal of Abnormal Psychology* 106:104–116.

Shiffman SM, Jarvik ME. 1976. Smoking withdrawal symptoms in two weeks of abstinence. *Psychopharmacology* 50:35–39.

Swan GE, Ward MM, Jack LM. 1996. Abstinence effects as predictors of 28-day relapse in smokers. *Addictive Behaviors* 21:481–490.

Tiffany ST. 1990. A cognitive model of drug urges and drug-use behavior: role of automatic and nonautomatic processes. *Psychological Review* 97:147–168.

Tiffany ST. 1992. A critique of contemporary urge and craving research: methodological, psychometric, and theoretical issues. *Advances in Behaviour Research & Therapy* 14:123–139.

Tiffany ST. 1997. New perspectives on the measurement, manipulation, and meaning of drug craving. *Human Psychopharmacology* 12:S103–S113.

Tiffany ST, Cox LS, Elash C. In press. Effects of transdermal nicotine patches on abstinence-induced and cue-elicited craving in cigarette smokers. *Journal of Consulting and Clinical Psychology.*

Tiffany ST, Drobes DJ. 1990. Imagery and smoking urges: the manipulation of affective content. *Addictive Behaviors* 15:531–539.

Tiffany ST, Drobes DJ. 1991. The development and initial validation of a questionnaire on smoking urges. *British Journal of Addiction* 86:1467–1476.

Tiffany, ST, Singleton, E, Haertzen, C, Henningfield, JE. 1993. The development of a cocaine craving questionnaire. *Drug and Alcohol Dependence* 34:19–28.

West RJ, Hajek P, Belcher M. 1987. Time course of cigarette withdrawal symptoms during four weeks of treatment with nicotine chewing gum. *Addictive Behaviors* 12:199–203.

West R, Hajek P, Belcher M. 1989. Time course of cigarette withdrawal symptoms while using nicotine gum. *Psychopharmacology* 99:143–145.

West RJ, Jarvis MJ, Russell MAH, Carruthers ME, Feyerabend C. 1984. Effect of nicotine replacement on the cigarette withdrawal syndrome. *British Journal of Addiction* 79:215–219.

West R, Schneider N. 1987. Craving for cigarettes. *British Journal of Addiction* 82:407–415.

Wilner P, Hardman S, Eaton G. 1995. Subjective and behavioural evaluation of cigarette cravings. *Psychopharmacology* 118:171–177.

Wise RA. 1988. The neurobiology of craving: Implications for understanding and treatment of addiction. *Journal of Abnormal Psychology* 97:118–132.