Published in final edited form as:
Addict Behav. 2007 October ; 32(10): 2130–2139.

Consistency of Subjective Responses to Imagery-Induced Tobacco Craving Over Multiple Sessions

Dustin C. Lee[a], **Carol S. Myers**[a], **Richard C. Taylor**[a], **Eric T. Moolchan**[a], **Ivan Berlin**[b], and **Stephen J. Heishman**[a]

a *Clinical Pharmacology and Therapeutics Branch, National Institute on Drug Abuse, Intramural Research Program, NIH, 5500 Nathan Shock Drive, Baltimore, MD 21224, USA*

b *Service de Pharmacologie, Groupe Hospitalier Universitaire Pitié-Salpêtrière, 47 Bd de l'Hôpital, 75013 Paris, France*

Abstract

Although studies have demonstrated the validity of imagery procedures to elicit tobacco craving responses in single sessions, few studies have examined the consistency of responding in the same individuals over multiple experimental sessions. In this study, nondeprived smokers were presented with a randomized series of imagery scripts that varied in the intensity of smoking urge content. At each of five sessions spaced over several weeks, participants were exposed to six imagery trials (two each of no-, low-, and high-intensity imagery scripts). After each trial, participants completed subjective measures of tobacco craving and mood. Ratings of craving and negative mood significantly increased as a function of smoking-urge intensity, which was consistent across the five sessions. Further, significant intraclass correlations indicated that craving and mood responses were highly reliable over the five sessions, as well as across two, three, and four sessions. These results have practical implications for examining individual differences in sensitivity to smoking cues and for studies involving repeated measurement of elicited craving over time.

Keywords

Craving; Tobacco; Smoking; Imagery; Reliability; Humans

1. Introduction

Cue-reactivity studies demonstrate that increases in self-reported craving and changes in autonomic functioning can be observed when drug users are exposed to drug-related stimuli compared with neutral stimuli (Carter & Tiffany, 1999). This reliable finding has fostered an experimental analysis of drug craving, which is commonly viewed as a critical factor in the maintenance of and relapse to addictive patterns of drug use (O'Brien, 2005). Craving for cigarettes is nearly universally reported by smokers trying to quit (Richter, McCool, Okuyemi, Mayo, & Ahluwalia, 2002;West & Schneider, 1987) and is highly predictive of relapse to smoking (Killen et al., 2006;Swan, Ward, & Jack, 1996).

Corresponding author: Stephen J. Heishman, Ph.D., NIDA Intramural Research Program, 5500 Nathan Shock Drive, Baltimore, MD 21224, USA, 410-550-1547 (voice), 410-550-1528 (fax), heishman@nih.gov

Numerous laboratory studies have shown that active imagery of auditory scripts describing smoking urge reliably increased self-reported tobacco craving compared with neutral imagery scripts (e.g., Conklin & Tiffany, 2001;Niaura et al., 1998). Heishman and colleagues (Singleton, Anderson, & Heishman, 2003;Taylor, Harris, Singleton, Moolchan, & Heishman, 2000) developed scripts that described no-, low-, or high-intensity of smoking urge and reported that smokers' ratings of craving increased as a function of increasing urge intensity. Although such studies demonstrated the validity of imagery procedures to elicit tobacco-craving responses in single sessions, few studies have examined response patterns over multiple experimental sessions.

Determining the consistency and reliability of craving responses elicited by smoking-related cues over time is important for at least two reasons. First, repetition of any experimental assessment can lead to diminished (habituation) or enhanced (sensitization) responding. Either response pattern could confound the effects of the independent variable manipulation. Establishing the response consistency of a paradigm would preclude such confounding and strengthen a study's internal validity. Second, determination of consistent responding would facilitate an analysis of individual differences in sensitivity to drugs or drug cues. Perkins, Jetton, Stolinski, Fonte, and Conklin (2003) noted that if responses over time were inconsistent, then observed between-subject variability could be due to random experimental error. If, on the other hand, responses were shown to be consistent and reliable, then response variability would reflect valid individual differences.

We conducted this study as a prelude to a larger study investigating, in part, changes in cue-elicited craving during ad libitum smoking and tobacco or nicotine deprivation in male smokers. The purpose of the present study was to examine the reliability of imagery-induced craving responses over multiple sessions using imagery scripts that varied in smoking-urge content (no-, low-, and high-intensity). We were interested in two aspects of reliability: (a) consistency, defined as the extent to which the mean intensity-related pattern in craving responses was maintained over sessions, such that the high-intensity condition elicited greater responses than low-intensity, which, in turn, elicited greater responses than no-intensity; and (b) test-retest reliability, defined as the extent to which the relative rank order of participants' responses was stable over sessions, such that individuals reported consistently high or low craving responses. We hypothesized that imagery-induced tobacco craving responses would demonstrate consistency and reliability across experimental sessions. Because the majority of our participants used drugs other than nicotine, we also hypothesized that magnitude of drug craving would increase as a function of intensity condition and that ratings of drug and tobacco craving would be positively correlated.

2. Method

2.1. Participants

Fifteen male smokers (10 African American, 5 Caucasian) were recruited through media advertisements in Baltimore in 2004. Inclusionary criteria were: 18–45 years old, smoking at least 15 cigarettes per day for the past 2 years, no interest in quitting smoking, and in good physical health. Participants averaged 38.7 years of age (SD = 6.1), reported smoking an average of 25 cigarettes per day (SD = 12.9), and had smoked an average of 24.5 years (SD = 6.5). Their mean score on the Fagerström Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991) was 5.4 (SD = 2.1). During screening, participants were given a medical examination and were interviewed about drug history. With respect to drug use in the past 14 days, 67% of participants reported drinking alcohol, 53% smoked marijuana, 40% used cocaine, and 13% used heroin. 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 compensated for their participation. The National Institute on Drug Abuse (NIDA) Institutional Review Board approved the study.

2.2. Materials

Imagery scripts were recorded on compact disc and presented to participants via stereo headphones. Scripts were similar to those used previously (Singleton et al., 2003) and consisted of scenes that described a person experiencing a desire to smoke cigarettes (low-intensity), a strong desire to smoke (high-intensity), or had no mention of smoking (no-intensity). There were 15 scripts (five at each intensity condition) that were recorded in a male and female voice for a total of 30 scripts.

2.3. Design and Procedure

The study consisted of five sessions scheduled at intervals of 4–7 days (mean length of participation = 25 days). At each session, participants were exposed to six imagery trials. Two scripts from each of the three intensity conditions were randomly selected for presentation at each session, and presentation order within each session was also randomized. Over the five sessions, each participant was exposed once to each of the 30 scripts.

Participants were instructed to smoke as usual before sessions, and all reported smoking within 30 min of each session. Participants were tested individually in a quiet room and were seated in a reclining chair for 45 min during the presentation of the imagery scripts. Participants were instructed to close their eyes while they listened to the scripts, imagine themselves in the scene, and continue imagining until they were told to stop. Each imagery trial consisted of 60 s of script presentation and 30 s of continued imagery, ending with the word *stop*. At the end of each imagery trial, participants completed the following questionnaires based on how they felt while they listened to the script: Tobacco Craving Questionnaire (TCQ), Mood Form, and Visual Analog Scale (VAS) questions. Between imagery trials, participants rested quietly for 5–10 min. A research assistant observed participants through a one-way window to insure their attentiveness to scripts and questionnaires.

2.4. Measures

2.4.1. TCQ—Factor analysis of the 47-item TCQ (Heishman, Singleton, & Moolchan, 2003) resulted in four factors, which we termed *emotionality* (smoking in anticipation of relief from withdrawal or negative mood), *expectancy* (anticipation of positive outcomes from smoking), *compulsivity* (inability to control tobacco use), and *purposefulness* (intention and planning to smoke for positive outcomes). In this study, we used a 12-item version of the TCQ comprising the 3 items from each factor that exhibited optimal within-factor reliability and inter-item correlation (Heishman, Singleton, & Pickworth, 2006). Cronbach's alpha coefficients were 0.90, 0.89, 0.78, and 0.69 for factors 1–4, respectively (Heishman et al., 2006). Factor scale scores for each participant were obtained by summing the 3 items in each factor, and a total TCQ score was obtained by summing the 12 items.

2.4.2. Mood Form—A 9-item Mood Form (Diener & Emmons, 1984) was administered to assess negative and positive mood. Each item was rated on a 7-point scale from 0 (not at all) to 6 (extremely much). Four of the items reflected positive mood states (happy, joyful, pleased, enjoyment/fun), and five of the items reflected negative mood (depressed/blue, unhappy, frustrated, worried/anxious, angry/hostile). A composite positive and negative mood score was obtained by averaging the individual items. The validity and reliability of composite positive and negative affect scales based on these items has been demonstrated (Diener & Emmons, 1984).

2.4.3. VAS questions—VAS questions were used to assess convergent validity with the TCQ and Mood Form. The six questions were (in order): How clear and vivid was your mental image of the scene? How much did you crave a cigarette while you imagined the scene? How much was your urge for a cigarette while you imagined the scene? How much did you crave your drug of choice while you imagined the scene? How positive was your mood while you imagined the scene? and How negative was your mood while you imagined the scene? Participants answered each question by placing a vertical mark along a 100-mm horizontal line between "not at all" on the left and "extremely" on the right. Reliability estimates of these VAS questions have not been established; however, they correlated significantly with the factor scales of the TCQ (Heishman et al., 2003).

2.5. Data Analysis

Because of random selection of imagery scripts, an unequal number of male- and female-voice scripts was typically presented at each session, and thus sex could not be entered as a variable in the overall factorial analysis. A one-way analysis of variance (ANOVA) indicated no sex difference on any of the measures. Data were then analyzed using three-factor, repeated measures ANOVA with intensity condition (no, low, high); within-session trial (1–2); and experimental session (1–5) as factors. Consistency of imagery-induced responses over sessions would be indicated by the absence of either a session main effect or a session by intensity condition interaction. Conservative *F* tests using Huynh-Feldt probability levels were used to interpret results of the ANOVA. Post hoc comparisons between means were conducted using Fisher's least significant difference test.

Repeated assessment of the TCQ, Mood Form, and VAS questions across intensity conditions and sessions allowed estimation of test-retest reliability, which is affected by shifts in the rank order of scores, but not by changes in mean scores. Although Pearson's product-moment correlation is typically used to evaluate test-retest reliability, the intraclass correlation coefficient (ICC) is recommended when there are more than two repeated administrations of the same measure to be correlated (Shrout & Fleiss, 1979). We calculated ICC values for measures across the five sessions and across two, three, and four sessions to examine reliability over fewer sessions. Only variables that showed a significant intensity condition effect in the ANOVA were included because reliability of responding in the absence of an imagery-induced effect would be irrelevant (cf., Perkins et al., 2003).

Pearson product-moment correlations were conducted to examine the relationship between craving for tobacco and drug of choice. Statistical tests were conducted using SPSS version 14, and results were considered significant at $p < .05$.

3. Results

3.1. Consistency of responding

Figure 1 shows mean intensity-related responses across the five sessions for selected variables. For illustration purposes, responses were averaged over trial. There was an intensity condition main effect for 10 of the 13 variables; however, no session main effect or session by condition interaction was found for any measure, indicating consistent responding across sessions. Significant increases as a function of intensity condition were obtained for all measures of tobacco craving: TCQ total score [$F(2,28) = 13.72$, $p < .001$]; TCQ factor 1 [$F(2,28) = 3.77$, $p = .05$]; TCQ factor 2 [$F(2,28) = 15.58$, $p < .001$]; TCQ factor 3 [$F(2,28) = 10.48$, $p < .001$]; TCQ factor 4 [$F(2,28) = 8.26$, $p < .01$]; and the following VAS items: *crave a cigarette* [$F(2,28) = 13.49$, $p < .001$] and *urge for a cigarette* [$F(2,28)=17.01$, $p < .001$]. A trial main effect was observed for TCQ factor 3 [$F(1,14) = 5.84$, $p < .05$]; VAS *crave a cigarette* [$F(1,14) =$

11.04, $p < .01$]; and VAS *urge for a cigarette* [$F(1,14) = 6.78$, $p < .05$]. Post hoc tests indicated that scores increased from trial 1 to 2 on each measure.

Mood Form ratings were also significantly affected as a function of script intensity (Figure 1), with increases observed on the negative scale [$F(2,28) = 7.03$, $p < .05$] and decreases on the positive scale [$F(2,28) = 3.72$, $p < .05$]. Positive and negative mood VAS ratings were not affected by intensity condition. Post hoc comparisons indicated that mood and craving responses to the high-intensity condition were significantly greater ($p < .05$) than responses to the no- and low-intensity conditions, whereas low-intensity responses were not greater than no-intensity responding (see Figure 1). Ratings of imagery vividness did not differ as a function of intensity condition.

3.2. Test-retest reliability

Table 1 presents ICC values across the five sessions for measures that showed a significant intensity condition main effect from the ANOVA. In both intensity conditions, ICC values were significant for all measures, indicating that the rank order of participants' responses was relatively consistent (test-retest reliability) across five sessions. ICC values in the no-intensity condition were also significant ($p < .001$) for all measures. Table 2 shows ICC values for responses in the high-intensity condition across two, three, and four sessions. Significant ICC values were obtained for all groups of sessions, indicating that reliable responding was observed across two, three, and four sessions. Responses in the low-intensity condition were similarly significantly correlated, with the exception of the two-session analysis in which ICC values for VAS *crave* and *urge* and Mood Form negative mood were not significant.

3.3. Drug craving

Twelve of 15 participants (80%) reported use of a drug other than nicotine during the past 14 days. The distribution of these participants' self-reported drug of choice was cocaine (50%), marijuana (42%), and alcohol (8%). Responses on the VAS item *crave drug of choice* were increased as a function of intensity condition [$F(2,28) = 3.36$, $p < .05$]. Across the five sessions, TCQ total score was positively correlated with VAS rating of *crave drug of choice*. For example, at session 5 in the low-intensity, $r = .65$ ($p < .05$) and in the high-intensity condition, $r = .55$ ($p < .05$).

4. Discussion

To our knowledge, this is the first study to determine over multiple experimental sessions the reliability of imagery-induced craving and mood responses using imagery scripts that varied in the intensity of smoking-urge content. Imagery-induced changes in self-reported craving and mood were consistent over time, such that orderly intensity-related effects were observed at each session. Further, significant intraclass correlations indicated that responses exhibited high test-retest reliability, such that individuals' scores remained high or low over the five sessions, as well as two, three, and four sessions. Singleton et al. (2003) validated the procedure of using imagery scripts varying in urge intensity to elicit tobacco craving. The results of this study further support and extend the procedure's validity by demonstrating that it evokes reliable craving responses over time.

The imagery-induced increase in tobacco craving responses is consistent with our previous research using imagery scripts varying in smoking-urge intensity (Singleton et al., 2003;Taylor et al., 2000) and that of others comparing smoking-related versus neutral imagery (Conklin & Tiffany, 2001;Niaura et al., 1998). The urge intensity-related increase in ratings of negative mood is also consistent with previous research (Maude-Griffin & Tiffany, 1996;Taylor et al.,

2000) and underscores the close association between negative affect, smoking, and craving (Brandon, Wetter, & Baker, 1996;Kassel, Stroud, & Paronis, 2003).

The finding of reliable imagery-induced craving and mood responses over time in this study is broadly consistent with the work of Perkins et al. (2003) who examined subjective, cardiovascular, and performance responses to acute nicotine administration in smokers within and between experimental sessions. They administered four doses of nicotine nasal spray at 30-min intervals in a single session and conducted four daily sessions (one placebo and three nicotine). Perkins et al. reported consistent responding (relative rank order) over the within-session nicotine dosing and greater response consistency across three nicotine sessions compared with two sessions. Using a paradigm similar to the present study, Carpenter, LaRowe, Upadhyaya, Saladin, & Brady (2006) presented smokers with smoking-related (cigarette) and neutral (pencil) cues over four weekly sessions. Preliminary data indicated no change in cue-elicited craving across sessions, although there was evidence of declining baseline-craving responses over time. These data and those of the present study suggest that stimulus-elicited tobacco craving responses do not habituate or sensitize across multiple laboratory sessions.

Because participants in this study reported recent use of drugs other than tobacco, we were able to assess the effect of imagery scripts on craving for their drug of choice as well as potential correlations between craving for tobacco and other drugs. Ratings of drug craving were increased as a function of smoking-urge intensity and were positively correlated with ratings of tobacco craving in the low- and high-intensity conditions. These results confirm our previous findings (Heishman et al., 2005;Singleton et al., 2003;Taylor et al., 2000) and indicate that environmental cues that elicit craving for tobacco can occasion craving for other drugs of abuse. That episodes of tobacco craving might trigger drug craving states, and hence increase the probability of relapse, has implications for treating tobacco dependence in drug treatment programs. For example, although fewer than half of methadone programs address tobacco dependence treatment (McColl, Richter, & Choi, 2005), evidence suggests that smoking abstinence achieved by methadone patients during contingency management treatment is strongly associated with concomitant reductions in opioid and cocaine use (Shoptaw et al., 2002).

Factors other than the differences in urge intensity of the imagery scripts might have produced the changes in self-reported craving. Variation in the ability of participants to form a mental image of the scripts might have contributed to the effect; however, there was no difference in mean ratings of imagery vividness across the intensity conditions. Characteristics of the experimental setting, including participating in a study at NIDA, might also have contributed to the observed increases in craving. However, the intensity-related increase in TCQ and VAS responses suggests that the increases in tobacco craving were the result of the imagery script content and not due to extraneous environmental variables.

Some limitations of the study should be mentioned. This study was a precursor to a larger study examining the influence of ad libitum smoking and tobacco deprivation on cognition, craving, and physiological measures, including stress and thyroid hormones and monoamine oxidase (MAO) activity. We are testing only men because of sex differences in MAO activity (Berlin, Spreux-Varoquaux, & Launay, 2000) and the variable effect of menstrual cycle phase on plasma cortisol concentration (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999), cognitive performance (Becker, Creutzfeldt, Schwibbe, & Wuttke, 1980), and tobacco withdrawal symptoms including craving (Carpenter, Upadhyaya, LaRowe, Saladin, & Brady, 2006). Thus, the results of the present study might not generalize to women. The imagery-induction procedure and measurement of craving using the TCQ and VAS items have been validated in smokers who were not attempting to reduce or quit smoking (Heishman et al.,

2003;Singleton et al., 2003). Thus, the present results may not extend to smokers trying to quit, former smokers, and smokers who are not nicotine dependent (i.e., chippers). For example, Shadel et al. (1998) reported that imagery scripts did not elicit tobacco-craving responses in smokers who were seeking treatment for nicotine dependence.

In summary, we found that imagery scripts varying in smoking-urge intensity can elicit consistent and reliable craving and mood responses across two, three, four, and five experimental sessions. These results have practical implications for examining responsivity to smoking cues. For investigations of potential differences in craving over time, such as treatment intervention trials comparing pre-quit to post-treatment craving intensity or experimental studies comparing cue-elicited craving during tobacco-deprived vs. nondeprived states, having a paradigm that engenders consistent and reliable responding would enhance a study's internal validity.

Acknowledgements

This research was supported by the Intramural Research Program of the NIH, National Institute on Drug Abuse. We thank Drs. Edward Singleton and David Epstein for consultation on statistical issues and Carol Ward, Cecile Shindell, and Heather Andes for their assistance with the conduct of the study and data support.

References

Becker D, Creutzfeldt OD, Schwibbe M, Wuttke W. Electrophysiological and psychological changes induced by steroid hormones in men and women. Acta Psychiatrica Belgica 1980;80:674–697. [PubMed: 7234455]

Berlin I, Spreux-Varoquaux O, Launay JM. Platelet monoamine oxidase B activity is inversely associated with plasma cotinine concentration. Nicotine and Tobacco Research 2000;2:243–6. [PubMed: 11082824]

Brandon TH, Wetter DW, Baker TB. Affect, expectancies, urges, and smoking: Do they conform to models of drug motivation and relapse? Experimental and Clinical Psychopharmacology 1996;4:29–36.

Carpenter, MJ.; LaRowe, S.; Upadhyaya, H.; Saladin, M.; Brady, K. Does cue-reactivity extinguish with repeated laboratory sessions?; Poster presented at the annual meeting of the College on Problems of Drug Dependence; Scottsdale, AZ. 2006 Jun.

Carpenter MJ, Upadhyaya HP, LaRowe SD, Saladin ME, Brady KT. Menstrual cycle phase effects on nicotine withdrawal and cigarette craving: A review. Nicotine and Tobacco Research 2006;8:627–638. [PubMed: 17008190]

Carter BL, Tiffany ST. Meta-analysis of cue-reactivity in addiction research. Addiction 1999;94:327–340. [PubMed: 10605857]

Conklin CA, Tiffany ST. The impact of imagining personalized versus standardized urge scenarios on cigarette craving and autonomic reactivity. Experimental and Clinical Psychopharmacology 2001;9:399–408. [PubMed: 11764016]

Diener E, Emmons RA. The independence of positive and negative affect. Journal of Personality and Social Psychology 1984;47:1105–1117. [PubMed: 6520704]

Heatherton TF, Kozlowski LT, Frecker RC, Fagerström KO. The Fagerström test for nicotine dependence: A revision of the Fagerström Tolerance Questionnaire. British Journal of Addiction 1991;86:1119–1127. [PubMed: 1932883]

Heishman SJ, Boas ZP, Hager MC, Taylor RC, Singleton EG, Moolchan ET. Effect of tobacco craving cues on memory encoding and retrieval in smokers. Addictive Behaviors 2005;31:1116–1121. [PubMed: 16157458]

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

Heishman, SJ.; Singleton, EG.; Pickworth, WB. Reliability and validity of a short version of the Tobacco Craving Questionnaire. 2006. Manuscript submitted for publication

Kassel JD, Stroud LR, Paronis CA. Smoking, stress, and negative affect: Correlation, causation, and context across stages of smoking. Psychological Bulletin 2003;129:270–304. [PubMed: 12696841]

Killen JD, Fortmann SP, Murphy GM, Hayward C, Arredondo C, Cromp D, Celio M, Wang Y, Schatzberg AF. Extended treatment with bupropion SR for cigarette smoking cessation. Journal of Consulting and Clinical Psychology 2006;74:286–294. [PubMed: 16649873]

Kirschbaum C, Kudielka BM, Gaab J, Schommer NC, Hellhammer DH. Impact of gender, menstrual cycle phase, and oral contraceptives on the activity of the hypothalamus-pituitary-adrenal axis. Psychosomatic Medicine 1999;61:154–162. [PubMed: 10204967]

Maude-Griffin PM, Tiffany ST. Production of smoking urges through imagery: The impact of affect and smoking abstinence. Experimental and Clinical Psychopharmacology 1996;4:198–208.

McColl RM, Richter KP, Choi WS. Benefits of and barriers to providing smoking treatment in methadone clinics: Findings from a national study. American Journal of Addictions 2005;14:358–366.

Niaura RS, Shadel WG, Abrams DB, Monti PM, Rohsenow DJ, Sirota A. Individual differences in cue reactivity among smokers trying to quit: Effects of gender and cue type. Addictive Behaviors 1998;23:209–224. [PubMed: 9573425]

O'Brien CP. Anticraving medications for relapse prevention: A possible new class of psychoactive medications. American Journal of Psychiatry 2005;162:1423–1431. [PubMed: 16055763]

Perkins KA, Jetton C, Stolinski A, Fonte C, Conklin CA. The consistency of acute responses to nicotine in humans. Nicotine and Tobacco Research 2003;5:877–884. [PubMed: 14668071]

Richter KP, McCool RM, Okuyemi KS, Mayo MS, Ahluwalia JS. Patients' views on smoking cessation and tobacco harm reduction during drug treatment. Nicotine and Tobacco Research 2002;4:S175–S182. [PubMed: 12573178]

Shadel WG, Niaura R, Abrams DB, Goldstein MG, Rohsenow DJ, Sirota AD, Monti PM. Scripted imagery manipulations and smoking cue reactivity in a clinical sample of self-quitters. Experimental and Clinical Psychopharmacology 1998;6:179–186. [PubMed: 9608350]

Shoptaw S, Rotheram-Fuller E, Yang X, Frosch D, Hahom D, Jarvik ME, Rawson RA, Ling W. Smoking cessation in methadone maintenance. Addiction 2002;97:1317–1328. [PubMed: 12359036]

Shrout PE, Fleiss JL. Intraclass correlations: Uses in assessing rater reliability. Psychological Bulletin 1979;86:420–428.

Singleton EG, Anderson LM, Heishman SJ. Reliability and validity of the Tobacco Craving Questionnaire and validation of a craving-induction procedure using multiple measures of craving and mood. Addiction 2003;98:1537–1546. [PubMed: 14616180]

Swan GE, Ward MM, Jack LM. Abstinence effects as predictors of 28-day relapse in smokers. Addictive Behaviors 1996;21:481–490. [PubMed: 8830906]

Taylor RC, Harris NA, Singleton EG, Moolchan ET, Heishman SJ. Tobacco craving: Intensity-related effects of imagery scripts in drug abusers. Experimental and Clinical Psychopharmacology 2000;8:75–87. [PubMed: 10743907]

West R, Schneider N. Craving for cigarettes. British Journal of Addiction 1987;82:407–415. [PubMed: 3555575]

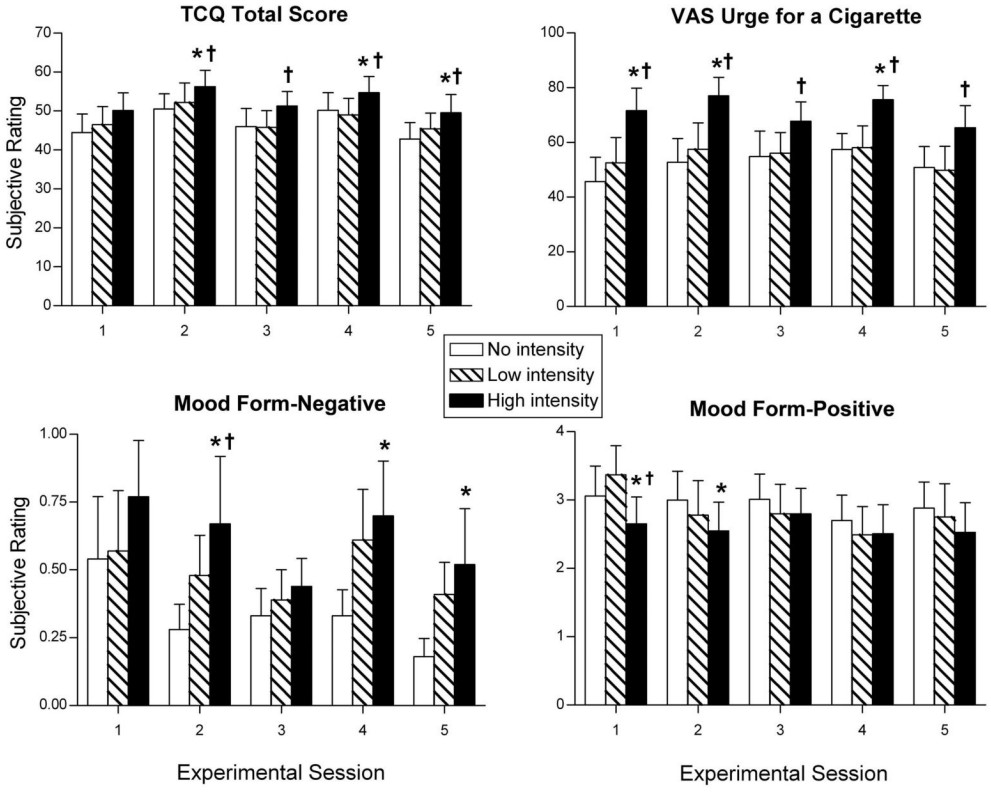

Figure 1.

Mean imagery-induced craving and mood responses as a function of smoking-urge intensity condition (no-, low-, and high-intensity) across five sessions for selected measures. Each column represents the mean of two trials for 15 participants, and error bars represent standard error of the mean. *$p < .05$ different from no-intensity condition. †$p < .05$ different from low-intensity condition.

Table 1

Intraclass correlation coefficients across five sessions for low-intensity and high-intensity imagery conditions.

Measures	Low-intensity Condition	High-intensity Condition
TCQ		
Total score	.87 (.72–.95)***	.79 (.56–.92)***
Factor 1	.94 (.87–.98)***	.91 (.80–.96)***
Factor 2	.83 (.65–.94)***	.82 (.62–.93)***
Factor 3	.79 (.56–.92)***	.65 (.26–.87)**
Factor 4	.89 (.76–.96)***	.80 (.57–.92)***
VAS		
Crave a cigarette	.76 (.50–.91)***	.72 (.41–.89)***
Urge for a cigarette	.75 (.49–.90)***	.76 (.49–.91)***
Crave drug of choice	.92 (.84–.97)***	.91 (.81–.97)***
Mood Form		
Positive mood	.94 (.86–.98)***	.96 (.92–.99)***
Negative mood	.85 (.67–.94)***	.87 (.72–.95)***

Note. 95% confidence intervals are shown in parentheses. Only measures showing a significant intensity condition main effect are shown.

** $p < .01$,

*** $p < .001$

Table 2

Interclass correlation coefficients across two, three, and four sessions for high-intensity imagery condition.

Measures	Sessions 1–2	Sessions 1–3	Sessions 1–4
TCQ			
Total score	.79 (.56–.92)***	.76 (.42–.91)**	.72 (.40–.90)**
Factor 1	.91 (.80–.96)***	.79 (.51–.92)***	.86 (.69–.95)***
Factor 2	.82 (.62–.93)***	.85 (.63–.94)***	.84 (.66–.94)***
Factor 3	.65 (.26–.87)**	.73 (.37–.90)**	.57 (.10–.85)*
Factor 4	.80 (.57–.92)***	.79 (.51–.93)***	.75 (.46–.91)***
VAS			
Crave a cigarette	.72 (.41–.89)***	.57 (−.02–.84)*	.68 (.31–.89)**
Urge for a cigarette	.76 (.49–.91)***	.62 (.11–.86)*	.73 (.41–.90)***
Crave drug of choice	.91 (.81–.97)***	.94 (.85–.98)***	.91 (.81–.97)***
Mood Form			
Positive mood	.96 (.92–.99)***	.97 (.93–.99)***	.96 (.92–.99)***
Negative mood	.87 (.72–.95)***	.85 (.65–.95)***	.82 (.61–.93)***

Note. 95% confidence intervals are shown in parentheses. Only measures showing a significant intensity condition main effect are shown.

* $p < .05$,

** $p < .01$,

*** $p < .001$