Psychology of Addictive Behaviors
2004, Vol. 18, No. 2, 148–159

0893-164X/04/$12.00 DOI: 10.1037/0893-164X.18.2.148

Assessment of Substance Cue Reactivity: Advances in Reliability, Specificity, and Validity

Werner G. K. Stritzke
University of Western Australia

Mary Jo Breiner
Florida State University

John J. Curtin
University of Wisconsin—Madison

Alan R. Lang
Florida State University

An arousal-control and cross-over design was used to evaluate the reliability, specificity, and validity of the Normative Appetitive Picture System (NAPS), a cue exposure protocol with sets of visual alcohol, cigarette, and control cues. The authors also examined the utility of conceptualizing cue reactivity as a multidimensional phenomenon involving independent approach and avoidance dimensions. University student participants (n = 369) rated multiple cue images in terms of arousing properties and capacity to elicit separate approach and avoidance inclinations. They also completed a battery of substance-related individual-difference measures. Results indicated that NAPS protocol reactivity profiles had good reliability and high specificity across cue types and individuals with different substance use histories. Avoidance reactivity independently predicted self-reports of substance-related behaviors, after controlling for approach reactivity.

An extensive literature documents diverse attempts to characterize acquired reactions to substance cues as motivational states that ultimately influence decisions about substance use or nonuse. Because reactions to drug cues can reflect a complex array of multiple influences, detailed contextual information is critical for strong inferences about the link between cue reactivity and drug-taking behavior (Piasecki, Smith, & Baker, 1999). The need for greater standardization of appropriate control procedures to elicit and assess substance cue reactivity was identified almost a decade ago (Drummond, Tiffany, Glautier, & Remington, 1995), yet considerable heterogeneity in methods and reporting of critical information continues to limit the scope of meaningful comparisons across studies (Carter & Tiffany, 1999). The first aim of the present research was to contribute to the further standardization of cue exposure protocols by validating visual cue sets for two commonly abused substances (alcohol and cigarettes) using a rigorous set of design criteria. The second aim was to evaluate the utility of a recent multidimensional model of craving (Breiner, Stritzke, & Lang, 1999) through independent assessment of approach and avoidance reactions to substance cues.

A core assumption of cue reactivity studies is that the pattern of responses to drug-related stimuli varies as a function of each individual's prior experiences with those stimuli. Differences in drug-stimulus reactions may be produced directly through conditioning experiments, but more commonly they are assumed to result from different naturalistic drug-taking histories. Accordingly, if cigarette cues, for example, were found to elicit different response patterns in smokers versus nonsmokers, this difference in reactivity would be attributed to different conditioning histories associated with prior smoking behavior. However, the validity of this inference depends on design features that (a) minimize unknown variance due to modality of cue presentation, (b) maximize reliability and specificity in the assessment of cue-elicited reactions, and (c) can account for motivational complexity in responses.

Modality of Cue Exposure

Inferences about differential reactivity to substance cues are complicated by their presentation in multiple modalities, including visual, olfactory, gustatory, tactile, auditory, and imaginary (e.g., Drobes & Tiffany, 1997; Palfai, 2001; Shiffman et al., 2003). Although use of a multimodal presentation of, for example, a glass of beer being poured so that it can be seen, smelled, heard, and perhaps touched or even tasted, increases the ecological validity of a cue manipulation, making sense of the resultant reactivity pattern can prove difficult. This is because the speed, intensity, and even directionality of cue-elicited responses can differ as a function of the modality of cue presentation. For example, individuals instructed to *hold* drinks tend to evince higher skin conductance and lower subjective pleasure ratings in response to alcoholic drinks versus nonalcoholic drinks, but individuals instructed to actually *drink* the beverages show the opposite response pattern (Glautier, Drummond, & Remington, 1992). Moreover, physiological changes associated with cue manipulations can reflect processing demands of the situation unique to a given modality rather than learned drug-stimulus associations (Tiffany, 1992). Such interac-

Werner G. K. Stritzke, Department of Psychology, University of Western Australia, Perth, Western Australia, Australia; Mary Jo Breiner and Alan R. Lang, Department of Psychology, Florida State University; John J. Curtin, Department of Psychology, University of Wisconsin—Madison.

Correspondence concerning this article should be addressed to Alan R. Lang, Department of Psychology, Florida State University, Tallahassee, FL 32306-1270.

tions and complexities are liable to produce inconsistent reactivity patterns. This suggests that there may be distinct advantages to presenting cues in a single modality that permits cue content and intensity to be systematically varied, controlled, and evaluated. Visual cues represent a modality that is closely tied to cue experiences in real life but without quite the overwhelming salience or intensity of *in vivo* exposure, especially for individuals at risk for relapse into problematic substance use. Despite these desirable properties, a recent meta-analysis found that with respect to licit drugs, such as alcohol and nicotine, only a minority (10%–16%) of studies had used a visual stimulus mode (Carter & Tiffany, 1999). Since then, new visual cue sets have been developed for alcohol (Townsend & Duka, 2001) and cigarettes (McDonough & Warren, 2001), but their specificity is as yet unknown because neither set included appetitive control stimuli that were also consumable (e.g., food), and no information on their reliability has been reported.

Reliability of Cue Reactivity Assessment

Besides the possible impact of modality of cue presentation on conclusions that can be drawn about differential reactivity to substance cues, the validity of any inference is also constrained by the reliability of the methods used to manipulate and assess cue reactivity (Sayette et al., 2000). Continuous presentation of a single, multifaceted cue has the advantage of relatively high ecological validity (e.g., Saladin, Drobes, Coffey, & Libet, 2002; Sayette, Martin, Hull, Wertz, & Perrott, 2003), but at the same time it often provides only limited coverage of the cue domain of interest and may impose a restriction on response range, thereby diminishing power to detect relevant effects. Protracted multimodal presentation of a single cue is also subject to dysynchronous measurement variations across time, and estimates of cue reactivity effects based on a single cue manipulation in effect have unknown reliability (Tiffany, 1992). Multiple and varied cue exposures offer the opportunity to establish reliability, allow for tracking of temporal variations in response to cues, and are less liable to produce the quick habituation that has been found when repeated presentation of the same stimulus was attempted (Staiger & White, 1991).

Specificity of Cue Reactivity

Comparing reactivity profiles across appropriate comparison groups and cue types can strengthen the validity of interpretations of observed differences in current cue-elicited responding attributable to different levels of past substance-related experiences. The aim is to triangulate the specificity of effects elicited by substance cues by controlling for: (a) differences in general reactivity across groups with different substance-use histories and (b) the confounding influence of stimulus properties (e.g., arousal) capable of enhancing reactivity in substance users and substance-naïve individuals alike. Ideally, comparison cues for psychoactive substances should have no psychoactive effects but should otherwise be as similar as possible to active substance cues. Unfortunately, even in recent reactivity studies, the smell and taste of alcohol cues, for example, were sometimes compared to the "smell" and "taste" of water (e.g., Kambouropoulos & Staiger, 2001; Palfai, 2001; Saladin et al., 2002), despite the fact that the stimulus properties of alcohol-related cues and water have obvious and demonstrable differences beyond those putatively under investigation (McCaul, Turkkan, & Stitzer, 1989; Demmel & Schrenk, 2003). Other researchers have used control cues matched for appearance and complexity, but not consumability (e.g., Bradley, Mogg, Wright, & Field, 2003; Townsend & Duka, 2001). Such confounds can be avoided by using comparison cues that share many critical properties of substance cues, including consumability, distinctive sensory properties, desirability, and capacity to elicit affective responses (Newlin, Hotchkiss, Cox, Rauscher, & Li, 1989; Payne et al., 1992; Staiger & White, 1991). Although control cues with these properties are necessary to establish that cue-elicited responses are specific to the substance-related cues, there are two additional design features that are required to support the inference that these responses are not only specific to substance cues but are also unique to individuals with the relevant substance use history.

One of these features is captured in an *arousal-control design* (Robbins & Ehrman, 1992). Such a design involves the inclusion of comparison cues unrelated to substance use and thought to be equally arousing to individuals regardless of their drug use history (e.g., appetizing images of food items). If drug-using and drug-naïve participants show no differences in reactivity to these arousing control cues, then differences in reactivity to substance-related cues cannot be attributed to differences in general arousability. An even more stringent variation of this design feature is the *cross-over response design* (Robbins & Ehrman, 1992). This strategy requires presentation of cues for two different drugs (e.g., alcohol and tobacco) and the inclusion of groups of participants who differ systematically in their use of only one of these drugs. Then, for reactivity to a particular category of cues to be attributed to a past history of use of that drug, each group (compared to drug-naïve controls) must demonstrate greater reactivity to the cues specific to their preferred drug. The cross-over response design is also useful because polysubstance use is common, and cues that elicit reactivity for the primary drug of choice may also evoke responses associated with a less preferred substance (e.g., Alsene, Li, Chaverneff, & de Wit, 2003; Drobes, 2002). Such cross-cue reactivity can be evaluated directly by formally testing for interaction effects. Specifically, a significant Group (nondrinkers vs. drinkers) × Cue (alcohol vs. cigarettes) interaction would be required to show that the difference between drinkers and nondrinkers is greater for alcohol than for cigarette cues and, likewise, a significant Group (nonsmokers vs. smokers) × Cue (alcohol vs. cigarettes) interaction would be required to show that the difference between smokers and nonsmokers is greater for cigarette cues than for alcohol cues.

Multidimensional Assessment of Cue Reactivity

In addition to methodological requirements affecting the reliability and specificity of cue reactivity protocols, there is an even more fundamental problem emanating from the common practice among cue reactivity researchers to conceptualize and operationalize response to substance cues as a unidimensional construct, generally defined as an increase in the inclination to approach and consume the substance associated with the cue. However, drug cues are complex events involving both appetitive and potentially aversive properties that consequently can elicit both approach and avoidance inclinations (Glautier & Remington, 1995; Stewart, 1999). Hence, if investigators rely on unidimensional assessment of approach inclinations to the neglect of avoidance inclinations, they "arbitrarily preclude a legitimate class of response that is likely to influence the dependent variables in which we are most interested" (p. 169, Greeley, Swift, & Heather, 1993). Indeed, failure to account for ambivalence due to competing approach and avoidance responses may lead to significant underreporting of approach inclinations by patients in treatment for substance problems. This is because acknowledgment of high approach inclinations in response to drug cues—unless there is an opportunity to offset them by concurrently reporting high avoidance inclinations—would appear to place patients at odds with treatment aims (cf. Duka, Townshend, Collier, & Stephens, 2002; Greeley et al., 1993; Newlin et al., 1989). Moreover, the unidimensional approach forces the researcher to label individuals who report low approach inclinations as "nonresponders" or "nonreactors" (Avants, Margolin, Kosten, & Cooney, 1995; Shiffman et al., 2003), even though they may have been "responders" with respect to avoidance inclinations or with respect to simultaneous (i.e., ambivalent) activation of both types of inclinations. In contrast, a multidimensional assessment of cue reactivity can accommodate ambivalent reactivity by conceptualizing cue reactivity as the *relative* activation of substance-directed response dispositions along the primary dimensions of approach and avoidance (Breiner et al., 1999). Thus, the net action disposition can be operationalized as a point in an "evaluative reactivity space" defined by the coordinates of approach and avoidance (cf. Cacioppo & Berntson, 1994).

The Present Study

We presented participants with photographic stimuli depicting alcoholic beverages, cigarettes, food, and nonalcoholic beverages. Our aims were to: (a) evaluate the reliability of a diverse set of visual substance cues and appropriate comparison cues through the use of multiple cueing trials with precise and temporally contiguous measurement of responses to each discrete stimulus, (b) select and assess participants in such a way that the impact of individual differences in substance use experience on cue reactivity could be evaluated and used to establish cue specificity and validity, and (c) apply independent assessments that capture the potentially distinct contributions to overall cue reactivity made by both approach and avoidance reactions to the substance cue, defined here as the strength of the participant's desire to consume or use the depicted item, and desire to avoid consuming or using it, respectively. With regard to the issue of specificity, we tested three hypotheses:

> *Hypothesis 1:* There will be a Substance Use × Cue Type interaction such that arousal ratings for cues of the preferred substance (i.e., either alcohol or cigarettes) will vary between groups differing in self-reported levels of use of that substance, but there will be no differences between these groups in ratings for cues of nondrug control substances.

> *Hypothesis 2:* There will be a Substance Use × Cue Type interaction such that approach and avoidance ratings for cues of the preferred substance will vary between groups differing in self-reported levels of use of that substance, but there will be no differences between these groups in ratings for cues of nondrug control substances.

> *Hypothesis 3:* There will be a Substance Use × Cue Type interaction for approach and avoidance ratings such that the difference between groups varying in level of alcohol use will be greater for alcohol cues than for cigarette cues, and the difference between groups varying in level of cigarette use will be greater for cigarette cues than for alcohol cues.

With regard to the issue of validity related to multidimensional assessment of cue reactivity, we tested two additional hypotheses:

> *Hypothesis 4:* Avoidance ratings of substance cues, after controlling for variance explained by approach ratings, will predict unique variance in measures of use of that substance.

> *Hypothesis 5:* Joint consideration of approach and avoidance reactivity will result in distinct reactivity profiles such that approach and ambivalent reactivity profiles will differentially predict readiness to change substance use behaviors.

Method

Participants

Participants were 369 (56% female) undergraduate students from introductory psychology classes at Florida State University (M age = 18.9, SD = 2.0). They were recruited on the basis of a simple screening instrument that assessed quantity and frequency of routine drinking behavior. Among drinkers, the mean consumption rate was 11.7 drinks per week (SD = 16.0). Participants received partial course credit for their participation.

Materials

Equipment. A Kodak Ektagraphic carousel slide projector with a Sestar zoom lens was used for slide presentation. An electronic slide advancing timer box controlled independent timing of preparatory slides, substance cues, and rating periods.

Slides. Forty-eight substance cue slides were developed to represent four appetitive substance categories: (a) alcoholic beverages (n = 18; 6 each for beer, wine, and hard liquor), (b) cigarettes (n = 6), (c) food (n = 12), and (d) nonalcoholic beverages (n = 12). Within all categories, individual slides varied by setting (e.g., bar, restaurant, home, neutral background), and activity state (e.g., substance sitting untouched on table, held in hand, or actively consumed).

To minimize potential brand preference biases, brand names and identifying symbols were excluded to the extent possible. In cases where brand identifiers were unavoidably present, more than one brand of the substance was displayed (e.g., a refrigerator cooler containing many different brands of beer). To avoid contamination of reactivity to substance cues with reactions to affective information conveyed by people depicted with the substance, cues were displayed without human involvement whenever possible. When people were depicted along with a substance, facial expressions and body posture were kept neutral.

In addition, 12 affective cues (4 each representing pleasant, neutral, and unpleasant categories and not depicting substances) from the Internationally Affective Picture System (Lang, Bradley, & Cuthbert, 1999) were quasi-randomly interspersed for normative purposes. All slide types were distributed evenly across three slide trays. Within each tray, slides were presented in a quasi-random order such that there were never two of any category in a row, and a particular category was never systematically followed by the same other category.

Measures

Substance cue reactivity ratings. Approach, avoidance, and arousal ratings were obtained for each substance cue slide presentation. *Approach* was defined as *wanting to consume* the item depicted in the slide. *Avoidance* was defined as *wanting to avoid consuming* the item shown in the slide. Each dimension was rated on a 9-point scale with low and high anchors of *not at all* (0) and *very much* (8). Participants were told that the scales were to be regarded as independent of one another (Powell, Gray, & Bradley, 1993), and examples of possible response patterns across the two scales were part of the instructions. The order of presentation of rating scales for approach and avoidance was counterbalanced across slides.

The arousal item assessed the participants' feelings of calmness versus arousal in reacting to the slides. A 9-point scale, with *completely calm* and *completely aroused* as the extreme anchors and *neutral* as the midpoint, was used for these ratings.

Individual-difference questionnaires: Alcohol. At the conclusion of the cue-rating task, participants completed a series of individual-difference questionnaires. Participants provided information about alcohol usage patterns on an expanded version of the standard quantity/frequency/variability instrument of Cahalan, Cisin, and Crossley (1969), that probed average number of drinking occasions per week, average number of alcoholic beverages per drinking occasion, and typical frequency of consumption to intoxication.

Two measures of subjective craving for alcohol were included. The Alcohol Urge Questionnaire (Bohn, Krahn, & Staehler, 1995) is an 8-item craving index that includes items such as: "I want a drink so badly I can almost taste it." Items are rated on a 7-point Likert scale with *strongly disagree* (0) and *strongly agree* (6) as anchors. The Alcohol Confidence Questionnaire is a 16-item index of confidence in the ability to resist alcohol cravings adapted from the 42-item Situational Confidence Questionnaire (Annis & Davis, 1988), and it includes items such as: "I would be able to resist the urge to drink if I were at a party and other people were drinking." Items are rated on a 6-point Likert scale with *not at all confident* (0) and *very confident* (5) as anchors.

Desire to control or restrain alcohol consumption was assessed with a single item from the CAGE–C (Heck, 1991): "Have you ever felt the need to cut down on your drinking?"

The Alcohol Withdrawal Scale (Hesselbrock, Babor, Hesselbrock, Meyer, & Workman, 1983) was used to assess the frequency of nine common withdrawal symptoms on a 5-point Likert scale with *never* (0) and *almost every day* (4) as anchors.

The Young Adult Alcohol Problems Screening Test (Hurlbut & Sher, 1992) was used to assess the frequency of alcohol-related problems in the past year.

Individual-difference questionnaires: Cigarettes. One item asked participants to categorize themselves as "nonsmokers," "occasional smokers," or "daily smokers." In addition, number of cigarettes smoked per day, and time to first morning cigarette, were assessed with items from the Fagerström Test for Nicotine Dependence (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Time to first morning cigarette is a good predictor of biochemical indices of nicotine dependence and of successful smoking cessation (Heatherton et al., 1991).

Desire to control or restrain cigarette use was assessed with a single item: "Have you ever attempted to limit your smoking to less than you usually smoke?"

Stages of change (Prochaska, DiClemente, & Norcross, 1997) were assessed with one item. Participants categorized their current smoking behavior into one of the five stages of change: (a) precontemplation (not planning to quit at this time), (b) contemplation (currently smoking, but planning to quit), (c) action (currently making an effort to quit), (d) maintenance (have quit smoking and maintaining abstinence), and (e) relapse (had quit smoking, but have since resumed smoking).

Cigarette craving was assessed with the 26-item Questionnaire on Smoking Urges (Tiffany & Drobes, 1991),which yields a total smoking urge index that reflects mild intentions and desires to smoke, anticipation of pleasure or relief from negative affect and nicotine withdrawal, and urgent and overwhelming desires to smoke.

Procedure

A maximum of 24 participants were scheduled in each experimental session. Participants were seated with sufficient space between them to guarantee privacy when recording their responses. After informed consent was obtained, participants were told that the purpose of the study was to examine perceptions of visual stimuli associated with common habits, such as drinking, smoking, and eating. They were informed that there were no right or wrong answers. Honest and accurate responses were encouraged. Participants were then given two packets of materials. The first packet contained all materials necessary to complete the slide-rating task (sample rating page and rating sheets for the practice slides and substance cue slides). The second packet contained the individual-difference questionnaires. After distribution of these materials, the experimenter resumed reading of standardized instructions describing the slide rating procedure and providing an opportunity to practice samples of the rating task.

Before the slide-rating task began, participants were instructed to refrain from commenting about the slides and/or their ratings during the procedure to avoid the possibility of biasing others' ratings. Participants viewed the entire slide set with two brief pauses as slide trays were exchanged. Each slide viewing trial began with a 5-s presentation of a preparatory slide that served to focus participants' attention on the slide screen. Substance cue slides were each presented for 6 s, followed by a 45-s rating period. Participants typically finished their ratings within 30 s, leaving a relaxation period of about 15 s for them to clear their minds before the next preparatory slide signaled the conclusion of the current rating period. After the slide-rating task, participants completed the questionnaires.

Results

Reliability of Reactivity Ratings for Normative Appetitive Picture System (NAPS) Cues by Substance Category

The internal consistency of approach and avoidance ratings within each substance category was high, with Cronbach's alphas ranging from .89 to .97 for alcohol, .95 to .98 for cigarettes, .83 to .86 for food, and .75 to .76 for nonalcoholic beverages.

Specificity of Reactivity Ratings for NAPS Cues by Substance Use History

For analyses with alcohol as the preferred target substance, participants were grouped according to their routine alcohol use. There were 65 abstainers. The remaining participants were divided into two groups using a median split on self-reported number of alcoholic drinks consumed per week. One hundred fifty participants were classified as "light" drinkers (<6 drinks/week; $M = 1.73$, $SD = 1.54$, $Mdn = 1.25$), and 154 participants were classified as "heavy" drinkers (>6 drinks/week; $M = 21.37$, $SD = 17.65$, $Mdn = 16.00$; cf. Dufour, 1999).

For analyses with cigarettes as the preferred target substance, participants were grouped according to their current frequency of cigarette use. There were 260 nonsmokers. The remaining participants were divided into two groups based on whether they were occasional smokers (i.e., smoked less than daily; $n = 53$) or daily smokers ($n = 56$).

Arousal control analyses. To test the predicted Substance Use × Cue Type interaction (Hypothesis 1), we conducted two 3 × 3 mixed-model multivariate analyses of variance, one for each of the two preferred target substances, with the respective substance use groups as the between-groups factor and cue type as the within-participant factor.

Mean arousal ratings for alcohol, food, and nonalcoholic beverage cues by alcohol use group are presented in the top panel of Figure 1. As predicted, the Alcohol Use × Cue Type interaction was significant, $F(4, 730) = 21.28$, $p < .001$, $\eta^2 = .10$. Arousal ratings increased as a function of drinking experience only for alcohol cues, $F(2, 366) = 23.89$, $p < .001$, $\eta^2 = .12$, and there were no significant group differences in arousal ratings for the control cues: $F(2, 366) = 1.88$ for food cues and $F(2, 366) = 1.82$ for non-alcohol cues.

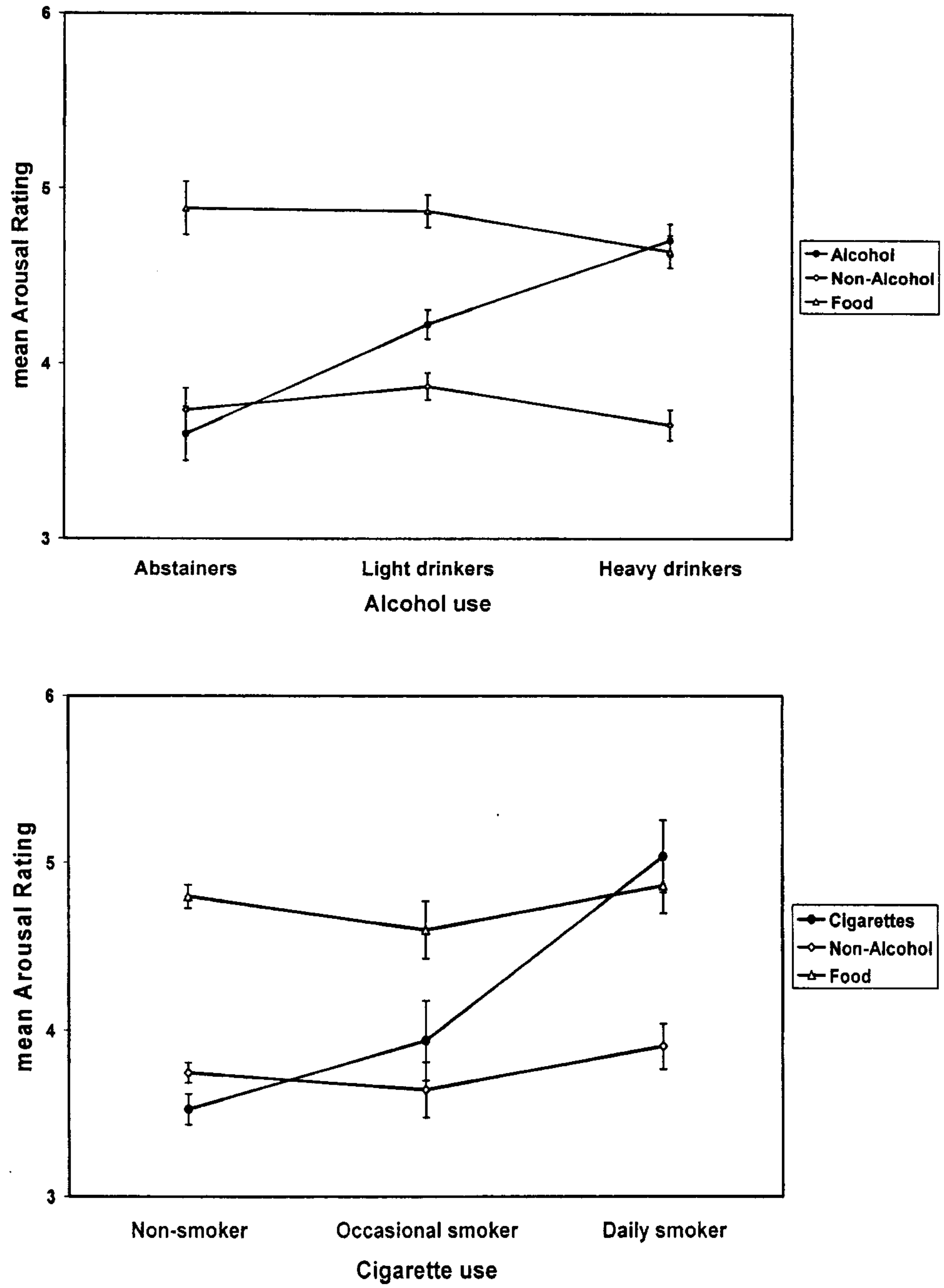

Figure 1. Specificity of arousal ratings by alcohol and cigarette use.

Mean arousal ratings for cigarette, food, and nonalcoholic beverage cues by cigarette use group are presented in the bottom panel of Figure 1. As predicted, the Cigarette Use × Cue Type interaction was significant, $F(4, 730) = 11.13$, $p < .001$, $\eta^2 = .06$. Arousal ratings increased as a function of smoking experience only for cigarette cues, $F(2, 366) = 22.48$, $p < .001$, $\eta^2 = .11$, and there were no group differences in arousal ratings for the control cues, all $Fs(2, 366) < 1$.

Approach and avoidance ratings. Mean approach and avoidance ratings for alcohol, cigarettes, food, and nonalcoholic beverage cues by alcohol use group are presented in the top panel of Figure 2. A significant Alcohol Use × Cue Type interaction was observed for approach ratings, $F(4, 730) = 71.30$, $p < .001$, $\eta^2 = .28$. Simple effect tests within each cue type revealed the predicted (Hypothesis 2) significant and large effect of alcohol use on approach ratings for alcohol cues, $F(2, 366) = 156.86$, $p < .001$, $\eta^2 = .46$, with increasing approach ratings associated with greater alcohol use. Alcohol use was also significantly related to approach ratings for nonalcoholic beverages, $F(2, 366) = 3.10$, $p < .05$, but the magnitude of this effect was very small ($\eta^2 = .02$) compared

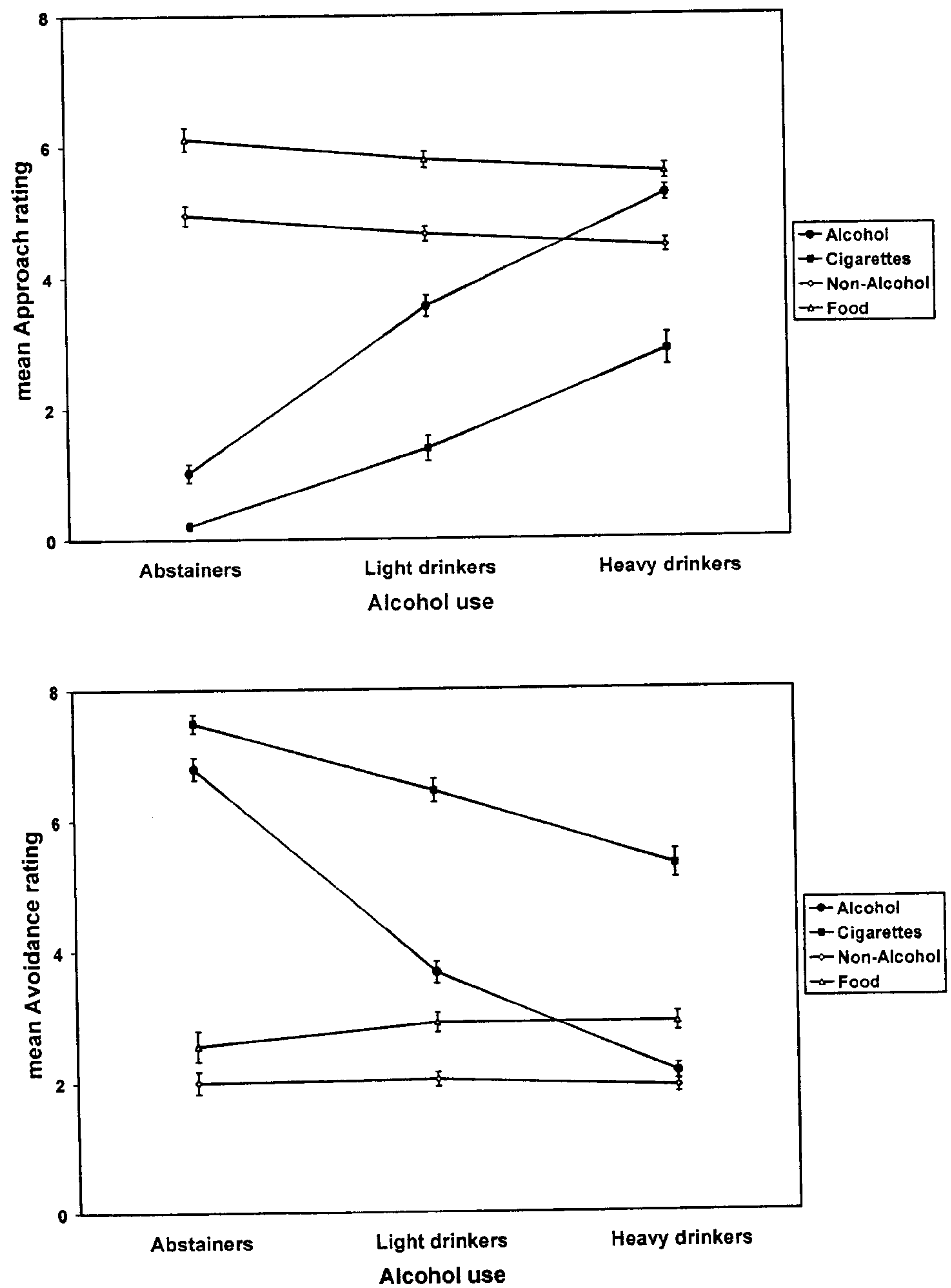

Figure 2. Specificity of approach and avoidance ratings by alcohol use.

to that for alcohol cues. Moreover, the trend here was in the opposite direction, with reactivity to nonalcoholic beverages declining as alcohol use experience increased. There was no significant effect of alcohol use on approach ratings for food cues.

A comparable pattern of results was found for avoidance ratings, also consistent with Hypothesis 2 (see Figure 2, bottom panel). The Alcohol Use × Cue Type interaction was again significant, $F(4, 730) = 69.96$, $p < .001$, $\eta^2 = .28$. Follow-up analyses revealed the predicted significant effect of alcohol use on avoidance ratings for alcohol cues, $F(2, 366) = 165.08$, $p < .001$, $\eta^2 = .47$, with decreasing avoidance ratings associated with greater alcohol use. There were no significant effects of alcohol use on avoidance ratings for either food cues or nonalcoholic beverage cues.

Figure 3 presents the mean approach (top panel) and avoidance (bottom panel) ratings for alcohol, cigarette, food, and nonalcoholic beverage cues by cigarette use group, which further substantiate Hypothesis 2. A significant Cigarette Use × Cue Type interaction was observed for approach ratings, $F(4, 730) = 120.85$, $p < .001$, $\eta^2 = .40$. Follow-up simple effect tests revealed the

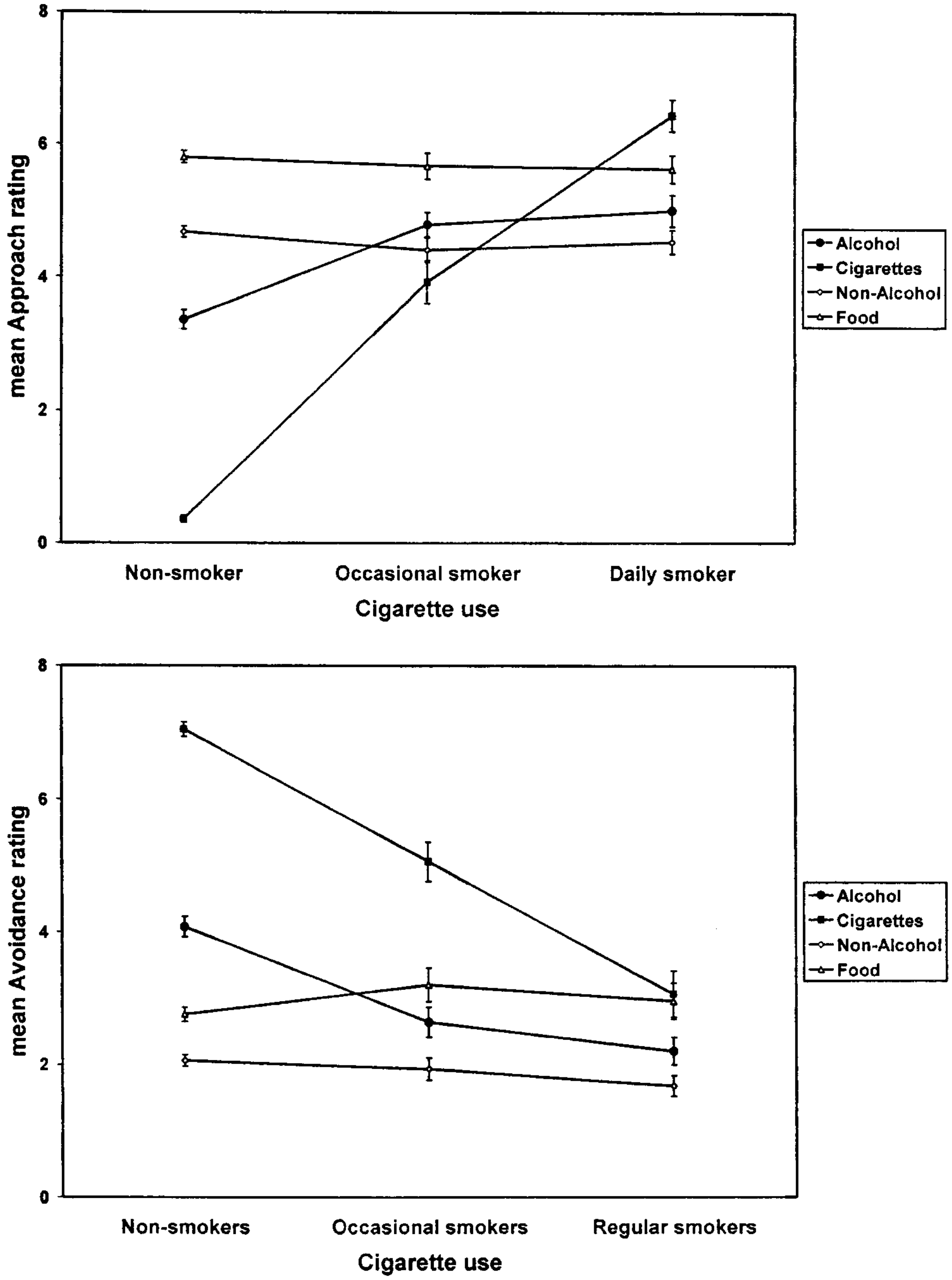

Figure 3. Specificity of approach and avoidance ratings by cigarette use.

predicted large, significant effect of cigarette use on approach ratings for cigarette cues, $F(2, 366) = 541.36, p < .001, \eta^2 = .75$, with increasing approach ratings associated with greater cigarette use. There were no significant effects of cigarette use on approach ratings for either food cues or nonalcoholic beverage cues.

An analogous pattern of results was obtained for avoidance ratings. The Cigarette Use × Cue Type interaction was again significant, $F(4, 730) = 41.06, p < .001, \eta^2 = .18$. Follow-up analyses revealed the predicted significant effect of cigarette use on avoidance ratings for cigarette cues, $F(2, 366) = 102.76, p < .001, \eta^2 = .36$, with decreasing avoidance ratings associated with greater cigarette use. There were no significant effects of cigarette use on avoidance ratings for either food or nonalcoholic beverage cues.

Cross-over response analyses. To test Hypothesis 3—that members of each substance use group will show greater reactivity to the drug cues specific to the type of drug (i.e., alcohol or cigarettes) defining their group membership than to cues for the other drug—we conducted a series of 3 × 2 (Substance Use Group × Cue Type) mixed-model multivariate analyses of variance, with substance use group as the between-groups factor and cue type as the within-subject factor. Mean approach and avoidance ratings for the respective cross-over cues appear in Figures 2 and 3.

As predicted, the Alcohol Use Group × Cue Type interaction for approach ratings was significant, $F(2, 366) = 7.66, p < .01, \eta^2 = .04$. This result indicates that the simple effect of alcohol use group on approach ratings was significantly larger for alcohol cues ($\eta^2 = .46$) than for cigarette cues ($\eta^2 = .14$). Analysis of avoidance ratings, in which the Alcohol Use Group × Cue Type interaction was significant as well, $F(2, 366) = 24.70, p < .001, \eta^2 = .12$, demonstrated that the simple effect of alcohol use group on avoidance ratings was significantly larger for alcohol cues ($\eta^2 = .47$) than for cigarette cues ($\eta^2 = .11$).

Similarly, the Cigarette Use Group × Cue Type interaction for approach ratings was significant, $F(2, 366) = 91.88, p < .001, \eta^2 = .07$, meaning that the simple effect of cigarette use group on approach ratings was significantly larger for cigarette cues ($\eta^2 = .75$) than for alcohol cues ($\eta^2 = .10$). A significant Cigarette Use Group × Cue Type interaction for avoidance cues yielded analogous results for avoidance cues, $F(2, 366) = 16.93, p < .001, \eta^2 = .09$, with a simple effect of cigarette use group on avoidance ratings that was significantly larger for cigarette cues ($\eta^2 = .36$) than for alcohol cues ($\eta^2 = .10$).

Criterion-Related Validity of Multidimensional Reactivity Ratings for NAPS Cues

Examination of the relationship between reactivity ratings for these cues and individual-difference measures assessing experiences with alcohol and cigarette use provided criterion validation of the NAPS cues. We performed regression analyses separately for each substance-related measure, with each measure regressed onto both approach and avoidance ratings. Semipartial correlation coefficients for approach and avoidance ratings provided an index of their unique contribution to the prediction of each substance-related measure (Hypothesis 4). We conducted analyses of quantity and frequency of substance use on the entire sample (including nonusers), whereas we restricted analyses of substance-related experiences (craving, withdrawal symptoms, etc.) to participants who reported current substance use ($n = 304$ for alcohol, $n = 109$ for cigarettes).

Alcohol. Results from the regression analyses examining correlates of alcohol approach and avoidance ratings are presented in Table 1. Semipartial correlation coefficients for approach ratings showed that greater report of approach reactivity to alcohol cues was associated with greater report of alcohol usage, craving, withdrawal symptoms, alcohol-related problems, and desire for restraint of use. In addition, semipartial correlation coefficients for avoidance ratings revealed that greater report of avoidance reactivity was associated with greater report of restraint and lower report of alcohol use.

Cigarettes. Comparable results were obtained for correlates of cigarette approach and avoidance ratings (see Table 1). Greater report of approach reactivity to cigarette cues was associated with greater report of cigarette usage, craving, desire for restraint, and dependence. In addition, after controlling for approach reactions,

Table 1
Semipartial Correlation Coefficients From Regressions of Alcohol and Cigarette Experience Measures on Approach and Avoidance Ratings

Dependent measure	Approach	Avoidance
Alcohol use		
Usage (N = 369)		
Drinks per occasion	.24***	−.18***
Frequency of use	.25***	−.15***
Frequency of intoxication	.22***	−.16***
Craving		
Alcohol Urges Questionnaire (N = 124)	.24**	.00
Alcohol Confidence Questionnaire (N = 304)	−.25***	.00
Restraint/ambivalence (N = 304)		
Alcohol use restraint	.16**	.12*
Withdrawal/problems (N = 304)		
Alcohol Withdrawal Scale	.24***	−.01
YAAPST	.29***	−.06
Cigarette use		
Usage (N = 369)		
No. daily cigarettes smoked	.59***	−.10***
Frequency of use	.63***	−.09***
Craving (N = 59)		
QSU total	.64***	−.21*
Restraint/ambivalence (N = 109)		
Cigarette use restraint	.33***	.18*
Dependence (N = 109)		
Time to first cigarette	−.23**	.19*

Note. This table contains semipartial correlation coefficients from simultaneous regressions of specific substance use measures on approach and avoidance ratings for alcohol cues (top section) and cigarette cues (bottom section). Semipartial correlations for each rating variable represent the unique relationship of that rating controlling for the other rating variable in the model. Squaring these coefficients provides the increase in R^2 associated with adding this rating variable to the model already containing the other. Reduced samples were available for the Alcohol Urge Questionnaire and Questionnaire on Smoking Urges (QSU), which were added to the test battery after the start of the study. YAAPST = Young Adult Alcohol Problems Screening Test.
* $p < .05$. ** $p < .01$. *** $p < .001$.

greater report of avoidance reactivity predicted a decrease in cigarette usage and craving and an increase in desire for restraint.

Examination of the Multidimensional "Reactivity Space"

After confirming that approach and avoidance reactivity made independent contributions to the prediction of several indices of substance use and associated experiences, we examined the reactivity space formed by the coordinates representing these separate dimensions of approach and avoidance reactivity. Among individuals reporting current alcohol use, approach and avoidance ratings for alcohol cues were significantly correlated ($r = -.62$). Among current smokers, a smaller correlation between approach and avoidance ratings for cigarette cues was observed ($r = -.39$). By dividing each rating scale at its numeric center, individuals can be categorized into one of four reactivity profiles: (a) approach (high approach, low avoidance), (b) ambivalent (high approach, high avoidance), (c) avoidant (low approach, high avoidance), or (d) indifferent (low approach, low avoidance). An important difference in the pattern of reactivity profiles emerged when the two high substance use groups (i.e., heavy alcohol drinkers and daily smokers) were compared. Among heavy alcohol drinkers, 70.1% were in the approach quadrant, and only 6.5% were in the ambivalent quadrant. In contrast, although there was a comparable proportion (67.9%) of daily smokers in the approach quadrant, a much larger proportion (25.0% versus 6.5%) fell in the ambivalent quadrant.

Stages of change as a function of reactivity profile for cigarette cues. There were significant differences in the relative representation of individuals within the five stages of change across the four reactivity profiles for cigarette cues, $\chi^2(12, N = 129) = 66.12$, $p < .001$ (see Table 2). Consistent with Hypothesis 5, among high-approach participants, half of those with an ambivalent profile reported behavior consistent with the action stage, whereas less than one fourth of those with an approach profile did so.

Discussion

Responses to drug cues are complex and multidetermined; hence, it is not surprising that cue reactivity research represents a creative medley of methods to elicit and measure responses to relevant target cues. Unfortunately, mismanagement of this diversity, especially in the absence of adequate accounting of contextual information, can limit the meaningful inferences one can draw from aggregated cue reactivity data (Carter & Tiffany, 1999). Thus, in the present study we applied a rigorous set of design features in an effort to establish the reliability and specificity of standard sets of visual cues for two commonly abused substances in the hope of providing a means for better cross-study comparisons in the future. We also sought to test the incremental validity in cue reactivity assessment that could accrue from incorporation of an emergent conceptual framework for craving that regards cue reactivity as a multidimensional phenomenon involving both approach and avoidance inclinations (Breiner et al., 1999).

We selected a single sensory modality (viz., vision) for cue presentation and held it constant across cue categories and individuals to minimize extraneous variability in the cognitive, behavioral, and physiological changes that would otherwise be associated with more diverse task demands. This had the benefit of reducing "noise" in reactivity patterns that accompany the processing of compound cues presented in multiple modalities, and hence it increased the reliability of our assessment of cue reactions. It should be noted at the outset, however, that this gain in control over contextual noise might arguably have been achieved at the cost of diminishing ecological validity, typically assumed to be maximized during *in vivo* cue exposure. Yet this assumption warrants some scrutiny. Consider, for example, that during a typical *in vivo* alcohol cue exposure, participants might sit in the presence of a research assistant who follows a standardized script, instructing them to hold and smell a drink for 3 min without being allowed to consume it (cf. Petrakis et al., 2001). Alternatively, a glass containing alcohol might be "placed on an adjustable table such that it rested directly under the participant's nose" (p. 100; Saladin et al., 2002). The decidedly "non-naturalistic" features of such manipulations suggest that the mere presence of an *in vivo* cue does not necessarily ensure that the experience will closely mirror real-life cue exposure situations. In contrast, the group context of cue exposure used in the present study may better capture the social nature of many naturalistic drinking situations. Moreover, it is noteworthy that the beer industry alone spent $3.48 billion on advertising between 1995 and 1999 (Center for Science in the Public Interest, 2000), mostly to make alcohol cues visibly ubiquitous in everyday contexts. On reflection then, there may be reason to question whether potent visual cues have any less ecological validity than a glass of beer wedged between a tray and a lonely participant's nose. The point is that each approach has its assets and liabilities in ecological terms, suggesting that perhaps greater attention should be focused on reliability estimates and criterion-related validity can be established.

The internal consistency of our visual cue sets for the alcohol and cigarette categories was very high, and the reliabilities for the comparison cue sets was also good. High *reliability* in the assessment of cue reactivity is particularly important when sample sizes have to be kept small. For instance, the high cost of investigating cue reactivity via functional imaging methods in clinical samples is typically limited to relatively small samples (e.g. George et al., 2001), thereby placing a premium on reliability.

Table 2
Distribution of Stage of Change Across Four Cigarette Cue Reactivity Profiles

	Cigarette cue reactivity profile			
Stage of change	Approach	Ambivalent	Avoidant	Indifferent
Precontemplation	7.5 (14)	0.0 (0)	12.8 (5)	38.5 (5)
Contemplation	31.4 (16)	26.9 (7)	7.7 (3)	7.7 (1)
Action	23.5 (12)	50.0 (13)	12.8 (5)	0.0 (0)
Maintenance	7.8 (4)	7.7 (2)	64.1 (25)	53.8 (7)
Relapse	9.8 (5)	15.4 (4)	2.6 (1)	0.0 (0)
All	100.0 (51)	100.0 (26)	100.0 (39)	100.0 (13)

Note. Table values are percentile and frequency (in parentheses) distributions of stage of change for each of the four cigarette cue reactivity profiles.

In addition to establishing the reliability of our visual substance cue sets, their *specificity* in eliciting response patterns unique to a particular target substance was demonstrated by triangulating the effects of drug use histories across appropriate control cues for substances that have no psychoactive effects, as well as across control cues for different psychoactive substances. Our arousal-control analyses confirmed that differences in reactivity to substance cues among groups varying in self-reported levels of use of that substance were not due to differences in reactivity to arousing cues in general. Results were also consistent with our hypothesis that approach and avoidance reactivity to cues of the preferred substance should differ as a function of self-reported levels of use of alcohol and cigarettes, respectively, but that there should be no significant differences as a function of substance use in reactivity to cues of the nondrug control substances. Finally, the cross-over response analyses showed that, when reactivity to cues of two different drugs was compared, the effect sizes for differences between groups as a function of prior use history were greatest for cues depicting the drug used to define the level of target substance use within the respective groups. Thus, the specificity of responses to these cue sets proved to be robust even when evaluated in the common context where there is a history of concurrent use of more than one substance.

Of course, adoption of the arousal-control and cross-over design criteria may not be sufficient to attribute differences in cue reactivity to conditioning processes, and it is also evident that a conditioning-based mechanism is only one of the alternative explanations that could account for cue exposure effects (Drummond et al., 1995). If the role of conditioning mechanisms is of interest, experimenter control over the actual conditioning history of participants would be desirable (e.g., Lazev, Herzog, & Brandon, 1999). However, if that is not feasible, the above design criteria should be incorporated in studies designed to infer differences in cue reactivity as a function of drug use history.

We also examined a fundamental conceptual issue bearing on the validity of inferences made from cue reactivity results. A number of researchers have speculated that the failure to assess avoidance inclinations as a complement to the typical evaluation of approach reactivity may oversimplify the complex constellation of approach and avoidance behaviors, including ambivalence, that can be elicited by drug cues (e.g., Duka et al., 2002; Glautier & Remington, 1995; Greeley et al., 1993; Newlin et al., 1989; Powell et al., 1993). Cognitive-processing accounts of cue responding (Tiffany, 1990), as well as motivational theories of drug use (Heather, 1998), maintain that individuals attempting to refrain from drug use while experiencing activation of concurrent approach inclinations should experience an approach–avoidance conflict characterized by ambivalence. Hence, Breiner et al. (1999) recently proposed that cue reactivity might be better conceptualized as the *relative* activation of substance-directed response dispositions that can be operationalized within an evaluative reactivity space formed by the coordinates of independent approach and avoidance dimensions. In this connection, Tiffany (1990) suggested that if individuals "were prompted, they might be able to provide some description regarding the cognitive processing they are undertaking to *avoid* [italics added] drug use" (p. 158). Accordingly, in the present study we had participants make independent reports of both their approach and their avoidance reactivity.

Consistent with our fourth hypothesis, semipartial correlation coefficients showed that avoidance reactivity contributed incrementally to the explained variance in measures of alcohol and cigarette use. It is noteworthy that both reactivity dimensions jointly predicted restraint, and hence ambivalence, toward alcohol and cigarette use. Furthermore, correlations between approach and avoidance reactions were not high enough for them to be considered simply reciprocals of each other. Taken together, these findings support the validity of conceptualizing cue reactivity as a complex event best indexed by multidimensional assessment.

Further support for a multidimensional conceptualization was evident in connection with Hypothesis 5. Avoidance reactivity to cigarette cues, when elicited concurrently with high approach reactivity (i.e., reflecting an ambivalent reactivity profile) was most strongly associated with the action stage of readiness to change. Indeed, none of the individuals with ambivalent reactivity profiles endorsed the item stating "I am not thinking about or planning to quit smoking at the present time," and all of them reported being either in preparation for, or actively engaged in, a change of their cigarette use behavior. Thus, the joint consideration of approach and avoidance reactivity allowed for the parsing of the evaluative reactivity space into regions representing distinct reactivity profiles that differentially predict readiness to change.

In contrast to the smoking data, the hypothesized positive relationship between avoidance ratings and self-reports of both alcohol problems and desire to change them was not significant. This apparently discrepant finding is easily understood in terms of limitations of our sample, which was composed of relatively young and high-functioning individuals whose histories of alcohol-related problems were probably too short to have become reliably associated with cue-elicited avoidance reactivity. Indeed, there is evidence of as much as a 10-year delay between the onset of drinking problems and treatment seeking (Schuckit, Anthenelli, Bucholz, Hesselbrock, & Tipp, 1995), and more than two thirds of heavy-drinking college students do not recognize a need to change their drinking behavior despite experience of noteworthy alcohol-related problems (Vik, Culbertson, & Sellers, 2000). Thus, where alcohol is concerned, it would be important to test whether avoidance reactivity in treatment seekers who are struggling to reduce or eliminate alcohol use would parallel the predicted pattern we found in the smoking data from this study.

The visual cue paradigm developed in the present study offers an empirically based opportunity for progress via greater standardization of methods used in the assessment of substance cue reactivity. Although further work with other samples and substances is needed to better evaluate the reliability, specificity, and validity of the paradigm and determine how well it generalizes, the existing data are promising and lend support to recent theorizing that assessment of cue reactivity should be multidimensional to account for the capacity of substance cues to elicit both approach and avoidance behaviors.

References

Alsene, K. M., Li, Y., Chaverneff, F., & de Wit, H. (2003). Role of abstinence and visual cues on food and smoking craving. *Behavioural Pharmacology, 14,* 145–151.

Annis, H. M., & Davis, C. S. (1988). Assessment of expectancies. In D.

Donovan & A. G. Marlatt (Eds.), *Assessment of addictive behaviors* (pp. 84–111). New York: Guilford Press.

Avants, K. S., Margolin, A., Kosten, T. R., & Cooney, N. L. (1995). Differences between responders and nonresponders to cocaine cues in the laboratory. *Addictive Behaviors, 20,* 215–224.

Bohn, M. J., Krahn, D. D., & Staehler, B. A. (1995). Development and initial validation of a measure of drinking urges in abstinent alcoholics. *Alcoholism: Clinical & Experimental Research, 19,* 600–606.

Bradley, B. P., Mogg, K., Wright, T., & Field, M. (2003). Attentional bias in drug dependence: Vigilance for cigarette-related cues in smokers. *Psychology of Addictive Behaviors, 17,* 66–72.

Breiner, M. J., Stritzke, W. G. K., & Lang, A. R. (1999). Approaching avoidance: A step essential to the understanding of craving. *Alcohol Research & Health, 23,* 197–206.

Cacioppo, J. T., & Berntson, G. G. (1994). Relationship between attitudes and evaluative space: A critical review, with emphasis on the separability of positive and negative substrates. *Psychological Bulletin, 115,* 401–423.

Cahalan, D., Cisin, I. H., & Crossley, H. M. (1969). *American drinking practices: A national study of drinking behavior and attitudes.* Monographs of the Rutgers Center of Alcohol Studies, No. 6, New Brunswick, NJ: College & University Press.

Carter, B. L., & Tiffany, S. T. (1999). Meta-analysis of cue-reactivity in addiction research. *Addiction, 94,* 327–340.

Center for Science in the Public Interest. (2000). *Beer industry advertising expenditures, 1995–1999.* Retrieved January, 6, 2003, from http://www.cspinet.org/booze/A-B_Campaign.html

Demmel, R., & Schrenk, J. (2003). Sensory evaluation of alcohol-related and neutral stimuli: Psychophysical assessment of stimulus intensity. *Addictive Behaviors, 28,* 353–360.

Drobes, D. J. (2002). Cue reactivity in alcohol and tobacco dependence. *Alcoholism: Clinical and Experimental Research, 26,* 1928–1929.

Drobes, D. J., & Tiffany, S. T. (1997). Induction of smoking urge through imaginal and *in vivo* procedures: Physiological and self-report manifestations. *Journal of Abnormal Psychology, 106,* 15–25.

Drummond, D. C., Tiffany, S. T., Glautier, S., & Remington, B. (Eds.). (1995). *Addictive behaviour: Cue exposure theory and practice.* Chichester, England: Wiley.

Dufour, M. C. (1999). What is moderate drinking: Defining "drinks" and drinking levels. *Alcohol Research & Health, 23,* 5–14.

Duka, T., Townshend, J. M., Collier, K., & Stephens, D. N. (2002). Kindling of withdrawal: A study of craving and anxiety after multiple detoxifications in alcoholic patients. *Alcoholism: Clinical and Experimental Research, 36,* 785–795.

George, M. S., Anton, R. F., Courtnay, B., Teneback, C., Drobes, D. J., Lorberbaum, J. P., et al. (2001). Activation of prefrontal cortex and anterior thalamus in alcoholic subjects on exposure to alcohol-specific cues. *Archives of General Psychiatry, 58,* 345–352.

Glautier, S., Drummond, D. C., & Remington, B. (1992). Different drink cues elicit different physiological responses in non-dependent drinkers. *Psychopharmacology, 106,* 550–554.

Glautier, S., & Remington, D. C. (1995). The form of responses to drug cues. In D. C. Drummond, S. T. Tiffany, S. Glautier, & B. Remington (Eds.), *Addictive behaviour: Cue exposure theory and practice* (pp. 21–46). Chichester, England: Wiley.

Greeley, J. D., Swift, W., & Heather, N. (1993). To drink or not to drink? Assessing conflicting desires in dependent drinkers in treatment. *Drug and Alcohol Dependence, 32,* 169–179.

Heather, N. (1998). A conceptual framework for explaining drug addiction. *Journal of Psychopharmacology, 12,* 3–7.

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerström, K. O. (1991). The Fagerström Test for Nicotine Dependence: A revision of the Fagerström Tolerance Questionnaire. *British Journal of Addiction, 86,* 1119–1127.

Heck, E. J. (1991). Developing a screening questionnaire for problem drinking in college students. *Journal of American College Health, 39,* 227–231.

Hesselbrock, M., Babor, T. F., Hesselbrock, V., Meyer, R. E., & Workman, K. (1983). "Never believe an alcoholic"? On the validity of self-report measures of alcohol dependence and related constructs. *International Journal of the Addictions, 18,* 593–609.

Hurlbut, S. C., & Sher, K. J. (1992). Assessing alcohol problems in college students. *Journal of American College Health, 41,* 49–58.

Kambouropoulos, N., & Staiger, P. K. (2001). The influence of sensitivity to reward on reactivity to alcohol-related cues. *Addiction, 96,* 1175–1185.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). *International Affective Picture System (IAPS): Instruction manual and affective ratings.* Gainesville: Center for Research in Psychophysiology, University of Florida.

Lazev, A. B., Herzog, T. A., & Brandon, T. (1999). Classical conditioning of environmental cues to cigarette smoking. *Experimental and Clinical Psychopharmacology, 7,* 56–63.

McCaul, M. E., Turkkan, J. S., & Stitzer, M. L. (1989). Psychophysiological effects of alcohol-related stimuli: I. The role of stimulus intensity. *Alcoholism: Clinical and Experimental Research, 13,* 386–391.

McDonough, B. E., & Warren, C. A. (2001). Effects of 12-h tobacco deprivation on event-related potentials elicited by visual smoking cues. *Psychopharmacology, 154,* 282–291.

Newlin, D. B., Hotchkiss, B., Cox, W. M., Rauscher, F., & Li, T.-K. (1989). Autonomic and subjective responses to alcohol stimuli with appropriate control stimuli. *Addictive Behaviors, 14,* 625–630.

Palfai, T. P. (2001). Individual differences in temptation and responses to alcohol cues. *Journal of Studies on Alcohol, 62,* 657–666.

Payne, T. J., Rychtarik, R. G., Rappaport, N. B., Smith, P. O., Etscheidt, M., Brown, T. A., & Johnson, C. A. (1992). Reactivity to alcohol-relevant beverage and imaginal cues in alcoholics. *Addictive Behaviors, 17,* 209–217.

Petrakis, I. L., Trevisan, L., Boutros, N. N., Limoncelli, D., Cooney, N. L., & Krystal, J. H. (2001). Effect of tryptophan depletion on alcohol cue-induced craving in abstinent alcoholic patients. *Alcoholism: Clinical and Experimental Research, 25,* 1151–1155.

Piasecki, T. M., Smith, S. S., & Baker, T. B. (1999). Comments on Carter & Tiffany's "Meta-Analysis of Cue-Reactivity in Addiction Research." *Addiction, 94,* 341–342.

Powell, J., Gray, J., & Bradley, B. (1993). Subjective craving for opiates: Evaluation of a cue exposure protocol for use with detoxified opiate addicts. *British Journal of Clinical Psychology, 32,* 39–53.

Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1997). In search of how people change: Applications to addictive behaviors. In G. A. Marlatt & G. R. VandenBos (Eds.), *Addictive behaviors: Readings on etiology, prevention, and treatment* (pp. 671–696). Washington, DC: American Psychological Association.

Robbins, S. J., & Ehrman, R. N. (1992). Designing studies of drug conditioning in humans. *Psychopharmacology, 106,* 143–153.

Saladin, M. E., Drobes, D. J., Coffey, S. F., & Libet, J. M. (2002). The human startle reflex and alcohol cue reactivity: Effects of early versus late abstinence. *Psychology of Addictive Behaviors, 16,* 98–105.

Sayette, M. A., Martin, C. S., Hull, J. G., Wertz, J. M., & Perrott, M. A. (2003). Effects of nicotine deprivation on craving response covariation in smokers. *Journal of Abnormal Psychology, 112,* 110–118.

Sayette, M. A., Shiffman, S., Tiffany, S. T., Niaura, R. S., Martin, C. S., & Shadel, W. G. (2000). The measurement of drug craving. *Addiction, 95*(Suppl. 2), 189–210.

Schuckit, M. A., Anthenelli, R. M., Bucholz, K. K., Hesselbrock, V. M., &

[redacted]

Tipp, J. (1995). The time course of development of alcohol-related problems in men and women. *Journal of Studies on Alcohol, 56,* 218–225.

Shiffman, S., Shadel, W. G., Niaura, R., Khayrallah, M. A., Jorenby, D. E., Ryan, C. F., & Ferguson, C. L. (2003). Efficacy of acute administration of nicotine gum in relief of cue-provoked cigarette craving. *Psychopharmacology, 166,* 343–350.

Staiger, P. K., & White, J. M. (1991). Cue reactivity in alcohol abusers: Stimulus specificity and extinction of the responses. *Addictive Behaviors, 16,* 211–221.

Stewart, J. (1999). Thoughts on the interpretation of responses to drug-related stimuli. *Addiction, 94,* 344–346.

Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behavior: Role of automatic and nonautomatic processes. *Psychological Review, 97,* 147–168.

Tiffany, S. T. (1992). A critique of contemporary urge and craving research: Methodological, psychometric, and theoretical issues. *Advances in Behaviour Research and Therapy, 14,* 123–139.

Tiffany, S. T., & Drobes, D. J. (1991). The development and initial validation of a questionnaire of smoking urges. *British Journal of Addiction, 86,* 1467–1476.

Townsend, J. M., & Duka, T. (2001). Attentional bias associated with alcohol cues: Differences between heavy and occasional social drinkers. *Psychopharmacology, 157,* 67–74.

Vik, P. W., Culbertson, K. A., & Sellers, K. (2000). Readiness to change drinking among heavy-drinking college students. *Journal of Studies on Alcohol, 61,* 674–680.

Received February 12, 2003
Revision received July 30, 2003
Accepted July 31, 2003 ■